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Effects of Nonfiction Guided Interactive Read-Alouds and Think-Alouds on Fourth Grader's Depth of Content Area Science Vocabulary Knowledge and Comprehension

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by

Tania Tamara Hanna

A Dissertation
Submitted to the Graduate Studies Office
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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ABSTRACT

EFFECTS OF NONFICTION GUIDED INTERACTIVE READ-ALOUDS AND THINK-ALOUDS FOR FOURTH GRADER'S DEPTH OF CONTENT AREA SCIENCE VOCABULARY KNOWLEDGE AND COMPREHENSION

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Effects of nonfiction guided interactive read-alouds and think-alouds as a supplement to basal science textbooks on three vocabulary measures, definitions, examples, and characteristics, and one multiple-choice comprehension measure were assessed for 127 fourth graders over three time periods: pretest, posttest, and a 2-week delayed posttest. Two of three fourth-grade elementary science teachers implemented a series of 12 content-enhanced guided interactive scripted lessons. Two of these teachers implemented two treatments each. The first condition employed basal science textbooks as the text for guided interactive read-alouds and think-alouds while the second treatment employed basal science textbooks in conjunction with nonfiction text sets as the texts for guided interactive read-alouds and think-alouds. The third teacher, guided by traditional lesson plans, provided students with silent independent reading instruction using basal science textbooks. Multivariate analyses of variance and analyses of variance tests showed that mean scores for both treatment groups significantly improved on definitions and characteristics measures at posttest and either stabilized or slightly declined at delayed posttest. The treatment-plus group lost considerably on the examples posttest measure. The treatment group improved mean scores on the examples posttest measure, outperforming the treatment-plus group and the control group. Alternately, the control group significantly improved on the delayed posttest examples measure. Additionally, the two groups implementing guided interactive read-alouds and think-alouds performed better than the independent reading group on multiple-choice comprehension measures at posttest and sustained those gains 2 weeks later on delayed posttests. Findings maintain the incremental nature of vocabulary acquisition and development research and emphasize the roles of listening and speaking as critical features for integrating vocabulary into long-term memory.

DEDICATION

To Mary Kate (Katye), John Isaac, and Meagan (Meg), and to the children who just want to know why.

ACKNOWLEDGMENTS

When I began this educational journey some 17 years ago, little did I know that my years of teaching a wide range of grades would work together to prepare me to be the mother of triplets and a teacher of teacher. It is fitting and appropriate that I should offer deep appreciation and a grateful heart to those who have come along side to help make this moment possible. To Dr. Ellen Ramp, Dr. Beth Richmond, Dr. Janet Boyce, Dr. Sandee Manning, Dr. Kathy York, and Alex O'Neal, sometimes words are not enough. Ellen's consistent proactive problem-solving approach to life, Beth's ongoing moral and professional support, Janet's stability and organization, Sandee's heartfelt transparency, Kathy's unwavering encouragement, and Alex's incredible patience and endurance have all served as pillars of strength on a very long journey. Each of you has touched my life in immeasurable ways.

To my grandmother, who at the age of 93 modeled the value of purpose and encouraged me to "always have a vision" and who—with only an eighth-grade education—taught me to "make pictures in my head." Your legacy is alive and well.

To my mother, thank you for the practical gift of time and your heart to help when you could.

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CHAPTER I

INTRODUCTION

This introductory chapter provides rationale for vocabulary acquisition and development research and any subsequent effects on comprehension by establishing the theoretical frameworks surrounding vocabulary acquisition and development research. A substantial corpus of pertinent research will follow, providing a foundational infrastructure from which this study was constructed. A second section will offer a statement regarding the problem, raised research questions, and hypothesized expectations. To better understand the major components of this study, terms central to the research will be defined. Additionally, this section acknowledges voluntary delimitations and notes relative assumptions. A final section justifies the necessity of the study, how it might integrate into existing literature, and proposes potential benefits.

The National Reading Panel (NRP), after review and preponderance of an elite sampling of experimental and quasi-experimental studies, concluded that a foundational component of reading comprehension is vocabulary acquisition and development (National Institute of Child Health and Human Development [NICHD], 2000). While the relationship of vocabulary to comprehension has long been recognized as one of mutual dependence, evidence to support a cause-and-effect relationship has been sparse (NRP, 2000). The complexities associated with vocabulary acquisition and development cross disciplines, creating many pedagogical and research conundrums (Graves, 2006; Nagy, 2004; Stahl & Fairbanks, 1986).

Consequently, answers to theoretically challenging questions are addressed herein only as they inform teaching and learning. Beck and McKeown (1991), Graves (2006), and Nagy (2004) proposed foundational questions regarding the role of vocabulary teaching and learning. Answers to these underlying questions that influence instructional decisions and outcomes, especially in content areas (Beck & McKeown, 1991; Graves, 2006; Nagy, 2004) are as follows:

1. What does it mean to know a word?
2. How does one assess depth of vocabulary knowledge?
3. How important is it to know words deeply?
4. Should words be taught directly or indirectly?
5. What are the best conditions for learning vocabulary?
6. What is the impact of vocabulary instruction on comprehension?

This study considered the complexities associated with these questions as they related to the acquisition and development of depth of technical science vocabulary and any subsequent effect on comprehension.

A universal criticism from middle and secondary teachers is that they find their students unable to keep pace with the demands of content-specific texts where concept-dense and technical vocabulary is frequently encountered (Harmon, Hedrick, & Wood, 2005). A small-scale example of this global phenomenon was represented in Chall, Jacobs, and Baldwin's (1990) 2-year longitudinal study. Using six different assessment measures, this study tracked vocabulary and comprehension skills and abilities of poor children in Grades 2, 4, and 6 and subsequent Grades 4, 6, and 8. These students' vocabulary scores began a downward spiral around the fourth grade.

Declining scores on vocabulary measures were the first and strongest indications of comprehension difficulties (Chall et al., 1990). What was true for those students also remains a recognized concern for the general population of fourth-grade students across the nation. Chall et al. (1990) proposed that this fourth-grade slump phenomenon correlates with demands of content-area reading. Chall et al. (1990) hypothesized that there is an increased likelihood of students' encountering unfamiliar words given the vocabulary in content areas is fairly specific to the discipline in which it occurs (Chall et al., 1990; Fang, 2006). Additionally, other studies point out that content-area science texts, in particular, require requisite knowledge of technical vocabulary terms and concepts (Fang, 2006; Williams et al., 2005). Moreover, Williams et al. (2005) contend that elementary school basal science textbooks contain abstract ideas and are written using multiple text structures, often within the same paragraph. One must consider these issues along with unfamiliarity and infrequent use of science vocabulary to fathom the obstacles students and teachers must navigate to be successful with content-area learning. Traditionally, it is not until the chasm between vague vocabulary knowledge and conceptually dense text is too great to overcome that speculations about cause are addressed (Harmon et al., 2005). Additionally, a recurring topic of conversation among educators was identified by Cronbach (1942) as an important consideration for assessing and analyzing vocabulary acquisition and development data. Cronbach's insightful concern is that children are able to guess correct answers to multiple-choice vocabulary assessments resulting in an "award" (a grade) for full knowledge which may not represent depth of word knowledge (Cronbach, 1942). The combination of false-positive vocabulary depth as demonstrated on some multiple-choice tests and the vague vocabulary knowledge resulting from too many content dense words in a short period of time support the need for additional research in this area.

A substantial research base exists to support the need for developing content-area science vocabulary and text strategies during the elementary years (Alvermann & Swafford, 1989; Duke, 2000; Yopp & Yopp, 2006). Even though several studies demonstrated that both primary and upper elementary students were highly motivated by and interested in nonfiction and informational texts and chose this type of reading over traditional narratives, the corpus of research exploring nonfiction or basal science textbooks, content-specific vocabularies, and how to effectively teach with those texts was nominal (Moss, 1991; Moss & Hendershot, 2002; Palmer & Stewart, 2005). An analysis of Yopp and Yopp's (2006) teacher surveys indicated a daunting 14% of 1,830 classroom read-aloud titles could be classified as informational or nonfiction text. An earlier study by Duke (2000) revealed similar findings. Out of 79 full days or 4 months, in 20 first-grade classrooms, a relatively miniscule amount (only 282 minutes) accounted for activities with nonfiction or informational books. The resulting norm of time on task was 3.6 minutes per day (Duke, 2000). Opportunities to choose nonfiction texts, read them, and hear them read are infrequent in the primary grades, thus perpetuating the infamous fourth-grade slump (Kragler, Walker, & Martin, 2005; Palmer & Stewart, 2005). The indications of these data are worthy of attention as they may direct a prescriptive approach to science literacy.

Of particular concern to this study were two of the aforementioned components, instructional conditions (explicit or wide reading) and text types (nonfiction, informational or textbooks), as they relate to depth of content-specific vocabularies and subsequent effects on comprehension. At the altar of research where theory and practice marry, explicit instruction has seen both commitment and reservation (Goodman, 1994; NRP, 2000). Advocates tout its merits through evidenced-based research demonstrating positive effects on learners' vocabulary and comprehension, especially struggling readers (Allington, 1981; Gambrell, Morrow, Neuman, & Pressley, 1999). The benefits of explicit instruction were evident; however, it is postulated that children may not apply strategies beyond the context in which they are presented or be able to transfer strategic knowledge to outside tasks (NRP, 2000; Spiro, Coulson, Feltovich, & Anderson, 1994). The cause and effect of explicit instruction in isolation can result in a classroom environment that becomes the Tao through which how to work with knowledge is conceptualized. Teaching vocabulary and comprehension strategies without the benefit and parallel of an environment which both encourages and demands cognitive flexibility, a mastering of the intricacies of taxonomic knowledge and knowledge transferability may result in rote strategy applications and comprehension (Spiro et al., 1994). If the many complexities encapsulated in vocabulary knowledge are to be developed, it must be applied, represented, and deeply processed (Spiro et al., 1994). Hence, the instructional conditions that promote working with knowledge and cognitive flexibility tend to balance explicit instruction, guided instruction, and independent learning (Gambrell et al., 1999). One of the many evidenced-based ways to work with knowledge and offer the benefits of explicit instruction is through a multidimensional instructional process such as Guided Interactive Read-Alouds (Brabham & Lynch-Brown, 2002).

Influenced by sociopsycholinguistics, Brabham and Lynch-Brown (2002) hypothesized that teacher practices during informational read-alouds affected vocabulary acquisition and comprehension. Experimental comparison groups consisting of 117 first graders and 129 second graders were divided into three groups: just-reading, performance, and interactional. The *just-reading* group participants were simply read to with no opportunities for discussion or elaboration. *Performance* group participants discussed books before and after the reading and interrupted the story to discuss words or events. The *interactiona*l group participants read and discussed words and events before, during, and after reading of the text. Performance groups and interactional groups outperformed the just-reading group on vocabulary acquisition and comprehension measures. Overall, interactional groups outperformed both groups on both measures. Research results and observations provided significant support for interaction and transaction-based read-alouds (Brabham & Lynch-Brown, 2002). Researchers have recognized quality of instruction, the processes, and procedures as key areas for current and future reading comprehension research (RAND Reading Study Group [RAND], 2004). As Morrow, Conner, and Smith (1990) (as cited in Brabham & Lynch-Brown, 2002) pointed out, "Reading to a child is not sufficient for maximum literacy growth. It is the talk about the books that surrounds the reading that seems to be the key" (p. 268). Guided interactive read-alouds, undergirded by a sociopsycholinguistic framework, provided students with the benefits of metacognition (strategic thinking aloud), reading aloud (verbal and social mediation), and opportunities to work with, represent, and apply knowledge (Forman & Cazden, 1994; Piaget, 1952; Rumelhart, 1994).

Primary students' encounters with informational texts were minimal; yet, the fourth-grade curricula required formal study in social studies and science (Duke, 2000). Students coming into the fourth grade were faced with content-area texts with which they had little experience. The NRP (2000) found that comprehension improved when students were strategic during encounters with difficult text. Williams et al.'s (2005) study included 7- to 8-year-old second graders (*N* = 128) and was designed to teach these students how to comprehend compare-contrast nonfiction text. One promising result indicated that teaching metacomprehension of text structure and content to primary grade students increased comprehension. Moreover, the ability of children to transfer that skill to texts not included in the intervention was also observed with the caveat that the text be of the same type of structure. In other words, students did transfer strategies to other nonfiction texts provided they were of the compare/contrast text structure. The implications suggested that awareness of how to read a text enhances vocabulary acquisition and comprehension (Williams et al., 2005). Moreover, Fang (2006) argued that science has a language all its own and it is in stark contrast to the social language of children. The results of this analysis of the language demands of science texts in the middle school led Fang (2006) to suggest the addition of informational texts to motivate and scaffold content dense vocabulary and concepts. Fang (2006) cautioned, however, that information texts in lieu of textbooks might further limit students' exposure to science terminology. Consequently, Fang's (2006) conclusions integrated the power of metacognition, the strengths inherent to social and cultural contexts, and the transactions among those three (Forman & Cazden, 1994; Piaget, 1952; Rosenblatt, 1994). Fang's sociopsycholinguistic approach was a call to develop the discourse of science when working through informational and science textbook structures (Forman & Cazden, 1994; Owens, 1996). Fisher, Flood, Lapp, and Frey (2004) and Moss (1991) also noted the influence of basal science text in the classroom. According to Moss (1991) and teacher survey results from Weiss, Banilover, McMahon, and Smith (2001) (as cited in Fang, 2006), 90% of American classrooms use basal science textbooks as a primary tool of instruction. Because of this historical influence, concern over text content, and the strong political, social, and economic components, offering practical, research-based additions to existing classroom materials in the form of nonfiction text sets as a supplement to basal science textbooks seemed appropriate. Nonfiction and informational texts presented the real world, organized information in ways that relate words, labels, and concepts to each other, and provided visual supports as quick reference points to filter meaning of text (Lyttle, 1982; Moss, 1991; Palmer & Stewart, 1997).

Statement of the Problem

This quantitative study explored the acquisition and development of depth of content-specific vocabulary knowledge and any subsequent effects on comprehension. This study examined the influence of guided interactive instruction using thematic nonfiction text sets as supplements to traditional basal science textbooks on learning outcomes for fourth-grade students in a public school setting in the southeastern United States. The primary purpose was to determine to what extent guided instruction using thematic nonfiction text sets improves students' depth of vocabulary knowledge. A secondary purpose was to ascertain the effects of content-specific vocabulary knowledge depth on comprehension.

Research Questions

The following research questions were investigated in this study:

1. Did guided interactive read-alouds using nonfiction text sets improve depth of content-specific vocabulary?
2. Did guided interactive read-alouds using nonfiction text sets as a supplement to basal science texts improve depth of content-specific vocabulary to a level that improves comprehension?

Research Hypotheses

The following research hypotheses were investigated in this study:

1. There are no differences in depth of vocabulary knowledge mean scores for students who participated in guided interactive vocabulary instruction using informational and nonfiction trade books/text sets, those who participated in guided vocabulary instruction using traditional science textbooks, and those who participated in traditional basal science instructional formats.
2. There are no differences in mean comprehension scores for students who participated in guided interactive vocabulary instruction using informational and nonfiction trade books or text sets, those who participated in guided interactive vocabulary instruction using traditional science textbooks, and those who participated in traditional basal science textbooks.

Definition of Terms

Guided Interactive Read-Alouds: a process by which the teacher (a) verbally mediates his or her thinking about content, vocabulary, and comprehension as she or he reads nonfiction text aloud; (b) prompts children to respond to the teacher and to each other by reading, writing, speaking, listening, viewing, and visual representation through predicting, inferring, and summarizing; and (c) gradually releases the responsibility of learning to the student as an integral component of guided interactive read-aloud.

Informational books: books written by authors who have studied their subject matter in depth and have created woven factual information into a supporting story context and presented information through texts and visual aids that serve to support a deeper learning about the topic (Pike & Mumper, 2004).

Nonfiction texts: books carefully crafted around conflict-specific ideas, facts, and principles, using both verbal and visual texts (Pike & Mumper, 2004). These books are organized around a main idea and use visual texts to support written text.

Text types: a category incorporating the genre of nonfiction with specific characteristics of text structure and text coherence. Text structure represents the pattern or style of writing the author uses to communicate, and text coherence refers to the relationships of ideas at the word, sentence, and paragraph level (Beck & McKeown, 1991; Pike & Mumper, 2004).

Delimitations

Of notable delimitation in this study was the use of intact fourth-grade classrooms from a historically high-performing elementary school; consequently, correlations may not be generalizable to students in lower performing schools. Additionally, permission was granted by the school district to be in the school district for the duration of one science unit (12 days). Ideally, a longer intervention and assessment period to accurately assess the intervention's effectiveness was desired. The short duration of the unit had possible negative effects on pretest, posttest, and delayed response tests due to sensitizing participants to aspects of the treatment, thus influencing posttest scores.

Assumption

For purposes of this study, the following assumption was made: Teachers maintained and sustained full implementation of guided lesson plans.

Justification

Given the statistics surrounding primary content-area science instruction, the fourth-grade slump, and a limited corpus of research, a study was designed to contribute to improving knowledge about the acquisition and development of content-area depth of vocabulary knowledge and subsequent comprehension (Chall et al., 1990; Duke, 2000; Yopp & Yopp, 2006). In a content-area review on the state of vocabulary instruction, Harmon et al. (2005) concluded that the relationships between and among words, labels, and concepts of a scientific nature require students to develop a depth of technical vocabulary knowledge. This research revealed a better understanding of how depth of vocabulary develops in response to interactive instructional techniques that embedded content-specific vocabulary learning in the language arts processes (reading, writing, listening, speaking, viewing, and visual representation) while in context of authentic nonfiction texts and basal science textbooks (Carr & Wixson, 1986; Graves & Prenn, 1986; Stahl & Fairbanks, 1986). Much of the current research centered on the need for science and social studies instruction in the primary grades and echoed historical concerns from middle-school content-area science teachers that the most significant hindrance to text comprehension was lack of content-area science vocabulary knowledge (Moss, 1991; Moss & Hendershot, 2002; Palmer & Stewart, 2005). Data collected from this research-based multidimensional and complex process contributed to the RAND Reading Study Group's (2004) envisage to explore "words, readers, types of texts, and outcomes" (p. 727) in the context of vocabulary development and comprehension.

Another potential benefit of examining data collected from this study was the potential cognitive and taxonomic insight of how children process technical vocabulary when engaging in guided interactive read-alouds. The type of information processed into long-term memory was assessed and that knowledge applied to subsequent teaching and learning. Since sustaining depth of knowledge was a major concern of many researchers (Nagy, 2004; RAND, 2004; Spiro et al., 1994), exploring specific ways information is processed into long-term memory may translate into more effective teaching practices.

Finally, this study sought to contribute research-based data assessing effective teaching practices associated with vocabulary instruction. Motivating students through high-interest books and teacher involvement, scaffolding thinking processes about science words in context, and integrating word meanings from text to personal connections and back to text are integrated components designed to capitalize on the "talk" around books. To summarize, this study was designed to contribute to a somewhat small corpus of existing literature for the purposes of informing and guiding primary and intermediate content-area pedagogy.

In summary, this chapter was first anchored in theoretical frameworks. Foundational research regarding read-alouds, think-alouds, text types, and how children organized, stored, and retrieved information in light of guided instruction were discussed and developed. The second section identified the goal of exploring the extent to which guided interactive instruction using different text types affects depth of vocabulary knowledge and comprehension. Two research questions were raised and two hypotheses expected, all four relating to the improvement of depth of vocabulary knowledge and effects on comprehension. The final section defined ambiguous terms, described the problem of intact classrooms as a voluntary limitation of the study, and stated the assumption that teachers will fully implement instruction as scripted. The last paragraph justified the study by responding to RAND's (2004) call to improve comprehension through vocabulary acquisition and development.

CHAPTER II

LITERATURE REVIEW

This chapter called into focus foundational research substantiating effective vocabulary methods and materials designed to increase depth of content-area vocabulary knowledge in intermediate-age school students. Of primary consideration is the research base associated with the influence of guided interactive read-alouds, the influence of informational and nonfiction trade books on the acquisition and development of depth of content specific vocabulary, and any subsequent effects on comprehension. This overview progresses from a review of the chronology of vocabulary acquisition and development research in the context of theoretical frameworks to an exploration of the research base concerning key measurement variables: acquisition and development of depth of vocabulary knowledge, guided interactive read-alouds, and comprehension with different text types (see Tables 1 and 2). The final section suggests implications for educational research and practice and develops a rationale for strategic development of depth of vocabulary in content-area science.

Table 1

Literature Review (According to Date)

Researcher(s)/Year	Assessment	Summary/Outcomes
Cronbach (1942)	Analysis of techniques for diagnostic vocabulary testing Investigation and analysis of assessment forms	Diagnostic testing requires more valid instruments of measurement
Dale (1965)	Title: Vocabulary Measurement: Techniques and major findings	Touts the benefits of quality vocabulary research. Concluded that research focus should be on language experiences and mental organization of words and the relationships of those words.
Alvermann & Swafford (1989)	Review of content-area strategies and Content-area methods textbooks	Summary: 1. What kinds of strategies are recommended by textbook authors? 2. What is the scope of the research base for strategies recommended by textbook authors? 3. How effective are these research-based strategies? 4. Which strategies do teachers say they implement? Outcomes: Greater number of studies were found to be effective (*n* = 62) than ineffective (*n* = 49). However organizers and strategic text structures were not found to be effective for science learning.
Harmon, Hedrick, & Wood (2005)	Overview of content-area vocabulary research	Overview of current knowledge about vocabulary instruction for content area. Suggestions for effective vocabulary instruction for struggling readers.

Table 2

Research Studies (According to Date)

Researcher(s) Date	Participants	Assessment	Summary/Outcomes
Danner (1976)	72 middle-class white suburban students: Grades 2, 4, and 6	1. Recall was tested by listening to two presentations: one organized and one disorganized. 2. Detection tasks: Oral stories presented in written form. Students discern if there are differences in organization. 3. Grouping task: Group sentences with same topic Together. 4. Stanford Achievement Tests 5. Topic Description Task—Identifying and generating main idea.	The organization of text correlated with how children comprehend text: Focus was on amount, organization, and perceived difficulty of recall in children from all three grades. Age reflected the child's ability to understand passage organization, their detection of it, and their understanding of its potential usefulness.
Chall, Jacobs, & Baldwin (1990)	30 children (10 from Grades 2, 4, and 6) followed For 2 years	Six subtests of DAR: word recognition, word analysis, oral reading, word meaning, reading comprehension, and spelling	When children of poorer SES hit the fourth grade curriculum, testing revealed that word meaning began to incrementally diminish, closely followed by reading comprehension and oral reading.

(table continues)

Table 2 (*continued*)

Researcher(s) Date	Participants	Assessment	Summary/Outcomes
Maher (1991)	20 boys and 20 girls from Grade 5 (random selection)	Pretest/posttest supplying word definition	Summary: Looked at word differences among students who looked words up and those who had the stories containing the words read to them. Outcomes: Fifth-grade students who were read aloud to acquired more word definition than those who read independently—a 50% retention rate of word definitions was noted among students receiving instruction with the words in context and those who learned words traditionally.
Beck & Dole (1992)	Grade 5	Summary of two research programs designed to examine how elementary grade students learn from content-specific text	Significant differences in comprehension levels when using revised text as opposed to original text.
Medo & Ryder (1993)	31 matched pairs of eighth-grade students	Comprehension questions pretest/posttest	Teaching text specific vocabulary instruction affected comprehension of content-area textbook and students' ability to answer explicit and implied cause/ effect relationships.

(*table continues*)

Table 2 (*continued*)

Researcher(s) Date	Participants	Assessment	Summary/Outcomes
Alexander, Jetton, Kalikowich, & Woehler (1994)	3 ninth-grade physical science teachers, 73 students (35 males, 38 females)	Tapes of class discussions, field notes, interview, and educational histories	Students are guided by what teachers value in text and it manifests in their reading and writing.
Loxterman, Beck, & McKeown (1994)	88 sixth-graders	Free recall and open-ended questions	Texts were reviewed, think-alouds added to read-alouds produced significantly better comprehension than when students silently read revised texts or silently read original texts or had original texts read aloud to them.
Watts (1995)	Six classrooms of Grades 5 and 6	Classroom observations over 4 months Teacher interviews Self-reported data	Teachers most frequently use definitional and contextual forms of instruction. Reliance on familiar discourse patterns in carrying out instruction Associated characteristics of evidence-based research instruction were not present. Teachers adequately described instruction to match observations. Vocabulary instruction nature-based reading series requirements.

(*table continues*)

Table 2 (*continued*)

Researcher(s) Date	Participants	Assessment	Summary/Outcomes
Schwanen-Flugel, Stahl, & McFalls (1997)	Elementary school children (43 fourth-graders) from low-middle to middle-class	Students provided definition for words they knew and marked words they didn't know, then they read stories containing some of the words, while other words served as controls.	Vocabulary growth was incremental for partially known and unknown words. Word type (concreteness) correlated with rate of growth even more so than text structure.
Brabham & Lynch-Brown (2002)	117 first graders and 129 second graders Total of 24 Classrooms	Vocabulary pretest with 40 multiple-choice items containing 20 vocabulary words from nonfiction story books. Posttest: Same words, different test Comprehension pretest/posttest, 17 multiple-choice questions with each question having 4 items to choose from. Contained both literal and inferential questions.	The reading aloud style of the teacher produced statistically significant differences. Interactional reading produced better vocabulary acquisition than performance reading aloud style or generic read-alouds. Both groups with verbal mediation produced significant differences when compared to the read-aloud without verbal mediation.
Moss & Hendershot (2002)	One sixth-grade classroom	Two-year ethnographic case study of language arts classes observation	The nonfiction genre has a motivational and interest component built into its nature. Argues for more nonfiction in classroom.

(*table continues*)

Table 2 (*continued*)

Researcher(s) Date	Participants	Assessment	Summary/Outcomes
Fang (2006)	Extensive analysis of content-area science basal textbook for eighth grade		Examined science as a language to advocate the necessity of explicit, strategic reading instruction.
Williams, Hall, Lauer, Stafford, DeSisto, & deCani (2005)	128 seven- to eight-year-olds 10 second-grade teachers	Pretest/posttest 1. Recall of clue words 2. Matrix sentence generation 3. Compare/contrast questions 4. Well-structured comparative statements 5. Vocabulary concepts	Strategic text structure awareness impacts comprehension outcomes for students in second grade. Transfer value occurred for students as long as compare/ contrast structure was present.

Historical Development of Vocabulary Acquisition and Development

Vocabulary is touted as one of the oldest areas in educational research (Alexander & Fox, 2004). While Beck and McKeown (1991) identified vocabulary as a historically senior and steady topic of discussion among educational researchers (Anderson & Freebody, 1981; Stahl & Fairbanks, 1986), its importance as an area of research has subsided for decades at a time (Beck & McKeown, 1991; Cassidy & Cassidy, 2004). Historical reviews revealed a host of variables serving to enlighten and complicate one's understanding about vocabulary processes and their impact on comprehension (Biemiller, 2001; Cronbach, 1942; Dale, 1965).

Beginning with the printing of psychologist E. L. Thorndike's *The Teacher's Word Book* efforts were made to organize the English vernacular into categories by frequency of occurrence in the English language. During this period in history, research was influenced by Skinnerian behaviorism and psychologists Gray, Thorndike, and others (Beck & McKeown, 1991). This psychological concept of behaviorism is based on cause-effect observable behaviors that are deconstructed into sets of discrete skills developed through practice and reinforcement until learning occurs (Alexander & Fox, 2004; Pearson & Stephens, 1994). Emerging from and filtered through this research orientation were two dimensions of vocabulary acquisition and development, the number of words known by individuals and words common to the discourse of the day (Beck & McKeown, 1991). These two dimensions seemed to set the precedent for future vocabulary research.

Accordingly, the early decades of the 20th century explored subsets of the original two categories: developmental growth as it related to vocabulary size (Biemiller, 2003; Nagy & Herman, 1987) and identification of useful words for the purpose of establishing a mastery word list for each grade level (Beck & McKeown, 1991). Readability formulas and word lists for children in the early grades resulted from interpretations of this research through the lenses of behaviorism, thus reinforcing that reading is a function of habit--the repetition (stimulus/response) of discrete sets of skills, including word recognition, in isolation. This mindset produced several modern-day methods and materials for vocabulary and reading instruction. For example, contrived word lists were integrated into controlled-vocabulary texts aptly named basal readers which are currently utilized in about 90% of American classrooms. Consequently, opportunities to encounter rich and robust vocabulary remained unlikely (Beck & McKeown, 1991). Nagy and Herman (1987) argue that, while the quality of literature used in basal readers has improved over the years, no causal effects on vocabulary and comprehension can be assumed.

In the 1960s and 1970s reading research moved away from its behavioristic roots toward a conception that learning to read and language development are processes--not just outcomes. During this paradigm shift, psychology, psycholinguistics, and sociolinguistics joined to form foundational theories on how print and information are developed and processed (Durkin, 1978-1979; Goodman, 1994). This processing-over-product era produced significant pedagogical upheaval due, in part, to the stark contrast between behaviorism and constructivism belief systems. Thus, all manifestations of language acquisition and development, which included reciprocal language arts processes (reading/writing, listening/speaking, and viewing/visual representation) and how they were learned and taught were questioned. Clifford (1978) (as cited in Beck & McKeown, 1991), conceptualizing the information era, articulates and captures the unreconciled philosophical stances when surmising that there is an emphasis on “the relationship between one’s stock of words and one’s stock of ideas” (as cited in Beck & McKeown, 1991, p. 790). In other words, the emphasis on the relationship of language to thought was interpreted differently based on the context of philosophical landscapes.

Foundational theory and complexities associated with word-to-idea relationships were missing key cognitive research findings, thus vocabulary research reached a plateau (Beck & McKeown, 1991, as cited in Barr, Kamil, Mosenthal, & Pearson, 1996; Pearson & Stephens, 1994).

Researchers in the early 1970s approached basic reading processes from a Piagetian perspective. Piagetian theory interprets memory, learning, storage, and retrieval of information through a progressive and sequential process filtered by a unitary conceptual cognitive construct (Owens, 1996). However, the undergirding wholistic and intrinsic nature of this construct does not offer consideration to the role of environmental interactions between the reader and his or her peers and somewhat interprets the role of the reader-to-text through a behaviorist lenses (Owens, 1996). The reader sees the text as having meaning and his or her role as interpreting instead of making meaning—generating it as he or she reads such as in Rosenblatt's (1994) transactional theory of the reader, the text, and the context of that text. Rosenblatt asserts that meaning is constructed in light of the reader, the text, and the context of that text and proposes that correct answers are relative. The influence on and role in vocabulary development from environmental stimuli, such as comes through sociocultural experiences in life, are underemphasized in Piagetian theory (Owens, 1996).

For instance, event-based knowledge and taxonomic knowledge are two types of knowledge structures, schemata, purported to channel the acquisition of words (Owens, 1996). Event-based knowledge encompasses sequences of familiar events and or routines through which memory and comprehension are augmented while taxonomic knowledge assigns words to classes and categories based on an existing mental organizational hierarchy with the more discerning characteristics and attributes residing in long-term memory (Bower, Black, & Turner, 1994; Owens, 1996). Multiple related groups of expectations or scripts formed as a result of repeated participation in an event provide schemata from which new knowledge associated with new activities can be interpreted. In general, children entering school have practiced, through routine and the interaction of others within those routines, to the degree that certain kinds of vocabulary knowledge are associated with or interpreted and developed from different events (Anderson, 1994; Forman & Cazden, 1994; Owens, 1996). Thus, a child's depth of knowledge about words may result from the memory of words as they were perceived in context (Pickert & Anderson, 1977). In other words, social contexts may introduce and expose children to words, but word meaning may be derived from presentation within that context (Owens, 1996; Pickert & Anderson, 1977). It is from these established routines in which objects have labels and are related to each other by some characteristic or attribute or sets thereof and scaffolds from others that vocabulary is acquired and developed (Owens, 1996; Pickert & Anderson, 1977). Event-based routines develop a sequence of anticipated expectations in both process and procedures, or schema scripts (Bower, Black, & Turner, 1994). These schema scripts become the structure through which narratives are filtered. Furthermore, it has been suggested that event-based knowledge, schema scripts, are fundamental components from which taxonomic knowledge, critical thinking, is developed (Bower et al., 1994; Spiro et al., 1994). Echoing this notion is Rumelhart (1980, as cited in Alexander & Fox, 2004), who defines schemata as the "building blocks of cognition" (p. 43). Consequently, an understanding of schemata's influence has had a profound impact on literacy pedagogy (Alexander & Fox, 2004).

A deeper appreciation for and understanding of how knowledge and language are represented in the mind during the construction of meaning became the foundation for modern-day text processing strategies, such as word mapping, self-regulation, task-monitoring, and Reciprocal Teaching, which is a strategic comprehension process incorporating predicting, summarizing, clarifying, and questioning (Alexander & Fox, 2004; Palinscar & Brown, 1984). Allington's (1981) research in this area revealed startling results. Allington (1981) investigated the mental organization of information and the differences between good and poor readers. The significant differences in knowledge and taxonomic representations between good and poor readers, according to Allington (1981), are due to differences in instruction rather than aptitude or learning styles. This research is one example of why schema theory is deemed "the most potent legacies of the time" (Alexander & Fox, 2004, p. 43; Block & Pressley, 2002).

The focus on mental representations of knowledge—its input, organization, storage, retrieval, and production—hereafter collectively referred to as working memory, prompted researchers to more fully explore vocabulary acquisition and development, which was highlighted by the National Reading Panel in a call for renewed interest in vocabulary and its subsequent domains (Alexander & Fox, 2004). Besetting such a rekindling of interest, however, are the complexities surrounding measurement forms and techniques as well as the sheer vastness of the multidimensional and multi-interdisciplinary nature of vocabulary. Perhaps cognizant of the extent of those issues, Beck and McKeown (1991) described the current state of vocabulary research as follows: "Vocabulary acknowledges vocabulary acquisition as a complex process that involves establishing relationships between concepts, organization of concepts, and expansion and refinement of knowledge about individual words" (Beck, McKeown, & Kucan, 2002, p. 7).

Depth of Vocabulary Knowledge

Research that addresses theoretical questions of what it means to know a word, what mental processes are required to learn a word, and their practical implications for vocabulary instruction are necessarily investigated. A literature review revealed early and current techniques and measurement scales of what it means to know a word, including the early research of Cronbach (1942) and Dale (1965) and the later research of Kame'enui, Dixon, and Carnine (1987) and Stahl (1986). Explorations of four prominent studies provided background for discovering how children acquire, process, and develop depth of vocabulary knowledge. The first study by Collins and Quillian (1969) as cited in Beck et al., (2002) postulates how the brain organizes, stores, and retrieves incoming information, the implications of which may inform instructional methods. The second study by Schwartz and Raphael (1985) contends that depth of word knowledge provides students with the information base to think critically. The third study by Carey (1978) associates the depth of word development to the number and quality of exposures while the fourth study by Schwanenflugel, Stahl, and McFalls (1997) suggests that the concreteness or abstractness of a word as well as the word's part of speech influence the number of exposures required to learn a word deeply.

Based on prior examinations of diagnostic vocabulary test forms, Cronbach (1942) surmises that there are certain behaviors that discern and discriminate levels of word knowledge. The abilities to define the word, apply the word's meaning in other contexts, make accurate associations of the word to other words, and apply underlying conceptual knowledge about the word represent and form Cronbach's criteria for evaluating depth of content-area vocabulary knowledge. Cronbach (1942), as a result of reviewing existing data, proposed that future studies focus on evaluating breadth in terms of multiple meanings and depth of vocabulary knowledge as it relates to students' ability to precisely use the word. Cronbach (1942) states that semantic precision of word usage is pivotal for diagnostic testing. A student's ability to use the word in familiar and unfamiliar circumstances and knowing when a word is used inappropriately is an indicator of depth of knowledge (Cronbach, 1942).

Dale's (1965) report proposed that understanding language behavior and development is crucial to effectively teaching students how to read, write, speak, and listen. Dale's techniques and major findings about vocabulary measurement encompass several important ideas, one of which is pertinent to the topic at hand: What it means to know a word. Dale (1965) asserts that knowing a word falls along a continuum. A linear scale indicating depth of word knowledge might progress as follows: "I've never seen the word before," to "I know there is such a word but I don't know what it means," to "a vague contextual placing of the word," to "I know it and I can use it." One of Dale's (1965) concluding remarks suggests that thoughtful and intensive foci should be placed on depth of technical vocabulary knowledge and on the development of instruments that discern vocabulary knowledge in better ways.

To expand and compare perceptions of word knowledge and create a conceptual understanding of what it means to know a word, one must necessarily survey the existing body of word knowledge propositions. Stahl (1986) interprets depth of word knowledge through three designations: association, comprehension, and generative. In Stahl's (1986) connectionist model, information must first cohere in relationship to the context in which it is presented and then be represented in memory through and with existing schemata. Words in the associative category are words that are accurately associated with other words even though the understanding of the word may be absent. The comprehension level means that there is a shared understanding of word meanings. The generation level, or deep processing level, indicates internalization or ownership of a word which manifests as novel use of the word in a context. Stahl's (1986) model depends on word understanding developing over the course of multiple encounters in multiple contexts. Stahl (1991) states that a conceptualization or deep processing occurs as the result of time and experience, a model consistent with learning words incidentally. This model tends to capture generalized differences in word level knowledge (Stahl, 1991).

A more discriminating model constituting depth of word knowledge is presented by Kame'enui et al. (1987). Kame'enui et al. (1987) explain word knowledge levels as follows:

> (a) full conceptual knowledge or the ability to recognize uninstructed examples of concepts as examples, and to discriminate them from similar examples drawn from other concepts; (b) partial conceptual knowledge allows for erroneous characteristics or even missing characteristics but formulates some meaning; and (c) an unknown conceptual knowledge identifying labels with objects. (p. 133)

In yet another vein, Kame'enui et al. (1987) subscribe to what they refer to as "derived knowledge" (p. 133). Derived knowledge defines word understanding as "just enough information" (p. 133) to answer questions about the word in the context. No long-term retention of the word is expected from the learner or the teacher. This derived knowledge is especially noticeable in intermediate grades when students are required to learn many words and their underlying conceptual frameworks for several content areas in record pace. Perhaps, the general pedagogical implications for traditional vocabulary instruction are well represented by Nagy and Scott (2000): "How well a person knows the meaning of *whale* depends in part on their understanding of *mammal*" (p. 272).

Collins and Quillian (1969, as cited in Beck et al., 2002), using three of Cronbach's (1942) criteria for depth of word knowledge, focus their answer to this question on how the brain stores, organizes, and retrieves information. Collins and Quillian (1969, as cited in Beck et al., 2002) hypothesize that the storage, organization, and information retrieval system in the brain conceptualizes and stores information hierarchically. General knowledge terms appear to be readily accessible while deeper, more detailed knowledge of terms appear to require more processing time. General or common knowledge terms, referred to by Beck et al. (2002) as naming words, are terms that serve as labels for a collection of general characteristics such as horse, table, and door. These labels are broadly defined by characteristics that are stored, organized, and developed in the brain through repeated encounters in multiple contexts. Because of this, these terms are easily accessed and are readily available for use. To assess the merits of this hypothesis, Collins and Quillian (1969, as cited in Beck et al., 2002) note the amount of processing time required to validate depth of knowledge statements about a series of sentences requiring yes or no answers, such as *Polar bears are white. Polar bears are mammals.* In other words, proximity and availability of information correlate with type and degree of word knowledge required.

Schwartz and Raphael (1985), enlightened by their initial studies with undergraduates and eighth graders, studied the impact of word mapping on fourth-grade students' growth of content-area terminology. Schwartz and Raphael (1985) contend that word meanings interpreted through a series of three prompts can increase students' word knowledge to a robust level defined as a "concept of definition" map. This concept of definition is divided into four categories: What is it? What is it like?; What are some examples of it?; and How can you include all components in a new definition of the word?. Purportedly, from this level of understanding, students may be more likely to engage in critical thinking, taxonomic knowledge. A 4-day intervention involving fourth graders from a Department of Defense School and using carefully crafted guides and prompts was implemented. On each of 4 days, the investigators explored a new category for concept of definition. Explicit modeling at the onset of the lesson was followed by opportunities to work with newly acquired knowledge, which helped participants work through a process Piaget calls mental disequilibrium. Another important element for this study was the use of guided but explicit instruction with what Vygotsky (as cited in Forman & Cazden, 1994) has deemed the zone of proximal development, which serves as a place to scaffold student learning. Students who employed this strategy evidenced a deeper understanding on written response measures than students who did not employ this strategy (Schwartz & Raphael, 1985).

In their study of incremental vocabulary growth independent of and in conjunction with reading comprehension, Schwanenflugel et al. (1997) indicated that vocabulary growth is perpetuated by two of their four variables, a word's tangibility and its syntactical position. This study required fourth graders to self assess their depth of word knowledge using an abbreviated version of Dale's (1965) scale. Participants rated their word knowledge as known, partially known, and unknown and had to define each of 24 words (Schwanenflugel et al., 1997). During the intervention phase, students read two of four stories that were 2 years above their grade level and were subsequently asked to summarize what they had read. The unread stories served as control conditions for each child. Results indicated measurable differences in depth of knowledge growth for partially known words, especially those characterized as people, places, and things (Schwanenflugel et al., 1997). There is, in fact, a stronger correlation in this study that kind of word plays a more important role than type of text when predicting depth of knowledge growth. This correlation has potentially significant teaching and learning implications for content-area specific vocabulary as these words can be abstract in nature and dependent upon underlying conceptual knowledge for development and interpretation.

Carey's (1978) seminal study documents the incremental development of children's word knowledge. Carey (1978) notes that first the exposure to words usually results in a "quick map," a mental association which partially represents the essence of the word (Kame'enui et al., 1987). Consequently, researchers, acknowledging the contribution of multiple exposures to deep learning, attempted to determine the number of encounters needed to transition from partial to rich representation of a word. However, in instructional settings, an average encounter for a word in context is approximately four (McKeown, Beck, Omanson, & Pople, 1985). Research does not find that four robust encounters can improve depth of word knowledge nor comprehension (McKeown et al., 1985).

A second and more thorough knowledge representation results from a process Carey (1978) calls *extended mapping*. This mapping occurs as students work with information repeatedly. This mapping is ever-changing in that word knowledge is continually refined, but the user is able to understand, articulate, and write with the word. de Bot, Paribakht, and Wesche (1997) extend Carey's (1978) model to consider a fifth dimension, writing to use the word in a sentence, as a noteworthy indicator of depth of word knowledge. Additionally, Nagy and Scott (2000) contend that within each of the five levels there exist distinguishable differences in receptive, expressive, and productive vocabularies. For example, a student might recognize the word in context (receptively), but be unable to organize and articulate (express) the word in a new or different context (Nagy & Scott, 2000). Furthermore, the student may not be able to use the word in production (writing). Thus, narrowing word knowledge by arranging it on a linear scale from no knowledge to the ability to use the word in production deemphasizes the multidimensionality and interrelated aspects of word knowledge. Graves (2006) correlates multidimensionality and interrelatedness with differentiated word tasks such as learning new concepts, new labels for known concepts, and bringing words into productive vocabularies. Vocabulary, as Beck et al. (2002) would say, "is not an all or nothing proposition" (p. 9).

One way to develop the premise behind multidimensionality and interrelatedness is for students to learn words both incidentally and directly (Blachowicz & Fisher, 2000; Marzano, 2004). Characteristics of effective and robust classrooms typically include both instructional conditions (Fisher et al., 2004; Stahl & Kapinus, 1991). Furthermore, these classrooms offer students opportunities to work with vocabulary words through reading and writing, listening and speaking, and viewing and visual representation (Moss, 1991; Nagy, 2004).

Researchers Cronbach (1942) and Dale (1965) acknowledged and indicated the need for vocabulary measures that discern quality and quantity of word knowledge. Anderson and Freebody (1981), reiterating and extending four decades of vocabulary research, postulate that the answers to what it means to know a word determines the criteria by which one assesses and evaluates improved methods of teaching vocabulary. Accordingly, these researchers propose that vocabulary develops incrementally through the parallel constructs of time and experience, and instructional methods and assessments should be adapted to incorporate this aspect of vocabulary development (Anderson & Freebody, 1981). Additionally, it is of importance to consider that the incremental growth described by Anderson and Freebody (1981) tacitly suggests that vocabulary development should be left to incidental learning through wide reading. Alternately, the National Reading Panel (2000) calls for direct instruction of vocabulary words.

Direct Instruction or Wide Reading

Two instructional conditions repeatedly addressed in the literature are direct instruction and incidental learning. This section explores the literature base that surrounds this philosophical conundrum and relates its relevance to read-alouds.

With the goal of improving depth of vocabulary to a level that improves comprehension, Nagy and Herman (1987) compared and contrasted evidence from these two diverse instructional conditions. While the two philosophies might be diverse, they share one of the five fundamental dimensions of word knowledge recognized by researchers: the incremental nature of vocabulary development (Nagy & Scott, 2000). Though wide reading (incidental learning) and direct instruction (intentional learning) supporters tout superior outcomes when subscribing to their respective approaches about vocabulary acquisition and development, both recognize that the ability of a child to “own” a word progresses by degrees through multiple quality exposures in multiple contexts (Beck et al., 2002). In Stahl and Fairbanks’ (1986) analysis of 50 vocabulary studies, a combination of definitional and contextual vocabulary instruction proves to be more effective than either alone. Furthermore, the number and quality of encounters with words have been shown to impact the degree of vocabulary acquisition and development (NICHD, 2000).

Especially problematic for elementary school students is the infrequent occurrence of science vocabulary in daily contexts. This problem is exacerbated by the topical organization of science curricula which tends to introduce and practice concepts and technical vocabulary in isolation, thus decreasing frequency and quality of word exposures as Scott, Jamison, and Asselin (1998) note in their research for 69 days in 23 intermediate classrooms. Infrequent encounters significantly impair acquisition and development, thus thwarting necessary components for robust incidental and intentional word learning (Beck et al., 2002; Scott et al., 1998).

Nagy and Herman (1987) approximate an average reader's vocabulary growth rate as 3,000 words per year during the intermediate and to the end of the high school years. Therefore, the task of directly teaching the estimated 3,000 words per year necessary to increase average students' overall vocabulary and influence comprehension is a challenging one (Nagy & Herman, 1987). It is this association that wide reading proponents identify as faulty from the first. An undergirding premise of wide reading is that children will acquire and develop vocabulary naturally as a function of exposure. Incidental word learning research estimates that children learn from 800-900 (Biemiller, 2003) to 3,000 (Nagy & Herman, 1985) words reading a wide range of books over the course of one year as compared to the 300-400 words learned through explicit instruction in school (Nagy & Herman, 1985). Whether or not a precise number of words learned can be extrapolated from any given measure or research, many studies have confirmed that the relationship of vocabulary acquisition to increased reading is reciprocal (Anderson & Nagy, 1991; Stahl, 1991).

Schwartz and Raphael's (1985) direct teaching of vocabulary through the instructional strategy concept of definition incorporates the language arts processes which seems to improve depth of content-area word knowledge, thus offering credence to both the intentional and incidental teaching of words. Graves and Prenn (1986), enlightened by 15 years of vocabulary research, surmised that individual word instruction combined with wide reading, learning strategy instruction, and metalinguistic awareness offers a balanced and practical approach to acquiring and developing vocabulary. In light of this research base, it seems appropriate to suggest a tandem approach, a fusion of direct instruction and wide reading, which holds the potential to benefit children learning content-specific science vocabulary (Watts, 1995).

In concert with the underlying conceptual frameworks of what it means to know a word deeply and the multiple exposures required to learn a word deeply identified and explored by Anderson and Freebody (1981), Cronbach (1942), Dale (1965), and Miller and Gildea (1987) brought attention to the instructional conditions associated with learning words deeply. In their expose on how children learn words, Miller and Gildea (1987) found that deepening word knowledge required multiple exposures in multiple contexts, both oral and written. Providing rich nonfiction text sets mediated by teacher-student interactions may be one way to create strategic instructional conditions conducive to harnessing the power inherent to both stances.

Guided Interactive Read-Alouds

In this section read-alouds, think-alouds, and guided interactive instruction are discussed as a blended instructional condition called *guided interactive read-alouds* (Brabham & Lynch-Brown, 2002; Loxterman, Beck, & McKeown, 1994). Research representing this relatively new instructional condition is called into focus. Worthy of report is the prevalence of nonfiction read-alouds and the research base surrounding guided interactive read-alouds.

Nonfiction read-alouds provide a structure and information base through which vocabulary is acquired and developed. Vocabulary instructional routines, guided interactive read-alouds using nonfiction text sets, resulted from read-aloud, think-aloud, and guided interactive instruction research bases (Beck & Dole, 1992; Brabham & Lynch-Brown, 2002; Danner, 1976; Fang, 2006; Loxterman et al., 1994; Maher, 1991; Medo & Ryder, 1993; Watts, 1995).

Reading aloud has a substantial research base confirming its instructional value for narrative text (Brabham & Lynch-Brown, 2002; Stahl, Rickek, & Vandevier, 1991). However, the same cannot be said of reading aloud expository text. A teacher survey that spanned kindergarten through sixth grade revealed that informational books are not generally available in most classrooms (Yopp & Yopp, 2006). Even when informational texts are present in the classroom, they are rarely introduced or read aloud (Yopp & Yopp, 2006). Duke's (2000) finding that 3.6 minutes a day are spent integrating informational texts suggests that intervention may be necessary.

It has been said that "the single most important activity for building the knowledge required for eventual success in reading is reading aloud to children" (Anderson, Hiebert, Scott, & Wilkinson, 1985, p. 23). This powerful statement demands investigation. Upon examination, the literature reveals that read-alouds increase word knowledge, develop vocabulary and listening skills, and expand background knowledge (Brabham & Lynch-Brown, 2002; Trelease, 1993). While research is replete with studies lauding the merits of narrative text read-alouds, research exploring and identifying effective instructional practices of teachers during read alouds is scarce.

Several effective practices emerged from a small corpus of research. Fisher et al.'s (2004) examination of teacher practices during read-alouds reveals several common factors. Initially, 25 expert teachers, as determined by qualitative and quantitative criteria, were selected for purposes of establishing baseline characteristics for a larger study of 120 teachers. Data gathered from multiple observation reviews identified the following common implementation practices: (a) balance among developmental, social, interests, and emotional needs of children to book choices; (b) book has been deeply processed by the teacher (familiarity); (c) having teachers set a purpose for reading and then making students aware of that purpose; (d) comprehension is communicated through fluent reading; (e) frequently using gesturing, prosody, and animation; (f) stopping at strategic points to prompt, question, or explain; and (g) having the read-aloud integrated with independent reading and writing (Fisher et al., 2004).

Recent research suggests that even more powerful effects on vocabulary and comprehension can result in read-alouds being integrated with strategic teacher-student interactions (Brabham & Lynch-Brown, 2002). Such strategic interactions merge the metacognitive power of think-alouds (Loxterman et al., 1994) with the power of discussions (Hart & Risley, 1995). Guided read-alouds provide needed scaffolds when concepts and new vocabulary are introduced and practiced. By using interactive read-alouds to demonstrate the thinking processes used by mature readers when reading nonfiction text, teachers expose students to vocabulary in context and suggest to them just how to use the text to relate ideas and concepts (Loxterman et al., 1994).

A central conviction to what happens after vocabulary knowledge is retrieved is that it must be integrated into a core conceptual structure (Bower et al., 1994). Interactive thinking aloud refines this integration process through discussions, reflections, applications and evaluations of word knowledge which is what Spiro et al. (1994) alluded to when they concluded that knowledge must be represented, applied, and reworked. Guided vocabulary instruction combines the benefits of reading, writing, speaking, listening, and viewing, and visual representation which enhance students' abilities to think critically (Loxterman et al., 1994).

Similarly, Chan, Cole, and Norris (1990) conclude that successful comprehension strategy instruction depends, in large part, on the degree to which the strategy sustains active interaction with the text. *Coconstructive interactional* is a term coined to characterize teacher interactions when reading aloud which has children predict, analyze, generate word meanings, and draw conclusions as they read (Brabham & Lynch-Brown, 2002). Results from the Brabham and Lynch-Brown's (2002) study indicate an extremely high correlation between the implementation of coconstructive interactional read-alouds and vocabulary acquisition and development. Additionally, moderate results are evidenced in comprehension (Brabham & Lynch-Brown, 2002).

Last but powerful evidence-based enticements to utilize nonfiction text sets through interactive read-alouds are the photographs and interesting art (Moss & Hendershot, 2002; Palmer & Stewart, 2005). Forty-eight out of 100 sixth-grade students surveyed stated that they were influenced by visual supports in trade books (Moss & Hendershot, 2002). The use of visual supports transmediate between the reader, the text, and the context of that text (Rosenblatt, 1994). Pictures provide multiple contexts from which teachers and students expand and develop mental connections between and among ideas. Verbal mediation with visual representations in multiple contexts of nonfiction text sets provides a robust environment for incremental vocabulary depth to be developed (Bower et al., 1994).

Nonfiction Texts and Trade Books

Research shows that students are highly motivated by and interested in nonfiction text sets (Moss & Hendershot, 2002; Palmer & Stewart, 2005). However, they are not frequently used, especially in content areas (Moss & Hendershot, 2002; Palmer & Stewart, 2005; Yopp & Yopp, 2006). Consequently, little research about nonfiction in the content areas is available (Albright, 2002). A 1982 study by Lyttle evaluating results of using nonfiction in elementary and secondary classrooms revealed that more often than not student involvement and success are associated with trade book usage. Conversely, Lyttle's (1982) study indicates no significant gains in achievement or attitude toward reading when students used trade books or textbooks in classes that embraced nonfiction books.

Moss (1991) lists five advantages for using nonfiction trade books in the classroom and addressed each one when supplemental texts were explored in content areas. Moss (1991) first considered the practical component of matching reader with text. Specifically, nonfiction topics span readability levels, which assists teachers in planning because they can adapt books on the same topic but meet the diverse needs of varying reading levels. A second advantage is the visual and content-aesthetic value (Gregg & Sekeres, 2006). Forty-eight percent of sixth-grade students stated that their book choices were related to visual appeal (Moss & Hendershot, 2002). Reciprocal language arts processes of viewing and visual representation support the comprehension process by forming mental representations of knowledge to be reconciled with language labels and concepts found in text. Illustrations and visual graphics, a second advantage, complement texts by representing main ideas, clarifying, restating, and or elaborating on important ideas. Additionally, these texts explore topics in detail, providing missing links not present in textbooks due to limited space (Gregg & Sekeres, 2006). The third and fourth advantages, multiple contexts and multiple exposures using current information, encourage in-depth investigation. With in-depth exploration come opportunities to build background knowledge in context of rich, meaningful, and current texts that reflect updated knowledge about topics (Moss, 1991). Though somewhat controlled by curriculum pacing, these opportunities lend themselves to wide reading which is touted as one of the better ways to build vocabulary (Stahl & Fairbanks, 1986). Along with building vocabulary in context, text explicitly identifies relationships among concepts and topics. Frequent interaction in multiple texts encountering the same vocabulary words has been shown to increase depth of vocabulary knowledge and increase concept knowledge comprehension, which some indicate is foundational for thinking critically about content-area science (NICHD, 2000). In addition to offering multiple texts and exposures, there is a fifth advantage. Teachers are actively involved in students' interpretations of what they read (Loxterman et al., 1994). Discussion, metacognitive reflection, application, and evaluation of word knowledge and text summarized and clarified understandings and developed speaking and listening skills (Loxterman et al., 1994).

Content-Area Textbooks: Text Structure and Text Coherence

More recently and consistent with Duke's (2000) earlier findings, kindergarten, first-grade, and second-grade teachers, who were recognized for their effective literacy practices, responded to a national survey about expository text use in their classrooms. Survey results categorized 6% of reading materials as expository text (Duke, 2000). Lack of exposure in the primary grades and unfamiliarity with informational text structures may be contributors to the fourth-grade slump.

Radcliffe, Caverly, Peterson, and Emmons (2003) indicate that textbooks appear to be a constant, since 90% of classrooms employ them in a majority of middle-school classrooms. However, their instructional content, format, and role resonate controversy (Beck & Dole, 1992; Fang, 2006). Research suggests that traditional basal science textbooks may have significant limitations (Beck &

Dole, 1992; Beck & McKeown, 1989; Kragler et al., 2005). Cursory attention to key vocabulary terms, coherency of text structures, and prerequisite knowledge of the topic influence students' ability to extrapolate necessary information for deep processing of vocabulary and comprehension. Fang (2006) concluded that format, content, and availability of texts can also influence students' interpretations of what they read and their ability to learn from the text.

In their reading and thinking with text study, Beck and Dole (1992) evaluated students' recall and thinking when using content-area science and social studies text. Beck and Dole (1992) observed that information found in textbooks leaves out important features that are necessary for immediate and future comprehension. One of those features, transitional connectors, or words that explicitly connect ideas, is more likely to produce long-term comprehension. It seems that memory is enhanced by and is correlated with the degree of information connectedness (Beck & Dole, 1992; Graves & Prenn, 1986). Changes in mental processing from students who read revised texts reflected more accurate conceptions, and those students were able to apply what they learned to new situations and topics (Beck & Dole, 1992). A second aspect regarding coherent text is that it serves as a model for mentally sequencing and relating ideas to each other for thinking and writing. Upon examination, researchers noted that revised texts improve memory and recall but do not improve anticipated taxonomic applications (Beck & Dole, 1992). Though students have the information they need to think critically, the patterns in their thinking do not change, even on a second attempt that corrects misconceptions (Beck & Dole, 1992). Simply stated, one half of the students did not learn from revised text. Fang (2006) attributed this to a broad array of linguistic features wholistically represented as the language of science. Within this language lie multidimensional text characterizations far removed from the language of daily conversations. Overcoming syntactic, semantic, and lexical challenges can be daunting for average, poor, and second language learners (Fang, 2006). While these challenges will need to be systematically addressed, Beck and Dole (1992) considered another qualitative difference in readers' engagement. Better readers tend to return to the text to clarify their thinking when answering research questions (Allington, 1981). Poorer readers recall literal information from memory and do not revisit the text or indicate that the text was the place to find the answer or clarify their thinking questions (Allington, 1981). Their responses to most questions reflect a lack of awareness, interest, and motivation (Allington, 1981).

The prevalent and historical use of content-area textbooks suggests they are staples in the diet of elementary and middle-school children. Recent years have brought new understandings about how children process information, particularly expository information (Beck & McKeown, 1989; Williams et al., 2005). Consequently, strategies were developed and designed to encourage interactions with text and guide readers through procedural sequences to maximize comprehension (Loxterman et al., 1994).

A companion to strategy development is the quality of text read. Content-area text structures and text coherence have long been scrutinized for their inconsistent construction, vague attention to topics, difficult lexicon, and ineffective and inefficient alignment of theory and practice (Fang, 2006; Loxterman et al., 1994). Kragler et al. (2005) stated that vocabulary words are generally explained from the teacher's content-area manual in the primary grades. Kragler et al. (2005) also stated the following:

> If textbooks are the primary tools that teachers use to teach science and social studies, it is going to be very difficult for teachers to provide the necessary assistance to help students effectively comprehend these materials in their current form. (p. 258)

Text structure and text coherence form fundamental conceptual relationships from which students build future understandings (Beck & McKeown, 1989). Moss and Hendershot (2002) reasoned that the most common and available medium to facilitate ownership of learning is the provision of authentic quality fiction and informational texts to perpetuate what Piaget called a state of *disequilibrium*. Savery and Duffy (1995) characterized this mental perplexing as a motivational structure for learning. It has been demonstrated that nonfiction and informational text are highly interesting and motivating to all elementary age students (Moss, 1991; Moss & Hendershot, 2002). Conjoining mental curiosities and high interest texts appears to enhance students' comprehension abilities (Albright, 2002).

Perhaps, an integration of teacher textbook mediation and mediation of supplemental nonfiction text sets will motivate, interest, and create a metacognitive awareness about the processes and procedures involved in comprehending expository information as was the case with Radcliffe et al. (2003). During this single-group design study of 4 weeks, students were taught to use comprehension strategies to better understand their textbooks. Importantly, modifications to strategies were implemented in response to informal assessments of student progress and content difficulty. Findings showed increased higher order thinking on concept maps and increased use of strategies when independently reading (Radcliffe et al., 2003). These findings indicate that teacher mediation between students and textbooks is a key component for textbooks to serve as useful and effective instructional materials in the classroom. A similar finding is noted in Williams et al.'s (2005) second-grade strategy comprehension instruction. Williams et al. (2005) found that verbal mediation of text by way of cueing and explanations is an effective technique to enhance expository text comprehension. Students need opportunities to work with knowledge, see it applied, and apply it independently through the transmediation of read-alouds.

Implications for Educational Research and Practice

Findings from this study may enhance the corpus of research interested in the role of speaking and listening in developing vocabulary. At the state level, language delays have been repeatedly recognized as a primary culprit in comprehension difficulties. One potential response is nonfiction interactive read-alouds which incorporate all of the language arts processes (speaking, listening, reading, writing, viewing, and visual representation). The simultaneous development of these processes through interactive read-alouds may provide richer, more precise information about where mental processing of content-area language, oral and print, is breaking down. The modeling and scaffolding required of the teacher and the students may provide the impetus to explore the "talk" that surrounds the text.

Particularly in the state of Mississippi, teachers could potentially benefit from clearer guidelines concerning the development of strategic reading, writing, speaking, and listening in the context of content-area instruction. Also, data collected could offer insight on how children process content-area science vocabulary which would better inform pedagogy. RAND (2004) concluded that vocabulary research should prioritize "conditions that improve comprehension--types of texts, words, readers, and outcomes" (p. 727).

The primary implication for research and practice is that it informs teaching and learning. In a broader sense it ultimately seeks to inform teaching and learning so that students can be responsible citizens who critically think about precepts and concepts in all content areas.

Rationale for Depth of Vocabulary Acquisition and Development

Stahl (Stahl & Fairbanks, 1986) states "the centrality of vocabulary knowledge to mental behaviors is staggering" (p. 73). However, little progress beyond comparing the effectiveness of one vocabulary strategy to another has been documented (Nagy & Herman, 1987). Research data point to the validity and worth of strategies that demonstrate word learning such as using words in possible sentences (Stahl & Kapinus, 1991), learning words in context (Dole, Sloan, & Trathen, 1995), and utilizing semantic mapping and concept of definition techniques (Schwartz & Raphael, 1985).

Daneman (1991) premises that enhancing vocabulary acquisition and development through the use of information processing strategies positions readers to spend more time and energy grappling with ideas in text. Nagy (2004) further qualifies vocabulary instruction, stating that "only those methods that go beyond providing partial knowledge, producing in-depth knowledge of the words taught will reliably increase readers' comprehension" (p. 3). Thus, the sparseness of technical science vocabulary research in relationship to or context of interactive teacher read-alouds provides a rich and potentially beneficial reason to focus on addressing vocabulary acquisition and development, especially in content-area science.

Summary

For this literature review, a historical chronology revisited the vacillating importance of vocabulary research in the context of theoretical frameworks. An exploration of the research base concerning key measurement variables: acquisition and development of depth of vocabulary knowledge, guided interactive read-alouds, and comprehension with different text types were presented and discussed. The final section suggested implications for educational research and practice and developed a rationale for strategic development of depth of vocabulary in content-area science.

CHAPTER III

METHODOLOGY

The purpose of this quantitative study was to explore the acquisition of and the development of depth of content-specific vocabulary knowledge and any subsequent effects on comprehension. This study examined the influence of guided interactive instruction using thematic nonfiction text sets as supplements to traditional basal science textbooks on learning outcomes for fourth-grade students in a public school setting in the southeastern United States. The primary purpose was to determine to what extent guided instruction using thematic nonfiction text sets improved students' depth of vocabulary knowledge. A secondary purpose was to ascertain the effects of content-specific vocabulary knowledge depth on comprehension. This chapter will first discuss the study design and describe the participants, followed by an explanation of the important elements of instrumentation which included a sample of scoring rubrics. Further clarification of the research intricacies, such as obtaining Institutional Review Board approval, data collection, and teacher and researcher training, will be presented in the Procedures section. A final section featuring important considerations for this study will be topically summarized.

Design

Pretest, posttest, and delayed-response quasi-experimental factorial design with random assignment of intact classes consisting of approximately 24 students per class (Gay & Airasian, 2000) was used to explore the impact of guided vocabulary instruction using nonfiction text sets on students' depth of content-specific vocabulary and comprehension. The first factor, guided interactive vocabulary instruction, involved three levels: (a) guided interactive vocabulary instruction using nonfiction text sets as a supplement to basal science textbooks; (b) guided interactive vocabulary instruction using basal science textbooks only; and (c) a control group that silently read the text, looked up vocabulary words in the dictionary, wrote definitions, and answered comprehension questions at the end of each of the three 3-day lessons. The treatment group received guided vocabulary instruction with basal science textbooks. The treatment-plus group received guided vocabulary instruction with nonfiction text sets as a supplement to traditional basal science textbooks. The second factor, nonfiction text sets, consisted of three levels: (a) guided instruction with text sets in conjunction with basal science textbooks, (b) guided instruction with basal science textbooks, and (c) traditional teacher instruction with basal science text. Dependent measures were Concept of Definition Card scale scores and multiple-choice lesson or unit tests. Pretest, posttest, and delayed response for the two dependent measures, Concept of Definition Card scale scores and correct responses to multiple-choice lesson or unit tests, were collected 2 days before, 2 days after, and 2 weeks after the 12-day thematic unit.

Instructional conditions. The treatment and control group lessons took place during the assigned period for science instruction as determined by the school principal and teachers. Teacher and student assignment to treatment or control group was random. Participants in the control group received instruction via Harcourt Science for Grade 4, Mississippi Edition (Harcourt Science, 2002). Participant inclusion was based on an 80% attendance rate for 10 unit lessons as well as participation in pretest, posttest, and delayed-response data collection.

Factors. The factors were treatment type at three levels, word type at two levels, time of testing, and measure type at three levels, respectively. The control group included silently reading basal science textbook material and looking up vocabulary words, writing them down, and defining them. Treatment group received guided vocabulary instruction using basal science textbooks. Treatment-plus received guided vocabulary instruction integrating nonfiction text sets as a supplement to basal science textbooks (Harcourt Science, 2002). The study took place for 13 days, which is the duration of an average science unit. Pre-intervention assessments were given 2 days prior to the intervention start date. Each of the two classroom science teachers received two 2-hour teacher training sessions in the classroom. The unit consisted of 10 guided interactive vocabulary instructional lessons. Each lesson targeted content-specific vocabulary words found in that textbook's unit of study, Animal Growth and Adaptations. Three fourth-grade teachers (one per two classes) participated. While the control group teacher received materials (written response activity sheets) and guided instructional formats to implement the traditional science textbook, the treatment groups received materials (written response activity sheets) and guided interactive supports to implement with either basal science texts or text sets as a supplement to traditional science textbooks. Two science teachers received materials and guided interactive vocabulary instruction supports for each of the 10 vocabulary-targeted lessons based on interactive read-alouds as researched by Brabham and Lynch-Brown (2002).

Vocabulary instruction routine with nonfiction text sets. Vocabulary instructional routines using nonfiction text sets to supplement basal science textbooks resulted from extensive vocabulary acquisition and development research (Lyttle, 1982). Guided vocabulary instruction combined the potential benefits of reading aloud, thinking aloud, and students' active engagement.

Students in treatment-plus group read and were read to using nonfiction text sets in conjunction with science textbooks. Text sets included a range of reading levels, which included topically related quality nonfiction texts and quality trade books. Nonfiction text and trade book concepts were aligned with *Mississippi Science Framework* (Grade 4) (Mississippi Department of Education, 2001). Students in treatment-plus group B read and were read to using basal science textbooks. Students in control conditions silently read basal science textbooks.

Additionally, supporting nonfiction text sets were used during each of the three lesson sets. *What is a Biome? and What is a Living Thing?* were introduced during Lessons 1 to 3. Nonfiction text sets for Lessons 4 to 6 included the following: *What are Camouflage and Mimicry?* Titles for Lessons 7 to 9 included these works: *What is Migration? and What is Hibernation*?

Vocabulary notebooks captured differing types of written responses to prompts before, during, and after treatments of guided interactive vocabulary instruction as well as after the control group read the text.

Twelve vocabulary words were chosen due to their centrality to the fourth-grade basal science textbook unit: Animal Growth and Adaptations which was common text among all participants. This unit of study was divided into three 3-day lessons. Each lesson was designed around the vocabulary terms for that set of lessons. Words were semantically related and were keys to the text and topic of study.

Participants

Subjects

Participants in this study included approximately 151 fourth-grade students (70 males and 64 females) distributed among six classes in a public elementary school in the southeastern United States. A drawing was held to assign intact classes to one of the three groups: control, treatment, or treatment-plus. Demographic data compiled by the participating school report race and ethnicity distribution as 78% White (non-Hispanic), 17% African-American, and 5% Hispanic, which is scaled to district demographics. Additionally, approximately two thirds (70%) of this school's fourth graders receive reduced (59%) or free (10%) lunches.

This school has continued to uphold a level 5/5, which is a status awarded to districts that comply with 100% of the process standards, standing on yearly educational progress monitoring for the last several years (Mississippi

Department of Education, 2007). Results from the Mississippi Curriculum Test Language Arts (2006) indicated a wide range—below average, average, and above average—of reading levels for this school's student population, which was reflective of district demographics (Mississippi Department of Education, Office of Research and Statistics, 2007).

Subject Recruitment

The University of Southern Mississippi Institutional Review Board and school district policies were followed. District administrators and school principals granted permission to conduct this study in August-September of the 2007-2008 school year (see Appendix A). Approval from The University of Southern Mississippi Review Board was obtained prior to the onset of the 2007-2008 study (see Appendix B). Parents of all fourth-grade students received permission letters (see Appendix C) describing the research project's goals and assessment protocols. Student permission forms accompanied parent consent forms (see Appendix D). Parent permission and student permission letters indicating consent and assent to participate were obtained, thus indicating that students who participated did so willingly. Students who returned signed forms with parent consent and student permission were eligible for participation. Additionally, teachers signed permission forms indicating their intention to participate (see Appendix E).

Designation of a student to an intervention group or the control group was based on which teacher the student was randomly assigned to at the beginning of the school year. A computer program used by the district randomly selected and assigned students to each of the six 4th-grade homeroom classes. Students, once assigned to homeroom groups, rotate among three subject areas: language arts, science and math, and social studies. There were three content area science teachers in the fourth grade with each teacher teaching two sections of science.

One of the three science teachers had surgery during the study so those two classes were deemed the control groups because the lesson plans could successfully be implemented by a substitute. A coin toss was employed to determine placement of the remaining classes in the treatment or treatment-plus groups. The control group was comprised of approximately 47 fourth-grade students who shared the same content area science teacher. The treatment group, the two classes with guided interactive vocabulary instruction using basal science textbooks, was comprised of approximately 47 fourth-grade students who shared the same content area science teacher. Treatment-plus group, the classes with guided vocabulary instruction using nonfiction text sets as a supplement to basal science textbooks, was comprised of approximately 56 fourth-grade students who shared the same content area science teacher.

Data from students who completed pretests, posttests, and delayed-response measures and who attended 80% of unit lessons were considered in statistical analysis. A two-way MANOVA with repeated measures was conducted to answer Research Question 1. A four-way MANOVA with repeated measures (3 groups X 3 times X 2 types of words X 3 vocabulary measures) was utilized to answer Research Question 2. Guidelines for human subjects' protection, as determined by The University of Southern Mississippi's Institutional Review Board, were followed.

Instrumentation

Students meeting participation requirements were assessed using two measures: Concept of Definition Cards (see Appendix F) and multiple-choice lesson and unit tests (see Appendix G). Concept of Definition Cards (adapted from Schwartz & Raphael, 1985) was used to measure depth of vocabulary knowledge based on three 4-point rubrics. Using rubrics developed from pilot study data and The Performance Assessment Reading Comprehension Levels--Concept Oriented Reading Instruction (CORI) (Guthrie, 2003), the researcher evaluated students on their responses to three different prompts. The pretest, posttest, and delayed-response test consisted of 12 content-specific vocabulary words from students' basal science textbook. A second measure, multiple-choice unit or chapter test questions (*Harcourt Science*, Grade 4; *McGraw Hill-Science Test Preparation Practice*, Grade 4; and *Brainchild Grade 4 software*), was used to assess comprehension. Each of the assessments will be discussed below.

Depth of Vocabulary Knowledge

Concept of Definition Cards. Concept of Definition Cards (adapted from Schwartz & Raphael, 1985) has been primarily used as a strategy to assist students in the acquisition and development of vocabulary knowledge (Pike & Mumper, 2004). However, these cards may be equally beneficial as assessment tools (Schwartz & Raphael, 1985). Data compiled during a pretest/posttest pilot assessment of Concept of Definition Cards were evaluated to document and establish a broad set of criteria and performance ratings scale. The three resulting rubrics were used to assess vocabulary depth of knowledge. Concept cards were formatted in the following manner. The vocabulary word was located in the middle of a rectangle divided into four equal quadrants. In the top left-hand quadrant, students recorded what they thought the word meant and responded to the prompt: "What is it?" In the top right-hand quadrant, students recorded examples of the word and replied to the prompt: "Give examples of this word." In the left bottom quadrant, students recorded adjectives, descriptions, or novel responses that compared the word to a similar functioning idea or word and responded to this prompt: "What is it like?" In the right bottom quadrant, students visually represented their understanding of the word. However, due to length and number of assessments, this quadrant was not utilized during this study.

Research assistants were trained to interpret and score responses to the Concept of Definition Card (adapted from Schwartz & Raphael, 1985). Responses to the Concept of Definition Cards generated from a pilot assessment were analyzed and used to establish three sets of criteria and performance ratings scale. The Performance Assessment Reading Comprehension Levels--Concept Oriented Reading Instruction (CORI) (Guthrie, 2003) was initially consulted to determine gradations of quality in conceptual and depth of vocabulary knowledge subsequently used to develop rubrics (see Tables 3, 4, and 5).

Table 3

Rubric for Scoring Definitions—Quadrant 1

Level	Definition
0	No definition is given; incorrect definition is given
1	Definition is partially known; it represents a broad association; it is over-generalized and tends to be vague; the definition may preserve the general semantic domain of the word; or the definition is limited and narrowly focused. Example: "I think shelter is somewhere you stay."
2	Definition contains correct information; student does not elaborate or qualify answer. Example: "An environment is an animal's surroundings."
3	Definition is correct and the student elaborates by qualifying the definition; definition may contain more than one aspect of the word (multiple meanings), which indicates an emerging conceptualization. Example: "A shelter is a place where you are safe." Hibernation is defined as "when something goes to sleep to survive."

Table 4

Rubric for Scoring Examples—Quadrant 2

Level	Example
0	No examples are listed; incorrect examples are listed; examples listed are extremely distant in semantic proximity to the definition of the word.
1	One or more examples are listed, and they illustrate/contain one aspect of the definition; the student preserves the general semantic domain of the word, but the example is still only partially correct; the example is narrowly focused with limited conceptualization of target word. Example: An example of shelter is "where people stay in—I live in a house not a shelter"; camouflage is "a color.' These preserve the general semantic domain of the word, but the example is still only partially correct.
2	One or more examples are listed, and they illustrate/contain Important features of the definition; examples correctly represent the fullness of the definition, attribute, or characteristic; listings maintain strength in semantic proximity. Example: The student lists "sunny, rainy, foggy, snowy, and cloudy" as examples of the target word *climate*. These words describe weather, which is the amount of sunshine, rain, heat, wind, and cloud cover at a specific time and place. Climate is the average of these conditions over a long period of time. *Dry, wet, and humid* are words one might expect to see associated with climate.
3	One or more examples are listed, and they contain one or more important features of the target word; emerging conceptualization is present: The student uses words to apply definition features to multiple contexts (multiple meanings). Examples: Target word—*camouflage*: "a man hunting a deer and the man blends in with the trees"; "a chameleon changing colors to match the forest so he doesn't get eaten up."

Table 5

Rubric for Scoring Properties, Characteristics, or Descriptions "Explain What is it like?"—Quadrant 3

Level	Properties, Characteristics, or Descriptions
0	"I've never heard of this word." No properties are listed, no descriptive words are used; or properties or descriptive words are listed, but they are incorrect.
1	"I have heard of this word." One or more properties, simple characteristics, and or descriptive words are listed; listed words are partially correct; they can be broadly related; the relationship is apparent but may be too limited in scope or too general.
2	"I have heard of this word and I know what it means." One or more properties, characteristics, and or descriptive words are listed; listed words are accurate in describing target word; definition may be restated.
3	"I have heard this word; I know what it means; I can use it in a sentence. One or more properties, characteristics, and or descriptive words are listed; accuracy is present, word lists reflect emerging conceptualization; student may offer a novel analogy. Example: Camouflage is like "hiding, concealing" and not like "popping out and seeing well."

Comprehension measure. Multiple-choice questions were selected and compiled from (a) *Harcourt Science (2002),* (b) *McGraw Hill-Science Test Preparation Practice, Grade 4 (1976)*; and (c) *Brainchild, Grade 4* (2007). To establish content validity, a panel of content-area and literacy experts evaluated each lesson/unit test item. Comprehension scores were used to compare the relative impact of guided vocabulary instruction with or without text sets between (a) control group vs. treatment group, (b) control group vs. treatment-plus group, and (c) treatment group vs. treatment-plus group.

The assessments. Pretest, posttest, and delayed-response assessments measured students' responses for each of three Concept of Definition Card prompts: (a) definition of the word, (b) examples of the word, and (c) properties, characteristics, and descriptions of the word. Through modeling and practicing and prior to pretest administration, the research team familiarized students with Concept of Definition Cards. The investigator and research assistants pretested one week before implementation of the intervention. Six Concept Cards were presented as a packet. Each quadrant required a different way of thinking about the vocabulary term. Quadrant 1 prompted for a definition of the word. Quadrant 2 required examples or illustrations that demonstrated conceptualization of the word. Quadrant 3 required the student to list properties, descriptors, or characteristics of the word. Quadrant 4 asked for a visual or symbolic representation of that word.

A second assessment, comprised of items from *McGraw Hill-Science Test Preparation Practice, Grade 4 (1976)* and *Brainchild, Grade 4* (2007), was used to measure comprehension at pretest, posttest, and delayed-response assessment intervals. Questions were rated for (a) depth (deep processing) of content-specific vocabulary and (b) responses to multiple-choice, multi-level comprehension questions containing key vocabulary and or concepts by content-area experts.

Procedures

Data Collection

Upon review and approval from The University of Southern Mississippi's Institutional Review Board, the investigator trained research assistants from The University of Southern Mississippi's Department of Curriculum, Instruction, and Special Education in appropriate protocols for administering vocabulary knowledge and comprehension pretests, posttests, and delayed posttests.

Specifically, research assistants were trained to interpret and score Concept of Definition Cards. In concurrent sessions, they also were trained to teach fourth-grade participants how to respond to the prompts on the Concept of Definition Cards as well as protocols for administering comprehension measures.

Training to interpret and score Concept of Definition Cards and comprehension protocols. The investigator trained experienced research assistants from The University of Southern Mississippi's Department of Curriculum, Instruction, and Special Education in appropriate protocols for interpreting and scoring Concept of Definition Cards. Each card contained one key vocabulary term and three accompanying prompts from the upcoming science unit. A packet containing two vocabulary cards per 8 x 10 sheet of paper (front and back) for a total of five sheets per student were used. The 12 vocabulary words were evenly distributed over the course of two 45-minute sessions for each of the six classes.

1. The investigator introduced Concept Cards. Through modeling, the investigator identified each of the four quadrants and one central oval containing the vocabulary term.
2. Prompts for each of the four quadrants were reviewed.
3. Following any other discussion, research assistants explained the content and purposes of quadrants 1, 2, and 3 by thinking and modeling out loud.
4. The investigator explained and applied each quadrant's correlating rubric. Samples from pretest and posttest pilot assessment study were used in the training session. Investigators and research assistants interpreted student responses and assigned rubric values to the cards. Group discussion ensued for purposes of establishing criteria for judging each quadrant and the Concept Card as a whole.

Comprehension measure. The investigator introduced research assistants to the second measure, expert approved multiple-choice items from the following: (a) *Harcourt Science (2002),* (b) *McGraw Hill-Science Test Preparation Practice, Grade 4 (1976)*; and (c) *Brainchild, Grade 4* (2007). Research assistants were instructed to give each participating student the multiple-choice unit test. Protocols were followed to train research assistants.

Training of research assistants. Research assistants followed these procedures:

1. The research team established rapport with students, focusing attention on creating a student-friendly environment to keep anxiety at a minimum.
2. The research team explained to students that it would help teachers be better teachers if they knew what kids already knew about certain words.
3. The investigator modeled and explained how to introduce Concept Cards to fourth graders. Through hands-on practice, research assistants role-played the student and teacher. The investigator explained each of the four Concept Card quadrants following the procedures listed under Training Fourth Graders How to Use Concept Cards (see Appendix H).

The investigator introduced to the research assistants the second measure, expert approved multiple-choice items from the following: (a) *Harcourt Science (2002);* (b) *McGraw Hill-Science Test Preparation Practice, Grade 4 (1976)*; and (c) *Brainchild, Grade 4* (2007). Comprehension and vocabulary measures were assessed at the same time. Research assistants were instructed to give each participating student the multiple-choice unit test. The following protocols were implemented:

1. The research team established rapport with students.
2. The research team explained that fourth graders can help teachers learn more about how children learn.

3. The team explained to students that this is not a test and it is okay if they do not know the answer to the questions, asking that they answer each question to the best of their knowledge and assuring them that understanding how kids think about how animals live will help with the project.
4. A team member handed out copies of measure 2 and asked students to put their names and the name of their science teacher at the top of the page. Students were told when to begin the assessment and where to place their packet upon completion.
5. The research team determined that each paper had a child's name and the teacher's name at the top of the page and then thanked each student for helping with the project.
6. The investigator and research assistants reviewed and repeated the process on Day 2 of pretest, Days 1 and 2 of posttest, and Days 1 and 2 of delayed-response data collection.

Teacher implementation of lessons training. All three fourth-grade content-area science teachers were selected to participate in the quasi-experimental factorial research design. The initial teacher training session began approximately 3 weeks prior to pretesting. While one teacher (Teacher A) implemented vocabulary lessons for the control group, Teacher B implemented guided instruction using basal science textbooks, and Teacher C implemented guided vocabulary instruction using nonfiction text sets as a supplement to basal science textbooks.

The investigator conducted a 1½-hour training session with two of the three teachers who were seasoned fourth-grade teachers with over 40 years of combined teaching experience. The third teacher was absent for medical reasons. Based on Fisher et al.'s (2004) protocols, training sessions included the following: (a) an overview of the project's goals and purposes, (b) rationale behind the instructional methods and materials, (c) protocols using guided interactive vocabulary instruction for each of the 10 lessons (see Appendix I), (d) modeling of read aloud with emphasis on vocabulary, and (e) opportunities for teachers to clarify and question the procedures and protocols of lessons and materials. With the exception of one instructional session, teachers were videotaped once during each of the three phases of instruction for a total of three times.

A Fidelity of Implementation Checklist (see Appendix J) instrument was used to evaluate the integrity of each teacher's instructional delivery of guided vocabulary lessons. With the exception of one session, fidelity of implementation was assessed three times for each teacher with all three comprising 30% of the lessons: (a) the beginning (Day 1), (b) the middle (Day 5), and (c) the end (Day 9). Each indicator was assigned a point value ranging from 0 to 2 based on presence, partial presence, or absence of that indicator. Resulting percentages were calculated and reported.

Research assistants were trained according to the Fidelity of Implementation criteria. They observed the videotaped lessons, completed Fidelity of Implementation Checklists, and returned checklists to the investigator. Scored checklists were evaluated to determine the fidelity of teacher implementation and inter-rater agreement between research assistants.

Limitations

Reliability, validity, and generalizability may have been influenced by possible sensitizing of participants through exposure to the pretest. The words used in the pretest were also the targeted vocabulary words for instruction and resurfaced on the posttest as well as on the delayed posttest. Also of concern was the short duration of this study.

Additionally, a significant limitation was the use of intact fourth-grade classes from a historically high-performing school which may decrease generalizability to students from lower performing schools.

Data Analysis

A four-way multi-analysis of variance (MANOVA) with repeated measures was conducted to determine the effects of guided interactive vocabulary instruction using nonfiction trade books and science textbooks (treatment-plus), guided interactive vocabulary instruction using traditional science textbooks (treatment), and traditional basal science textbooks (control) X two word types (abstract and concrete) X three time periods (pretest, posttest, and delayed response) on two dependent variables: depth of vocabulary knowledge mean scores using three measures (definitions, examples, and characteristics) and mean comprehension scores. MANOVA was chosen over other analyses due to increased protection against a Type I error. Accordingly, MANOVA procedures with repeated measures were performed to ascertain the main effects of time, group, word types, and four interactions. Further, two-way mixed ANOVAs were conducted to examine three of the four interactions: word type X group, time X group, and word type X time yielding 18 analyses. Finally, a three-way mixed ANOVA was conducted to examine the fourth interaction of word type X time X group.

A two-way mixed ANOVA with repeated measures 3 (group: control vs. treatment vs. time) X 3 (time: pretest vs. posttest vs. delayed response posttest) was performed to analyze the multiple-choice comprehension measure. The main effect of group yielded no significant difference; however, this analysis revealed significant differences for the main effect of time and an interaction of time X group. Accordingly, one-way ANOVAs were performed to examine the interaction of time X group, which yielded six simple effect results. Cohen's (1977) effect sizes (.10 small effect, .25 moderate effect , and .40 large effect) were employed to further interpret data.

Research Questions

The following research questions were investigated in this study:

1. Did guided interactive read-alouds using nonfiction text sets improve depth of content-specific vocabulary?
2. Did guided interactive read-alouds using nonfiction text sets as a supplement to basal science texts improve depth of content-specific vocabulary to a level that improves comprehension?

Two-way and four-way MANOVAs with repeated measures were used to evaluate the following hypotheses:

1. There will be differences in depth of vocabulary knowledge mean scores for students who participate in guided interactive vocabulary instruction using informational and nonfiction trade books/text sets, those who participate in guided vocabulary instruction using traditional science textbooks, and those who participate in traditional basal science instructional formats.
2. There will be differences in mean comprehension scores for students who participate in guided interactive vocabulary instruction using informational and nonfiction trade books or text sets, those who participate in guided interactive vocabulary instruction using traditional science textbooks, and those who participate in traditional basal science textbooks.

Summary

In summary, approximately 134 fourth graders from a traditionally high-performing school in the southeastern United States participated in a multiple-variable research study. The fourth graders were evenly distributed among six classes which were further combined into three groups (control, treatment, and treatment-plus) by science teachers. In other words, there were three teachers who teach science to two different groups during the day. One of the teachers had surgery at the onset of the study so the students under her charge were deemed the control group because the lesson plans for the control group could be easily implemented by a substitute. The remaining teachers each taught one treatment and one treatment-plus group. Students were tested three times:

pretest, posttest, and delayed-response (2 weeks after the posttest). For each testing period, students responded to two instruments: Twelve Concept of Definition Cards on three measures (definitions, examples, and characteristics) classified as two word types: abstract words and concrete words and one 22-item, multiple-choice, multi-level comprehension test. A four-way MANOVA with repeated measures was conducted to analyze data for the vocabulary assessment and a two-way MANOVA with the repeated measure of time was conducted to analyze data for the comprehension assessment.

Analyses of data will be discussed in Chapter IV.

CHAPTER IV

ANALYSIS OF DATA

This chapter progresses from demographic discussions and teacher fidelity of implementation statistics to an exploration of descriptive and inferential statistics on two key measurement variables: depth of technical science vocabulary and multiple-choice comprehension measures. A final section summarizes statistical outcomes.

Demographics

To assess demographic (i.e., gender and ethnicity) similarities across the three groups of 127 participants, a chi-square analysis was conducted. Analysis of gender distributions indicated that gender proportions did not differ across groups. Specifically, males were evenly distributed among control (61%), treatment (40%), and treatment-plus (55%) groups. Additionally, females were evenly distributed among control (40%), treatment (60%), and treatment-plus (46%) groups.

A majority of participants were Caucasian (80%) followed by African American (16%) and Hispanic (4%). Groups' analyses showed ethnicity distributions within control group as Caucasian (74%), African American (18%), and Hispanic (7.9%) and similar ethnicity distributions within the treatment group as Caucasian (88%), African American (12%), and Hispanic (0%). Treatment-plus group showed distributions as Caucasian (77%), African American (18%), and Hispanic (4.5%) (see Table 6). These demographics are consistent with district demographics.

Table 6

Demographic Distributions

Distribution	Control[a] *n*	Control[a] %	Treatment[b] *n*	Treatment[b] %	Treatment-Plus[c] *n*	Treatment-Plus[c] %
Gender						
Male	23	60.5	17	39.5	24	54.5
Female	15	39.5	26	60.5	20	45.5
Ethnicity						
African American	7	18.4	5	11.6	8	18.2
Caucasian	28	73.7	38	88.4	34	77.3
Hispanic	3	7.9	0	0.0	5	4.0

[a]*n* = 38. [b]*n* = 43. [c]*n* = 44.

Fidelity of Implementation

Each of the three teachers was videotaped three times, one time per lesson phase. Videotapes were observed and fidelity of implementation was rated on a scale of 0 to 2 on each of 12 indicators. Two raters independently rated implementation of nine lessons, three per teacher. Resulting scores were computed and assessed by percentage agreement.

Pretest Group Equivalency

One-way ANOVAs (analysis of variance) were conducted to ascertain depth of word knowledge group equivalence on six vocabulary measures at the pre-treatment testing phase. The Bonferroni post hoc test, with an adjusted alpha of .008 (.05 divided by 6), was employed to determine whether groups were different from each other on each of the six vocabulary measures. Vocabulary words were classified as *abstract* or *concrete*, with a final distribution of six words per category. Depth of word knowledge was then evaluated on three measures for abstract words and three measures for concrete words: definitions, examples, and characteristics. Results ($p < .008$) substantiated that there were no significant main effects for groups on the six pre-vocabulary measures as follows: abstract definitions, $F(2, 131) = 2.77$, $p = .07$; concrete definitions, $F(2, 131) = 1.13$, $p = .05$; abstract examples, $F(2, 131) = 3.79$, $p = .03$; concrete examples, $F(2, 131) = 4.12$, $p = .02$; abstract characteristics, $F(2, 131) = 1.96$, $p = .15$; and concrete characteristics, $F(2, 131) = 1.40$, $p = .25$.

Data Analysis Summary

Analysis Overview

A four-way multivariate analysis of variance (MANOVA) with repeated measures was conducted to determine the effects of guided interactive vocabulary instruction using nonfiction trade books and science textbooks (treatment-plus), guided interactive vocabulary instruction using traditional science textbooks (treatment), and traditional basal science textbooks (control) X two word types (abstract and concrete) X three time periods (pretest, posttest, and delayed response) on two dependent variables: depth of vocabulary knowledge mean scores using three measures (definitions, examples, and characteristics) and mean comprehension scores. MANOVA was chosen over other analyses due to increased protection against a Type I error. Accordingly, MANOVA procedures with repeated measures were performed to ascertain the main effects for time, group, word types, and four interactions. Further, ANOVAs were used to follow up the four interactions: word type X group, time X group, word type X time, and word type X time X group.

A two-way mixed ANOVA with repeated measures 3 (group: control vs. treatment vs. time) X 3 (time: pretest vs. posttest vs. delayed response posttest) was performed to analyze the multiple-choice comprehension measure. There was no main effect for group; however, this analysis revealed a significant main effect for time and an interaction of time X group. Accordingly, one-way ANOVAs were performed to examine the interaction of time X group, which yielded six simple effect results. Cohen's effect sizes (.10 small effect, .25 moderate effect , and .40 large effect) were employed to further interpret data.

In summary, definitions, examples, and characteristics measures' means showed significant increases for the treatment and treatment-plus groups but not the control group. The main effect for word type revealed significant increases for concrete word types over abstract word types. Additionally, main effect for time revealed significant increases from most pretest to posttest and most pretest to delayed response testing periods. However, increases were not typically noted from posttest to delayed response testing periods. Finally, comprehension measures revealed increases at posttest and a sustained increase at delayed response for the two treatment groups but not for the control group. The control group demonstrated a slight increase at posttest and a slight decrease at delayed response.

Group effect definitions, characteristics, examples vocabulary measure. Specifically, the main effect for group revealed difference on definition's measure. Mean differences between treatment and control groups were (M = .42), treatment-plus group and control groups (M = .25), but not treatment and treatment-plus groups (M = .17). These differences were significant between the intervention groups and the control group ($p < .001$) but not between the intervention groups ($p < .10$).

For the characteristic's measure, mean increases between the treatment and control groups (M = .36), treatment and control groups (M = .24), and the treatment and treatment-plus groups (M = .12) were observed. However, significant differences were only noted for the treatment and control group ($p < .001$) and the treatment-plus and the control group ($p < .001$).

For the example's measure, groups did not behave as they did on definitions and characteristics measures. Mean increases were noted between the treatment and treatment-plus group (M = .28), the treatment and control groups (M = .48), and between the treatment-plus and control group (M = .20). On this measure, the treatment group significantly outperformed the treatment-plus and control groups. However, there were no significant differences between the treatment-plus and control groups.

Word type main effect definitions, characteristics, and examples vocabulary measures. For the main effect for word type, the mean differences on the definition's measure was $M = .11$, the examples measure was $M = .06$, and the characteristic's measure was $M = .09$. Significant differences were noted on the definitions ($p <. 001$) and characteristics ($p < .001$) and the example's measure ($p = .009$). For each of the measures, concrete words were significantly higher than abstract words.

Time main effect for definitions, characteristics, and examples vocabulary measures. For the main effect for time, the mean differences on the definitions' measure from pretest to posttest ($M = .27$), pretest to delayed posttest ($M = .23$), and posttest to delayed posttest ($M = .04$) were significant from pretest to posttest and pretest to delayed posttest. The mean differences on the examples measure from pretest to posttest ($M = .23$), pretest to delayed posttest ($M = .27$), and posttest to delayed posttest ($M = .04$) were significant from pretest to posttest and pretest to delayed posttest but not posttest to delayed posttest. Characteristic's measure from pretest to posttest ($M = .15$), pretest to delayed posttest ($M = .16$), and posttest to delayed posttest ($M = .01$) revealed significant differences from pretest to posttest ($p < .001$) and pretest to delayed response ($p < .001$) but not posttest to delayed posttest.

Comprehension measure. Mean increases for the comprehension measure for the treatment group included pretest to posttest ($M = 6.1$), pretest to delayed response ($M = 10.7$), and posttest to delayed posttest ($M = 4.7$). Mean increases for the treatment-plus group included pretest to posttest ($M = 11.1$), pretest to delayed response ($M = 14.0$), and posttest to delayed posttest ($M = 2.9$). Mean increases for the control groups included pretest to posttest (*M* = 5.4), pretest to delayed response (*M* = 4.1), and posttest to delayed response (*M* = 1.4). Significant differences were observed for the treatment group's pretest to posttest ($p < .001$) and delayed response ($p < .001$) and the treatment-plus group's pretest to posttest ($p < .001$) and pretest to delayed response ($p < .001$). However, the control group increases were not significant.

Research Question 1

Research Question 1 was as follows: Did guided interactive read-alouds using basal science textbooks with/without supplemental nonfiction trade books improve depth of content-specific vocabulary knowledge? To answer this research question, a four-way MANOVA was conducted. Significant main effects were revealed in three main effects for time, group, and word type on each of the vocabulary dependent measures of definitions, examples, and characteristics. Additionally, significant main effects were found for the interaction of time X group.

The first hypothesis predicted significant main effects of the mean in vocabulary scores across three measurement times (pretest, posttest, and delayed response posttest) among the three groups (control, treatment, and treatment-plus). Student responses were evaluated and assigned a score ranging from 0 to 3. A low score of 0 represented incorrect and or no response answers, while the highest score of 3 required a novel use of the targeted word. Scores were averaged for each of the six vocabulary measures: abstract and concrete definitions, abstract and concrete examples, and abstract and concrete characteristics.

Overall, mean scores indicated that student responses for definitions, examples, and characteristics were fairly low for all groups. Collectively, students did not perform well on vocabulary depth of knowledge measures. However, the treatment and treatment-plus groups appeared higher than the control group on all measures. Both of these groups tended to follow very similar patterns. Specifically, the two treatment groups increased substantially at posttest and either declined or stabilized at the delayed posttest; whereas the control group seemed to decline at posttest but increase at delayed posttest.

Standard deviations tended to be somewhat high and characteristically almost equal to and or larger than the mean. These wide variations could indicate skewed data. Data analyses revealed that there were many scores of 0 and 1 and not many scores of 2 or 3, thus indicating the lower means and wide variances in standard deviations (see Table 7).

Table 7

Means and Standard Deviations of Depth of Vocabulary Knowledge

Vocabulary knowledge	Pretest		Posttest		Delayed response	
	M	*SD*	*M*	*SD*	*M*	*SD*
Definitions abstract						
Control	.38	.28	.35	.37	.54	.54
Treatment	.66	.60	1.09	.80	.97	.64
Treatment-plus	.58	.52	.99	.63	.68	.56
Definitions concrete						
Control	.48	.28	.35	.37	.54	.54
Treatment	.66	.60	1.09	.80	.97	.64
Treatment-plus	.58	.52	.99	.63	.68	.56
Examples abstract						
Control	.30	.30	.29	.37	.57	.57
Treatment	.59	.48	1.02	.86	1.00	.79
Treatment-plus	.48	.48	.83	.58	.58	.54
Examples concrete						
Control	.38	.36	.38	.42	.68	.62
Treatment	.74	.68	1.00	.92	1.14	.90
Treatment-plus	.46	.48	.81	.53	.62	.57
Characteristics abstract						
Control	.32	.29	.15	.22	.41	.51
Treatment	.49	.46	.81	.80	.76	.49
Treatment-plus	.47	.46	.76	.57	.49	.49

(*table continues*)

Table 7 (*continued*)

Vocabulary knowledge	Pretest		Posttest		Delayed response	
	M	*SD*	*M*	*SD*	*M*	*SD*
Characteristics concrete						
Control	.40	.34	.32	.43	.57	.54
Treatment	.59	.49	.81	.80	.86	.82
Treatment-plus	.46	.54	.80	.57	.62	.63

Note. Scale = 0 to 3 on each measure.

Multivariate analyses revealed significant main effects for group, word type, and time and interactions on vocabulary dependent measures of definitions, examples, and characteristics. Post hoc with a corrected Bonferroni was conducted on significant multivariate analyses (see Table 8).

Table 8

Means for Group Effect, Word Type Effect, and Time Effect

Effect	Definitions	Examples	Characteristics
Group			
Control	.53	.49	.36
Treatment	.95	.91	.72
Treatment-plus	.77	.63	.60

(*table continues*)

Table 8 (*continued*)

Effect	Definitions	Examples	Characteristics
Word Type			
Abstract	.70	.63	.52
Concrete	.80	.69	.60
Time			
Pretest	.58	.49	.46
Posttest	.85	.72	.61
Delayed posttest	.81	.76	.62

Main effect for group. For the main effect for group, differences were observed. Specifically, definition's measure contained the highest mean score among all three groups which was followed by examples and characteristics, respectively. The means demonstrated a recurring behavior in both group performance and measure performance in that the treatment and treatment-plus groups appeared to score higher than the control group on each of the three measures.

MANOVA results indicated main effects for treatment, treatment-plus, and control groups. Greenhouse-Geisser analyses revealed main effects for groups on the following: definitions, $F(2, 124) = 7.5$, $p = .001$, $\eta^2 = .11$; examples, $F(2, 124) = 9.3$, $p = .001$, $\eta^2 = .13$; and characteristics, $F(2, 124) = 6.4$, $p = .002$, $\eta^2 = .09$. Though differences were revealed, effect sizes were relatively small (.10 small, .25 moderate, and .40 large). LSD post hoc results for group main effect for definitions and characteristics indicated that both the treatment and treatment-plus groups scored higher than the control group, but did not score dissimilar from one another. Conversely, LSD post hoc results for group main effect for examples indicated that the treatment group significantly outperformed the control group and the treatment-plus group, but the control and treatment-plus scores are not different from one another. Except for the examples measure, the treatment and treatment-plus groups consistently outperformed the control group. However, no differences were noted between treatment and treatment-plus groups.

Main effect for word type. The 12 science words, classified by degree of tranquility, resulted in 6 abstract words and 6 concrete words. Outcome means for word type followed an anticipated pattern in that concrete word scores were significantly higher than abstract word scores across all three measures.

Significant main effects for word type (abstract vs. concrete) were also noted, Wilks Λ = .854, $F(3, 122) = 6.92$, $p = .001$, $\eta^2 = .15$. Furthermore, univariate ANOVA revealed significant differences for word type for definitions, $F(1, 124) = 18.7$, $p = .001$, $\eta^2 = .13$; examples, $F(1, 124) = 7.13$, $p = .009$, $\eta^2 = .054$; and characteristics, $F(1, 124) = 12.17$, $p = .001$, $\eta^2 = .089$. However, multivariate effect sizes were small (.10 small, .25 moderate, and .40 large). Abstract and concrete words seemingly behave in the same way in that scores for concrete words were significantly higher than scores for abstract words across definitions, examples, and characteristics measures.

Main effect for time. Outcome means from the main effect for time indicated increases from pretest to posttest and a slight decline or stabilization at delayed posttests across measures. It appears that definition's scores at pretest, posttest, and delayed response tended to be the strongest on the three measures. Examples pretest, posttest, and delayed response were next followed by characteristics pretest, posttest, and delayed posttest.

Multivariate analyses showed significant multivariate time effects, Wilks $\Lambda = .70$, $F(6,119) = 8.7$, $p = .001$, $\eta^2 = .31$. A moderate effect size was observed. Univariate analyses revealed significant time effect differences for definitions, $F(2, 124) = 26.0$, $p = .001$, $\eta^2 = .17$; examples, $F(2, 124) = 22.2$, $p = .001$, $\eta^2 = .15$; and characteristics, $F(2, 124) = 1.0$, $p = .001$, $\eta^2 = .07$.

Time Effect Definitions, Characteristics, Examples Vocabulary Measure. Though relatively small effect sizes were noted across measures, the definition measure was slightly higher (.10 small, .25 moderate, and .40 large). Pair-wise comparisons for definitions revealed that posttests and delayed posttests were higher than pretests. However, no difference was found between posttests and delayed posttests.

Likewise, pair-wise comparisons for characteristics revealed that pretests and posttests differed significantly and that pretests and delayed posttests differed significantly. Posttest and delayed posttest scores continued to be higher than pretest scores; whereas no differences were found between posttests and delayed posttests.

Furthermore, pair-wise comparisons for examples revealed that posttests and delayed posttests were significantly higher than pretests. However, posttests and delayed posttests did not differ significantly from one another.

Table 9

Collapsed Means and Standard Deviations with Repeated Measures of Depth of Vocabulary Knowledge

Vocabulary knowledge	Treatment[a]		Treatment-Plus[b]		Control[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Definitions						
Pretest	.73	.57	.58	.49	.42	.29
Posttest	1.07	.74	.99	.57	.49	.41
Delayed	1.03	.67	.75	.55	.66	.55
Characteristics						
Pretest	.54	.42	.46	.47	.36	.29
Posttest	.81	.75	.78	.55	.24	.30
Delayed	.81	.70	.56	.53	.49	.50
Examples						
Pretest	.67	.54	.47	.46	.34	.29
Posttest	1.00	.86	.82	.53	.33	.37
Delayed	1.10	.81	.60	.52	.63	.56

[a]*n* = 44. [b]*n* = 45. [c]*n* = 38.

Multivariate results (dependent variables of definitions, examples, and characteristics). MANOVA revealed a significant main effect for time, $F(12, 238) = 3.28$, $p = .001$, $\eta^2 = .142$ (see Figures 1-6). Specifically, the pretest and posttest measures were significantly lower than either the posttests or delayed posttests, the latter not being different from each other. The same analysis showed no effect for word type.

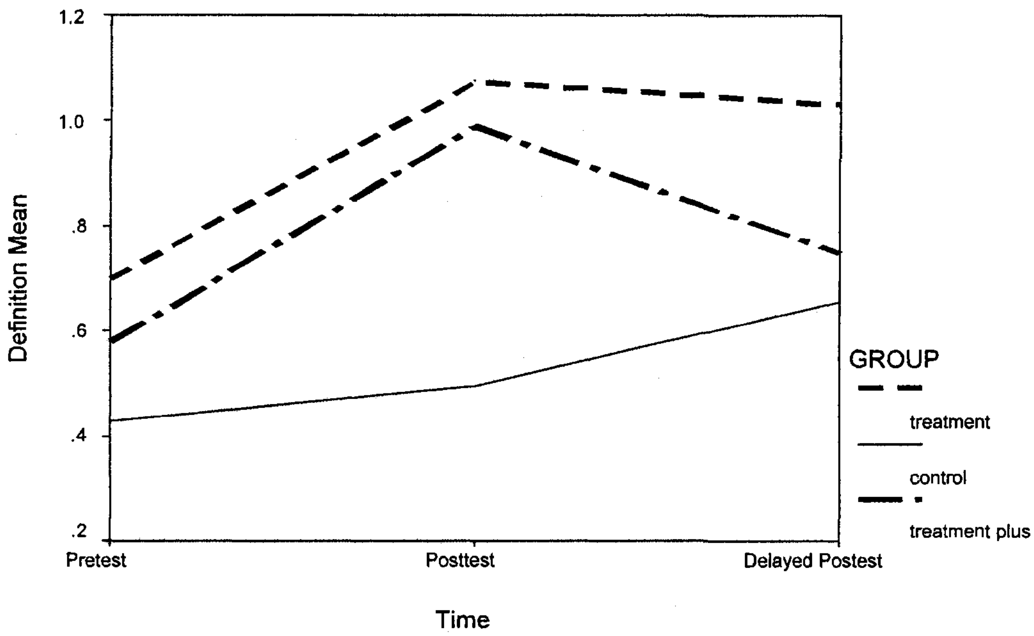


Figure 1. Time X group vocabulary definitions.

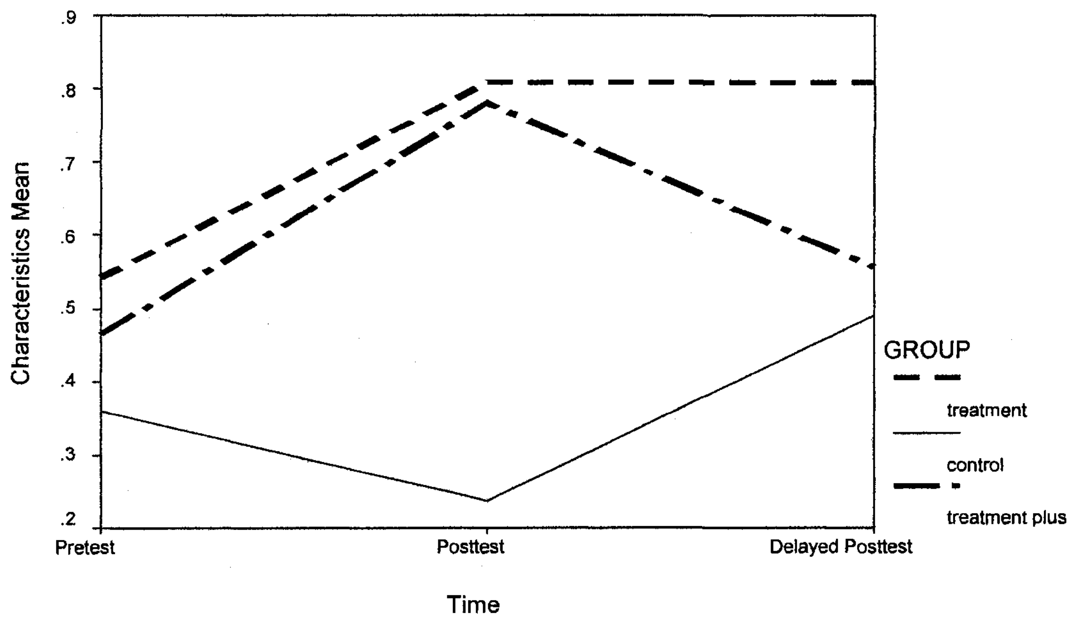


Figure 2. Time X group vocabulary characteristics.

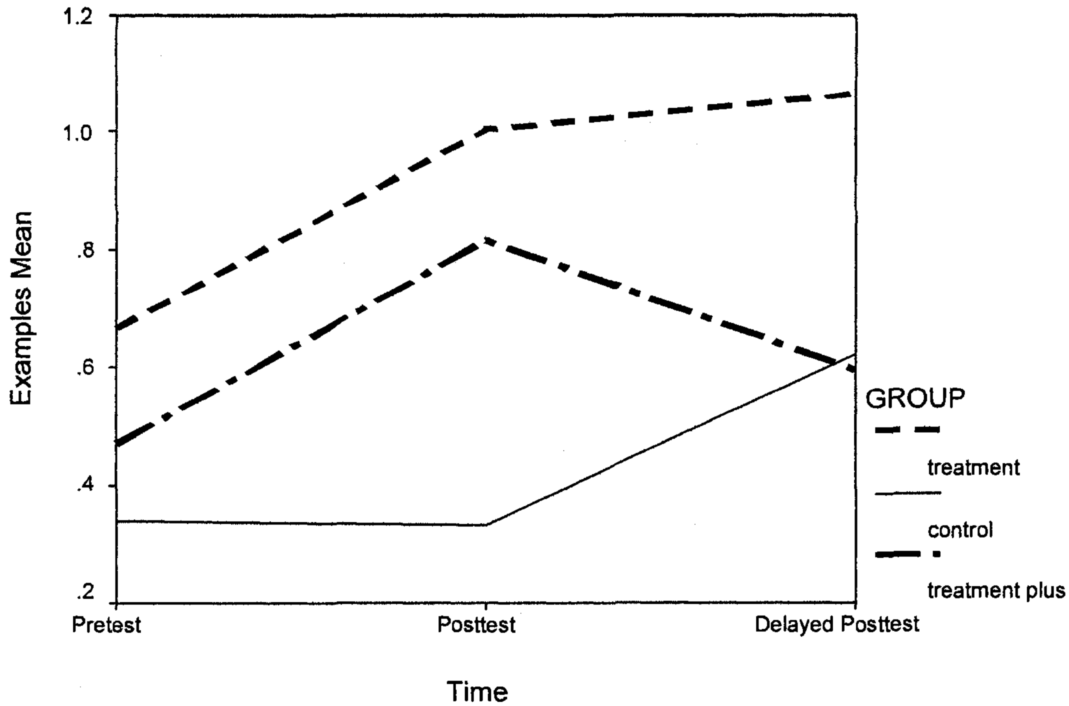


Figure 3. Time X group vocabulary examples.

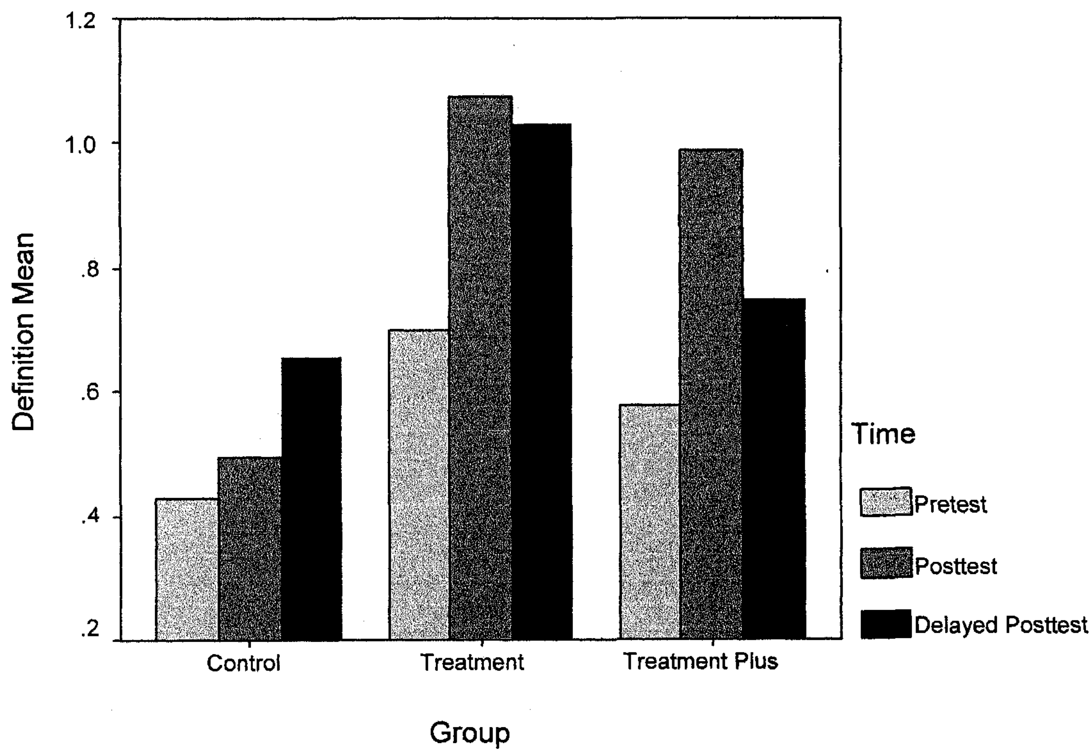


Figure 4. Group X time definition.

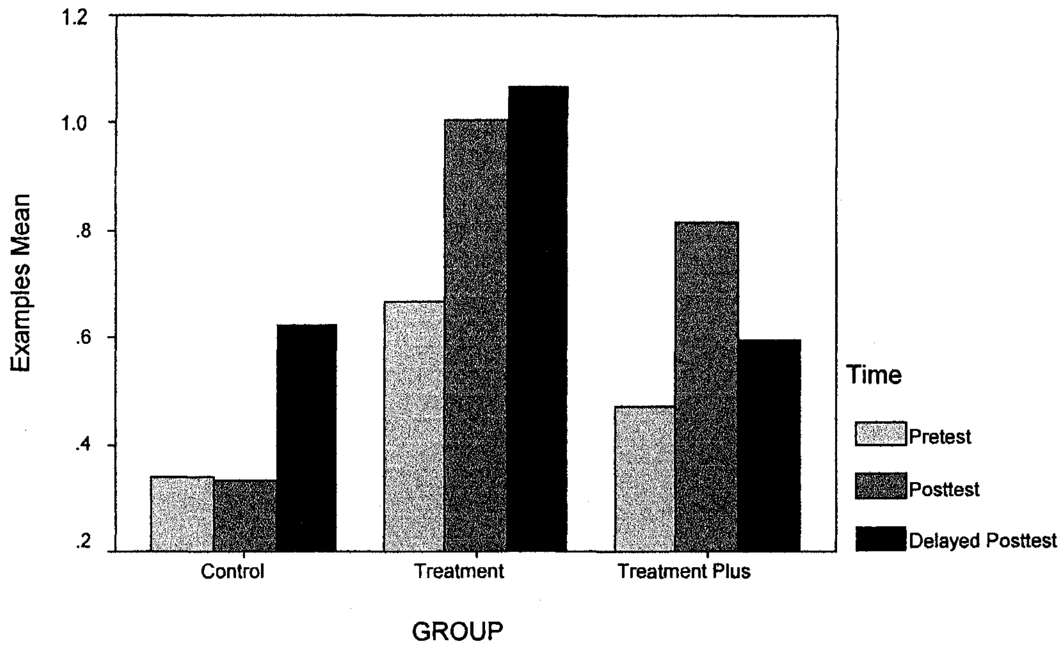


Figure 5. Group X time examples.

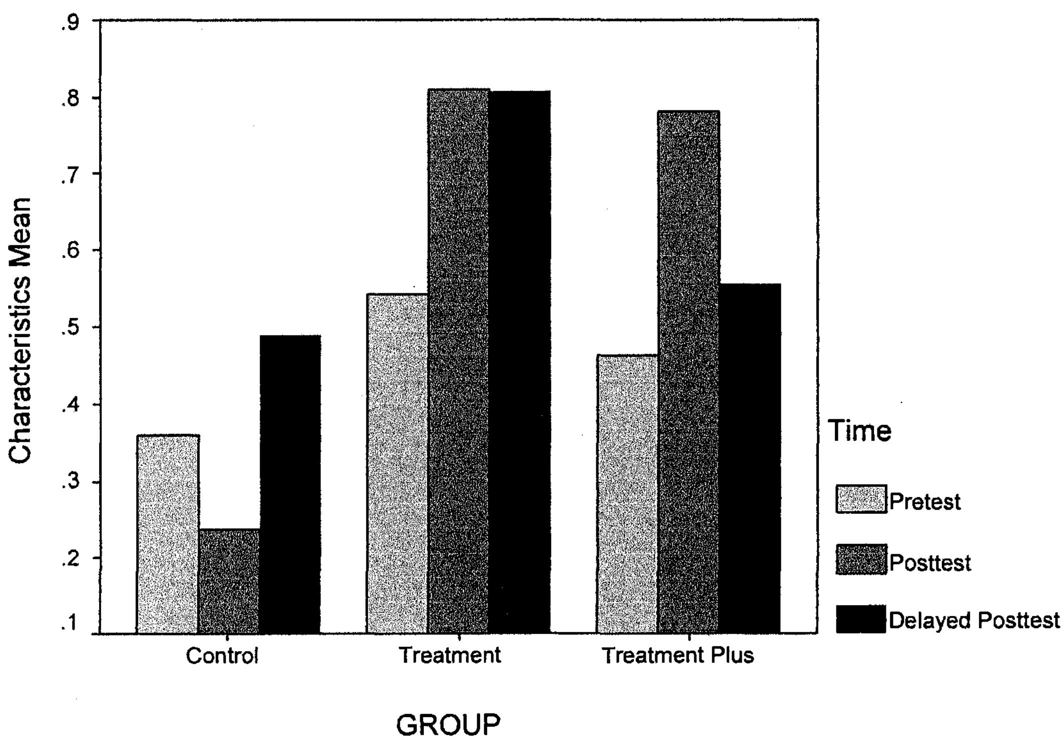


Figure 6. Group X time characteristics.

A simple effects ANOVA across treatment groups was conducted by first collapsing concrete and abstract means which resulted in the following nine dependent vocabulary measures: (a) pre-definition, (b) pre-characteristics, (c) pre-examples, (d) posttest definitions, (e) posttest characteristics, (f) posttest examples, (g) delayed posttest definitions, (h) delayed posttest characteristics, and (i) delayed posttest examples (see Table 10).

Table 10

Means and Standard Deviations of Collapsed Concrete and Abstract Means (One-Way Vertical Interactions) Depth of Vocabulary Knowledge

	Control		Treatment		Treatment-Plus	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*
Post definitions	.48	.41	1.07	.74	.98	.57
Post examples	.33	.36	1.00	.86	.81	.52
Post characteristics	.23	.29	.81	.75	.77	.54
Delayed examples	.63	.55	1.00	.82	.60	.52

Note. Scale = 0 to 3.

Using the Bonferroni procedure, each ANOVA was evaluated with an adjusted alpha of .005 (.05 divided by 9). Tukey's honestly significant differences (HSD) post hoc analyses revealed no significant differences on five of the nine measures. Specifically, significant changes were not noted on any of the three pretests: definitions pretest (p = .045), characteristics pretest (p = .176), or examples pretest (p = .015). Additionally, no significant changes were found on delayed characteristics posttest ($p = .094$) nor the delayed definitions posttest ($p = .026$). Alternately, main effects for all three posttests and one delayed examples posttest were revealed. Specifically, posttest definitions ($p < .001$), posttest examples ($p < .001$), posttest characteristics ($p < .001$), and a delayed examples posttest ($p = .005$) were significantly different. Main effects manifested in that the two treatment groups scored significantly higher than the control group on each posttest measure. Alternately, the treatment group significantly outperformed the treatment-plus and the control group on the delayed posttest examples measure. Main effects were not revealed for the treatment-plus group and the control group on the delayed examples posttest measure. Groups were different in that the treatment group revealed significant differences on the delayed posttest examples measure, but the treatment-plus group and the control group were not.

Collapsed abstract and concrete word type means were used in the simple time effect analyses across groups for definitions, characteristics, and examples. Overall, time effect for definitions and characteristics across treatment groups revealed that the treatment and treatment-plus groups scored higher than the control group. Posttests and delayed posttests were significantly higher for the treatment and treatment-plus groups but not for the control group, with the exception of the delayed examples posttest. Conversely, time effect for examples across treatment groups revealed that treatment and treatment-plus groups scored significantly higher at posttest than delayed posttests and the control group scored significantly higher from pretest examples to delayed examples posttest.

Group behavioral patterns emerged across the definitions, examples, and characteristics measures. The control group seemed to decline at posttest, but increased at delayed posttest; whereas, the two treatment groups increased drastically at posttest and declined slightly at delayed post. The two treatment groups maintained parallel behaviors across measures. A simple effects analysis was conducted to examine the significant interactions of time by group.

Main effect for time X group. Mean increases on the definition's measure showed the treatment group's pretest to posttest (M = .34) and pretest to delayed posttest (M = .30) as an incremental improvement (0 to 3 scale). On the other hand, posttest to delayed posttest (M = .04) indicated no significant difference in performance which is an anticipated outcome typically found at the delayed posttest. These outcomes suggest that the treatment group showed an initial increase in definition knowledge and maintained that level of knowledge 2 weeks after the posttest. The treatment-plus group also showed significant mean increases from pretest to posttest (M = .41), and, though not as robust, pretest to delayed posttest (M = .17) and an unanticipated increase from posttest to delayed response (M = .24). In comparison, the mean increases for the control group on the definition's measure indicated nominal increases from pretest to posttest (M = .07), a small increase posttest to delayed response (M = .16), but a significant means increase from pretest to delayed response (M = .23).

On the example's vocabulary measure, mean increases showed significant improvement of the treatment group's pretest to posttest (*M* = .34) and pretest to delayed posttest (*M* = .40), but posttest to delayed posttest (*M* = .06) showed no significant improvement. Additionally, the treatment-plus group's mean increases on the example's measure indicated positive increases on all measures—pretest to posttest (*M* = .35), pretest to delayed posttest (*M* = .13), and posttest to delayed posttest (*M* = .22). Control groups mean increases on the example's measure indicated pretest to posttest (*M* = .008), pretest to delayed posttest (*M* = .13), and posttest to delayed posttest (*M* = .29).

Furthermore, mean increases on the characteristics measure for depth of technical science vocabulary knowledge indicated the treatment group pretest and posttest (*M* = .27) and pretest to delayed posttest (*M* = .27) but only a minimal increase from posttest to delayed posttest (*M* = .001). Treatment-plus group's characteristics measure demonstrated a significant loss in mean differences from pretest to posttest (*M* = .34) and pretest to delayed posttest (*M* = .09), and a nominal improvement from posttest to delayed posttest (*M* = .06). Control group means increases on the characteristic's measure were not significant from pretest to posttest (*M* = .12) and pretest to delayed posttest (*M* = .13). Alternately, an increase (*M* = .25) from posttest to delayed posttest was noted.

Treatment-plus group's characteristics measure demonstrated a significant change from pretest to posttest (*M* = .34) and pretest to delayed posttest (*M* = .09), and a nominal improvement from posttest to delayed posttest (*M* = .06). Control group means increases on the characteristic's measure were not significant from pretest to posttest (*M* = .12) and pretest to delayed posttest (*M* = .13). Alternately, a significant increase (*M* = .25) was found from posttest to delayed posttest.

Treatment group's behavior across definitions, characteristics, and examples indicated significant increases at posttest and a slight decline but stabilization at delayed posttest. Treatment group's definition mean scores at pretest (*M* = .733), posttest (*M* = 1.07), and delayed posttest (*M* = 1.04) followed earlier trends of increasing at posttest and slightly declining at delayed posttest. Time effect for treatment group on dependent variable definitions was significant. Follow-up pair-wise comparisons on definitions revealed significant increases from pretest to posttest ($p < .001$), pretest to delayed posttest ($p < .001$), but no significant difference from posttest to delayed posttest ($p = .391$). In other words, treatment group posttests and delayed posttests were significantly higher than pretests on the definitions measure. The trend continued for yet a second measure--characteristics. Mean scores for characteristics at pretest (*M* = .54), posttest (*M* = .81), and delayed posttest (*M* = .81) showed an increase from pretest to posttest and a stabilization from posttest to delayed posttest. Likewise, time effect for treatment group dependent variable characteristics was also significant. Furthermore, pair-wise comparisons revealed significant differences from pretest to delayed posttest ($p = .002$), but no significant difference was found from pretest to posttest

(p = .003) nor posttest to delayed posttest (p = *.983)*. This reveals that treatment group scores on characteristics were significantly higher at delayed posttest only.

Treatment group mean scores for examples at pretest (M = .67), posttest (M = 1.00), and delayed posttest (M = 1.07) demonstrated an increase at posttest, and another slight increase at delayed posttest. Even so, time effect for treatment group dependent variable examples was also significant. Pair-wise comparisons revealed significant differences from pretest to posttest (p = .001) and pretest to delayed posttest (p = .001). No significant difference was found from posttest to delayed posttest (p = .229). Both posttest and delayed posttests revealed significantly higher scores from pretest.

The second treatment group, the treatment-plus group, tended to follow a similar pattern. Mean scores for definitions at pretest (M = .58), posttest (M = .99), and delayed posttest (M = .75) indicated a substantial increase at posttest and a decline at delayed posttest. Time effect for treatment-plus group dependent variable definitions was significant. Pair-wise comparisons revealed significant differences from pretest to posttest (p = .001) and posttest to delayed posttest (p = .001) but no significant difference from pretest to delayed posttest (p = .003). In other words, from pretest to posttest and posttest to delayed posttest scores were significantly higher. Alternately, posttest scores were not significantly different from pretest scores.

Treatment-plus group mean scores for the characteristics measure at pretest (M = .46), posttest (M = .78), and delayed posttest (M = .56) demonstrated an initial increase at posttest but a significant decline at delayed posttest. Likewise, time effect for treatment-plus group dependent variable characteristics was significant. Pair-wise comparisons revealed significant differences from pretest to posttest (*p* = .001) and posttest to delayed posttest (*p* = .001) but no significant difference from pretest to delayed posttest (*p* = .140). Again, scores were significantly higher from pretest to posttest and posttest to delayed posttest. However, the slight decrease in scores on the delayed posttest resulted from pretest to delayed posttest. Additionally, mean scores for treatment-plus group examples at pretest (*M* = .47), posttest (*M* = .82), and delayed posttest (*M* = .59) indicated an initial increase at posttest but a decline at delayed posttest. Subsequently, time effect for treatment-plus group dependent variable examples was significant. Posttest (*p* = .001) scores were significantly higher than pretest scores, and delayed response (*p* = .001) scores were significantly higher than posttest scores. However, delayed posttest (*p* = .06) scores were not significantly higher than pretest scores.

Control group mean definition scores at pretest (*M*= .43), posttest (*M* = .50), and delayed posttest (*M* = .66) indicated a slight increase at posttest and a robust increase at delayed posttest. Alternately, mean characteristic's scores at pretest (*M* = .36), posttest (*M* = .24), and delayed posttest (*M* = .49) indicated a decrease at posttest but an increase at delayed posttest. Accordingly, time effect for the control group dependent variables definitions and characteristics was not significant. Control group mean examples scores at pretest (*M* = .34), posttest (*M* = .33) and delayed posttest (*M* = .63) indicated a

slight decline at posttest but a hearty increase at delayed posttest. Consequently, time effect for the control group dependent variable examples was significant. Pair-wise comparisons revealed significant differences from pretest to delayed posttest
(p = .001). Scores were significantly higher from pretest to delayed posttest but not pretest to posttest (p = .922) nor posttest to delayed posttest (p = .01).

In summary, treatment and treatment-plus groups scored significantly higher on definitions and examples posttests as well as definitions, examples, and characteristics delayed posttests. Comparatively, with the exception of examples delayed posttests, the control group did not score significantly higher on any of the vocabulary measures. Also, significant differences between the treatment and treatment-plus groups were not evident.

In response to Research Question 1, it appears that guided interactive vocabulary instruction using basal science textbooks (treatment) and or using basal science textbooks in conjunction with nonfiction text sets (treatment-plus) influences depth of vocabulary knowledge as measured by definitions, examples, and characteristics. Whereas, the absence of guided interactive vocabulary instruction seemed to negatively influence the acquisition and development of depth of technical science vocabulary knowledge as measured by definitions, examples, and characteristics. Across all measures, both treatment groups mirrored increases and decreases. However, no differences were found between the two treatment groups which suggest that the resulting significances were influenced by guided interactive read-alouds.

Research Question 2

Research Question 2 was as follows: Did guided interactive read-alouds using nonfiction basal science textbooks with or without supplemental nonfiction trade books increase depth of vocabulary knowledge to a level that improved comprehension? The second hypothesis predicted significant differences for groups among mean comprehension scores across three measurement times: pretest, posttest, and delayed response posttest across the three groups (control, treatment, and treatment-plus). To assess whether guided vocabulary instruction increases vocabulary depth of knowledge to a level that improves comprehension, a two-way ANOVA with repeated measures 3 (groups: control vs. treatment vs. treatment-plus) X 3 (time: pretest vs. posttest vs. delayed response posttest) was conducted. Additionally, one-way ANOVAs with repeated measures were used in response to time effects and the interaction effect of group by time (see Table 11).

Table 11

Means and Standard Deviations Based on Comprehension Multiple-Choice Responses by Group

	Pretest		Posttest		Delayed response	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*
Control	58	18.0	64	19.0	62	18.4
Treatment	62	17.3	68	22.0	73	16.0
Treatment-plus	58	15.4	69	16.0	72	17.0

Note. Scale = 0 to 100.

Prior to the treatments, group equivalency was substantiated using data collected from comprehension tests before the intervention. Mean comprehension scores for each group at pretest were the same for control and treatment-plus groups and similar for the treatment group. At the conclusion of the intervention, posttest data showed an increase in means for all groups. Two weeks after the posttest, delayed response posttest data showed a slight decrease for control but slight increases for treatment and treatment-plus. This finding indicates that the treatment and treatment-plus groups made significant gains from pretest to posttest and maintained that gain 2 weeks later. Alternately, the control group increased slightly from pretest to posttest but slightly decreased at delayed posttest.

Analysis of multivariate results indicated a significant main effect for time, $F(2, 108) = 46.0$, $p = .001$, $\eta^2 = .46$, as well as a significant main effect for group X time, $F(4, 216) = 3.79$, $p = .005$, $\eta^2 = .07$, but not a significant groups' main effect, $F(2, 109) = 1.43$, $p = .244$. A simple effects analysis was conducted to examine the effect of time and the interaction of group X time.

The simple effects ANOVA of time across groups did not reveal significant main effects for the control group ($p = .017$). Alternately, simple effects ANOVA ($p < .008$) on time revealed significant differences for the treatment group ($p < .001$) and treatment-plus group ($p < .001$). Further, pair-wise comparisons on the main effect for time for the treatment group showed significant increases from pretest to posttest ($p = .006$) and pretest to delayed posttest ($p < .001$) but no significant increase from posttest to delayed posttest

(p = .074). The treatment group's mean scores were significantly higher at posttest and continued to be high at delayed posttest. However, changes between posttest and delayed posttest were not observed. Likewise, pair-wise comparisons on the main effect for time for treatment-plus group differed significantly from pretest to posttest (p < .001) and present to delayed posttest (p < .001), but not posttest to delayed posttest (p = .154). In other words, posttest and delayed posttest scores were significantly higher than pretests; however, no difference was found between posttest and delayed posttest scores. Alternately, the control group showed no significant time differences from pretest to posttest (p = .009), pretest to delayed posttest (p = .038), or posttest to delayed posttest (p = .559).

A univariate ANOVA was used to examine the simple effects of groups in the interaction of group by time on dependent comprehension measures. This examination yielded three analyses. To evaluate pair-wise differences among groups by time, each ANOVA was tested using the Bonferroni follow-up procedure at the .008 (.05 divided by 6) level. Tukey post hoc results indicated that groups did not differ significantly from each other at pretest (p = .444), posttest (p = .443), or delayed posttest (p = .03) (see Figures 7 and 8).

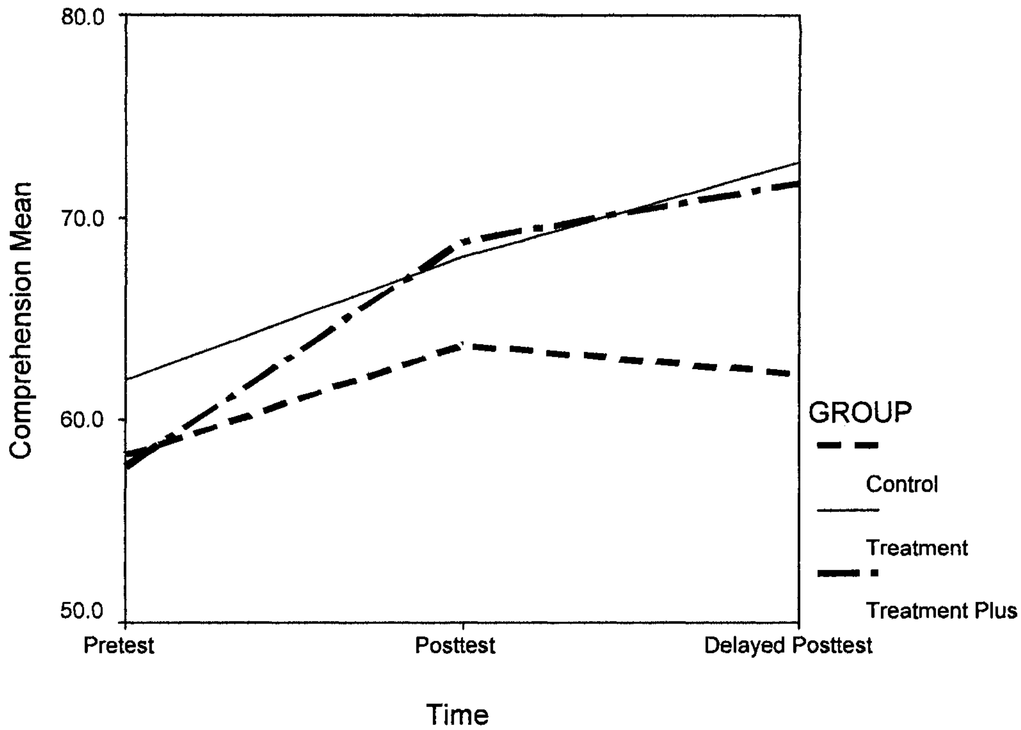


Figure 7. Time X group comprehension.

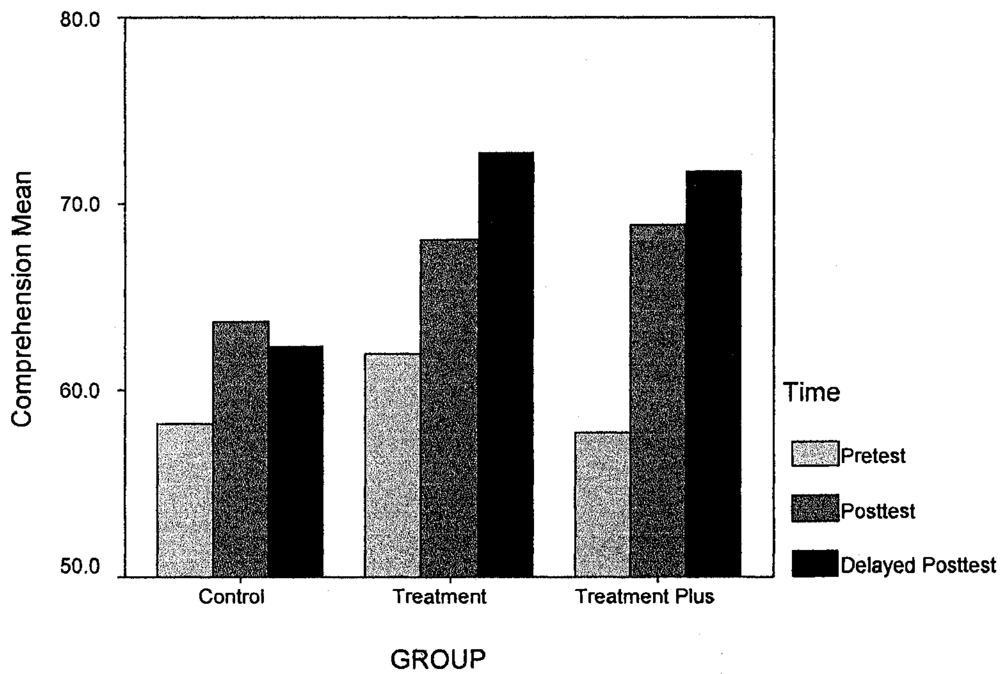


Figure 8. Group X time comprehension measure.

Results indicated significant differences in mean comprehension scores across the main effect for time for treatment and treatment-plus groups. Both treatment and treatment-plus groups' means significantly increased at posttest and maintained that increase on the delayed response posttest. Control group means were not significantly different at any one point in time on the comprehension measure.

In response to Research Question 2, guided interactive vocabulary instruction using basal science textbooks (treatment group) and or supplemental nonfiction text sets in conjunction with basal science textbooks (treatment-plus) seemed to influence depth of vocabulary knowledge to a level that improved multiple-choice comprehension scores as compared to a control group that did not receive guided interactive vocabulary instruction. Additionally, the influence of this type of instruction seemed to reflect an integration into long-term memory as demonstrated after a 2-week interval without instruction.

The effects of guided interactive read-alouds on vocabulary acquisition and development will be discussed in Chapter V. Moreover, this chapter will discuss recommendations for policy and practice, limitations of this study, and conclusions and implications for future research.

CHAPTER V

SUMMARY

RAND Reading Study Group (2004) concluded that vocabulary research should prioritize "conditions that improve comprehension--types of texts, words, readers, and outcomes" (p. 727). This study sought to respond to RAND's call by examining the effects of guided interactive vocabulary instruction using informational text sets as supplements to traditional basal science textbooks on learning outcomes for fourth-grade students. The primary purpose was to determine whether guided interactive read-alouds and think-alouds using nonfiction text sets in conjunction with basal science textbooks improved students' depth of vocabulary knowledge across three measures. Additionally, a secondary purpose was to ascertain any subsequent effects of improved vocabulary knowledge on comprehension. This chapter progresses from conclusions and discussions of Research Questions 1 and 2 on three vocabulary measures and a multiple-choice comprehension measure. A discussion of limitations and future research is followed by policy and practice recommendations.

Findings

Research Question 1

Depth of vocabulary knowledge. Research Question 1 was as follows: Do guided interactive read-alouds using basal science textbooks and or supplemental trade books improve depth of content-specific vocabulary knowledge across three key measures--definitions, examples, and characteristics?

Results from this quasi-experimental comparison of guided interactive read-alouds and think-alouds support hypothesis one, which predicted differences on definitions, examples, and characteristics vocabulary measures between students participating in guided interactive read-alouds and think-alouds using nonfiction text as a supplement to basal science textbooks, those participating in guided interactive read-alouds and think-alouds using basal science textbooks, and those participating in traditional silent reading with basal science textbooks.

The significant components of this study, teacher and peer cognitive, linguistic, and verbal mediation, call into focus undergirding principles of a sociopsycholinguistic theoretical framework. Groups emphasizing the social dimension of learning gleaned positive effects on depth of vocabulary knowledge and comprehension scores. As Morrow, O'Conner, and Smith (1990) (as cited in Brabham & Lynch-Brown, 2002) contend, "It's the talk surrounding the books that seems to make a difference" (p. 473). Differences manifested on posttest and delayed posttest for the treatment groups and the control group.

Effects of interactive read-alouds and think-alouds using basal science textbooks were statistically significant for treatment and treatment-plus groups' definitions, examples, and characteristics posttest measures. Substantial mean increases on posttests were noted across measures for the treatment (*M* = .34, definitions; *M* = .27, examples; and *M* = .43, characteristics) and treatment-plus groups (*M* = .41, definitions; *M* = .32, examples; *M* = .35, characteristics), but not the control group posttests (*M* = .07, definitions; *M* = .12, examples; and *M* = .01, characteristics). Group behaviors noted in Brabham and Lynch-Brown's (2002) read-aloud study followed similar patterns. The "just reading" group, a group similar to the control group, showed small vocabulary mean increases when compared to two other groups participating in the read-aloud style (Brabham & Lynch-Brown, 2002). Effects on the delayed examples posttest indicated that the treatment group (*M* = 1.10, examples) outperformed the treatment-plus (*M* = .60, examples) and control groups (*M* = .63, examples), which marked the first time that the treatment and treatment-plus groups did not behave similarly.

Overall comprehension results indicated that interactive read-alouds and think-alouds using basal science textbooks improved depth of content-specific vocabulary knowledge on key measurement variables of definitions, examples, and characteristics. The influence of incremental vocabulary development correlated with scores on the multiple-choice comprehension measure. The treatment group's comprehension scores at posttest paralleled vocabulary outcomes at posttest. On both measures, substantial increases were noted at posttest and a sustained effect at delayed posttest. This sustained increase is thought to be supported by the use of (a) guided interactive read-alouds and think-alouds and (b) meaningful, repetitive opportunities--integrating the language arts processes--to represent, rework, and apply knowledge using the same text and information. Teacher mediation through content-enhanced scripted read-alouds and think-alouds provided important conceptual knowledge necessary for fostering depth of vocabulary knowledge. Sustained increases on the comprehension measure reflected the contextual and the sociopsycholinguistic influences of read-alouds and think-alouds. Similarly, the treatment-plus group paralleled the treatment group's substantial increase on vocabulary across measures. However, the treatment-plus group declined on posttest examples and slightly declined on comprehension posttests. A sustained effect was noted on the delayed posttest comprehension measure but not on the delayed vocabulary measures. A contributing factor for the initial increase and subsequent decrease on vocabulary measures could lie in the amount of material to be read by the treatment-plus group. Teacher comments implied that the volume of information combined with a short science period necessitated a slightly condensed version of the read-alouds and think-alouds. Therefore, it is reasonable to assume that students had less time to deeply process information from multiple texts; thus, students quickly mapped information. Perhaps, most theoretically representative of the aforementioned scenario is Stahl's (1986) connectionist model. This model suggests that the orthographical nature of science vocabulary is used as a mental prompt to connect it to the information in the context in which it was presented (Schwanenflugel, Stahl, & McFalls, 1997). Initial exposures provide students with a vague awareness of the word as it is associated with the initial text in which the word was first encountered. Subsequent encounters serve to reinforce the quick map so that the word becomes defined, but only by the context in which it was encountered most frequently. As comprehension occurs, concepts and words integrate with other information in working memory. This integration process may or may not include important characteristics or features of a word. Attention to these important characteristics and features of a word is related to the number and quality of exposures. If a word is explicitly or implicitly defined in several sources, the mind tends to overgeneralize by broadly focusing on the definition in relationship to the text being read. The overgeneralization is associated with other information in working memory which then becomes how the child perceives the word. It is important to note that other information related to the word, such as important details, characteristics, and attributes, may substantially decrease because they were not appropriated as an important value when defining of the word Schwanenflugel et al. (1997). This may offer insight into why the treatment-plus group consistently outperformed the control group but did not produce the stronger sustained scores that the treatment group produced. However, both treatment groups produced evidence to support the theory that interactive guided read-alouds enhance the acquisition and development of science vocabulary depth of knowledge to a level that improves comprehension.

Conclusions and Discussion

This study offered support to an existing small corpus of integrated vocabulary acquisition and development research. Researchers Beck and McKeown (1991) offered an insightful perspective that captures the multidimensional components of this study when they describe the current state of vocabulary research. "Vocabulary acknowledges vocabulary acquisition as a complex process that involves establishing relationships between concepts, organization of concepts, and expansion and refinement of knowledge about individual words" (Beck, McKeown, & Kucan, 2002, p. 7). Cronbach (1942) further refines the notion of what it means to deeply know a word when he surmises that there are certain behaviors that discern and discriminate depth of word knowledge. Such behaviors include the ability to define a word, apply the word's meaning in other contexts, make accurate associations of the word to other words, use the word with precision, and apply underlying conceptual knowledge (Cronbach, 1942). It is through these frameworks that the current research was conducted and interpreted.

Recent reading aloud research suggests that even more powerful effects on vocabulary and comprehension can result from the integration of read-alouds with strategic teacher-student interactions (Brabham & Lynch-Brown, 2002). Such strategic adult and peer mediations merge the metacognitive power of think-alouds (Loxterman et al., 1994) with the power of listening and speaking (Hart & Risley, 1995). Guided read-alouds provide needed linguistic, cognitive, and verbal scaffolds when concepts and new vocabulary are introduced and practiced. By using interactive read-alouds to demonstrate and model the thinking processes used by mature readers when reading nonfiction text, teachers expose students to vocabulary in context and suggest to them just how to use the text to relate ideas and concepts (Loxterman et al., 1994).

Behavioral patterns across measures for the treatment and treatment-plus groups were quite different from the control group. A key difference is that both treatment groups received guided interactive read-alouds and think-alouds using a basal science textbook as the common text. While the control group shared the same text, they did not share the content-enhanced guided interactive read-alouds and think-alouds. It appears that peer and adult verbal, cognitive, and linguistic mediation in the context of the language arts processes of reading, writing, listening, speaking, viewing, and visually representing enhances the acquisition and development of science vocabulary. While the language arts processes work in harmony with each other, this study emphasized the role and subsequent influence of listening and speaking as a verbal, cognitive, and linguistic scaffold for deepening science vocabulary knowledge, an area for which a large corpus of research does not exist.

A hallmark of traditional vocabulary instruction is to assign students the task of defining new words, usually through looking them up in a dictionary or textbook. Of particular interest is the fact that this type of instructional activity is a rather automated mental exercise for many students. In other words, incoming data meet with little cognitive resistance. Or, as Piaget might suggest, a state of mental disequilibrium is not achieved. This path of least resistance is likened unto a mental infrastructure that organizes, stores, and retrieves information (working memory) through a process called “quick mapping” (Carey, 1978). Quick mapping, the initial stages of assimilating and accommodating information with known ideas, provides students with an anchor from which conceptual knowledge is supposedly developed. Because students are more familiar with the mental processes involved in quick mapping definitions, a kind of rote assimilation and accommodation takes place. While this procedural knowledge is desirable for the purposes of initial intake, subsequent instruction of science vocabulary must develop the overgeneralized or under-generalized quick map association to a level of emerging conceptualization with the ultimate goal of integration into long-term memory. It is the journey from quick mapping to emerging conceptualization that was the focus of the current research.

A central conviction as to what happens after vocabulary knowledge is retrieved is that it must be integrated into a core conceptual structure (Bower et al., 1994). Interactive thinking aloud refines this integration process through discussions, reflections, applications, and evaluations of word knowledge, which is what Spiro et al. (1994) eluded to when they concluded that knowledge must be represented, applied, and reworked. Guided vocabulary instruction combines the benefits of reading, writing, speaking, listening, and viewing and visual representation, which enhance students' abilities to deeply process and think critically (Loxterman et al., 1994).

A discriminating marker between the mental processes required to define words and those required to generate examples and characteristics is that the mental infrastructures for definition processing are familiar to students. Students did not have to process or navigate new or different mental infrastructures. Cognitive capacity was made available for words and word meanings to receive attention. Consequently, scores from the definition's measure represented a slightly stronger effect size than other measurement instruments. When placed in the context of how children organize, store, and retrieve technical science vocabulary, it is reasonable to assume that the cognitive familiarity of defining words served as an anchor for assimilating and accommodating unfamiliar science vocabulary and is likely an explanation for stronger scores on the definition's measure. The definition's measure showed more gain in that many treatment and treatment-plus students were at what Stahl (1986) identifies as an association level of word understanding. Students in this beginning stage partially know a word, which indicates semantic proximity to the targeted word is maintained but tends to be either overgeneralized or narrowly focused as evidenced in this student response. Environment is "a place where animals live. It is the wild." Students defining words at the association level earned a score of 1 out of a possible 3. Posttest mean scores of the treatment group (M = 1.07) and treatment-plus group (M = .99) indicated students had a partial knowledge of the targeted science vocabulary. Furthermore, delayed posttest mean scores for the treatment (M = 1.03) and treatment-plus (M = .75) groups indicated some long-term retention of partially known words. Posttest mean definition scores of the control group (M = .49) indicated that definitions were semantically distanced from even broad associations of the targeted word and did not offer precise definition features as noted in this student response--climate, "It's a rocky place where animals love to go." Alternately, the control group's delayed posttest mean scores (M = .66) indicated an increase from posttest mean scores.

While the increase is noteworthy, the mean scores of this group did not indicate that they collectively reached a level of understanding that could be represented as partial knowledge of targeted science words, or a score of 1. It is important to reiterate that silent reading, writing, viewing, and visual representation (control group) did, indeed, improve depth of vocabulary knowledge; however, the addition of verbal, linguistic, and cognitive peer and adult mediation increased those improvements to a level beyond partial word knowledge. The second stage in Stahl's (1986) progression of word understanding is comprehension. In the comprehension stage, students correctly define words but depth of word knowledge may or may not be present. Words associated with each other in the form of a definition are present, but deep word understanding may or may not be present (considered a score of 2 out of 3) as indicated in this student response. Metamorphosis is "something that changes into something else." The third and deepest word understanding is what Stahl (1986) refers to as generation and Cronbach (1942) referred to as the precise use of the word. Treatment and treatment-plus groups more frequently defined the word, used the word in a novel way, elaborated on the word, and qualified the word in some way.

The second vocabulary measure, the examples, was designed to assess the degree to which students wholistically conceptualized and represented important features of the target word. Posttest and delayed response mean scores and standard deviations for the treatment group suggested that many student responses reached a level 1, a partially correct example containing a limited conceptualization of the target word as noted in this student response. An example of shelter is "where you live" or 2, full knowledge example that represents the fullness of the definition, attribute, and or a characteristic as in this student response. An example of shelter is "My grandma lives in a trailer, that is her shelter; my sister lives in a house and that is her shelter; a tree is a shelter for animals". Treatment group posttest (M = 1.00) and delayed posttest (M = 1.10) means indicated that many students' examples correctly represented precision or fullness of the targeted word. The treatment-plus group posttest (M = .82) and delayed posttest (M = .60) indicated an initial increase but subsequent decrease in depth of vocabulary knowledge as represented on examples measures. The treatment-plus group's posttest examples indicated an increasing but limited conceptualization of the targeted word. These students preserved the general semantic domain of the words, but their examples represented either too narrow or too broad of a focus resulting in partially correct responses. The control group's mean posttest scores (M = .33) reflected either an absence of answers or incorrect answers. However, delayed posttest mean scores (M = .63) significantly improved from posttest and were comparable to the treatment-plus group's delayed posttest (M = .60). Again, this represents an improving but limited conceptualization of the target word. Results are in line with Beck and McKeown's (1991) generating examples research. They contend that when students are asked to generate an example for a partially known definition, about 50% are able to do so, which is consistent with findings from the current research. Full knowledge examples and or provision for a word's synonym rarely occurred (Beck & McKeown, 1991).

The third depth of vocabulary measure, characteristics, appeared to be the most difficult for students to organize, store, and retrieve as was demonstrated by lower scores across groups. The treatment group's posttest mean (*M* = .81) and the delayed posttest (*M* = .81) mean initially increased, followed by a stabilization. Though many students scored 1 or 2, several scores of zero indicated that attributes, properties, and descriptive terms were either not listed or the listings were too distanced from the target word. At level one, the relationship of the describing words was evident, though may have been too general or narrow in scope as was the case in this student's response. *Shelter* is like "if you did not have shelter then you could not survive" or "you stay in." For a score of 2, characteristics from the definition may be restated and or descriptive words may be listed that are accurate in describing the target word *shelter* as in this student's response. Shelter is like "to protect, to hide somewhere, to get away." The treatment-plus group significantly improved at posttest (*M* = .78) but then significantly declined at delayed posttest (*M* = .56). It appears that the storage, retrieval, and organization of characteristics had not reached automation which allows children to attend to the actual features, attributes, and or characteristics of targeted words. As the quality of responses demonstrated, the degree of familiarity with the mental infrastructures of organizing, storing, and retrieving descriptive data may influence the amount of cognitive capacity available for working with new knowledge, thus creating implications for transfer and cognitive flexibility. Efficient information processing procedures appear to support critical thinking and cognitive flexibility. Bower et al. (1994) referred to this process as developing schema scripts. Just as children develop structural expectations for what comes next in a narrative, they can develop schema scripts for nonfiction text based on type of text structure and text coherence (Williams et al., 2005). This encourages automated procedural knowledge which allows more attention toward understanding the targeted word or passages.

Results indicated that groups receiving interactive vocabulary instruction significantly improved depth of science vocabulary knowledge on definitions, examples, and characteristics at posttest and slightly declined or sustained a level of improvement at delayed posttest. However, there did not seem to be mentionable differences between the two groups who received guided interactive vocabulary instruction. In fact, the treatment group that used the science textbook and guided instruction tended to score higher and maintain those scores over time. The treatment-plus group, who used the basal science text and nonfiction trade books with guided instruction, tended to parallel the treatment group's posttest behaviors. However, unlike the treatment group, they did not maintain or stabilize, but rather slightly decreased at delayed posttest and decreased considerably on the examples delayed posttest.

Control group' posttest results indicated that students who did not participate in guided interactive vocabulary instruction did not demonstrate significant improvement on measures of definitions, characteristics, and examples at posttest. Though not significant, the control group increased slightly on definitions posttest, stabilized on examples posttest, and declined on characteristics posttest. Control group gains were consistent with the "just reading" group increases reported by Brabham and Lynch-Brown (2002). Students in a "just reading" group listened to read-alouds but did not discuss or interact with the read-aloud, a similar condition to this study's control group. "Just reading" group first graders increased vocabulary scores by 5.3% and "just reading" third graders increased scores by 12%. Comparatively, first graders who experienced interactive read-alouds increased vocabulary by 25% while third graders increased vocabulary by 27% which simulates treatment and treatment-plus groups' performances (Brabham & Lynch-Brown, 2002).

The control group's performance on delayed posttest indicates increases on definitions and characteristics measures, but these increases were not significant. Alternately, the examples measure increases showed significant improvement from pretest to delayed posttest. Clearly evidenced in this group's performance is the incidental learning that takes place when children read independently (Nagy & Herman, 1987). Additionally, the basal science textbook contains many visual supports usually representing examples. Visual supports offered in basal science texts are more often pictures representing examples of key vocabulary. Students then mentally associate a particular image with a word or concept–even if that example contains missing components. The features and characteristics that are represented as an example are synthesized intact and not analyzed. Comparatively, definitions and characteristics may require more processing and interpretation of words rather than an overall image association such as one would find in an example. Even so, students still have difficulty retrieving words to express the visual representation as was demonstrated on delayed posttest examples for all groups. A likely explanation for the phenomena is that students associated a whole picture with a particular word. In so doing, a generalized and vague knowledge about a word is created. The mental processes of generating words to describe and develop important features of a visual representation in the form of an example were left unexplored, thus affecting students' organization, storage, and retrieval capabilities as well as how they link to other stored information.

In summary, likely explanations for the similarities and differences of treatment, treatment-plus, and control group performances lie in the incremental, multidimensionality, and interrelatedness of vocabulary lessons evident in the guided interactive read-alouds. In particular, lessons were divided into three phases, each of which represented the introduction of new vocabulary words. Each phase added three new words, except for the first phase, which introduced five words. Thus, guided interactive read-aloud scripts for the first day of each phase were exactly the same for both groups. For days 2 and 3 of any given phase, the treatment-plus group responded to guided interactive scripts using nonfiction texts as a supplement to their basal science readers. The treatment group responded to the guided interactive basal science textbook read-alouds through reading, writing, speaking, listening, viewing, and visually representing. As opposed to the treatment-plus group, the treatment group had the slight benefit of a familiar textbook structure, deeper exploration of words through reading, writing, listening, speaking, viewing, and visually representing. However, the treatment-plus group worked with both their basal science textbook structures and the nonfiction trade book text structures. It appears that the treatment-plus group did not improve much beyond what Kame'enui et al. (1987) called a first mental association or a partial representation of the word. Vocabulary measures reflected how working memory processed information in that a majority of students did not extend, clarify, or use the targeted words in novel ways as often in the treatment-plus group as in the treatment group.

The text and visual representations in the nonfiction trade books provided a developed conceptual knowledge about the targeted science words. Even with guided support, time and depth of processing involved in using multiple texts indicated less is better. In other words, multiple texts are excellent tools for developing deeper understandings, but the volume and depth of information can be overwhelming for teachers and students given the 30- to 40-minute time allotments devoted to science instruction. In addition to multiple texts, text structure and text content significantly influenced depth of vocabulary knowledge. The content-enhanced guided scripts for the treatment and treatment-plus groups were designed to elaborate and extend the existing basal science text. As Stahl's (1986) connectionist model purports, text factors enhance the levels of understanding by the degree of emphasis and development of any topic (Schwanenflugel et al., 1997). The basal science texts made many assumptions about what children knew about the unit topic; thus, scripts were enhanced and developed using multiple content resources. The researcher analyzed the text for coherence and structure and found that key concepts and text structure needed detailed attention to offer students the support needed for depth of vocabulary knowledge.

Even with the aforementioned considerations, treatment and treatment-plus groups behaved similarly on posttest and delayed posttest outcomes which are in stark contrast to the performance of the control group. It appears that content-enhanced guided interactive read-alouds using basal science textbooks or content-enhanced guided interactive read-alouds using nonfiction trade books as supplements to basal science textbooks significantly improve depth of vocabulary knowledge.

Research Question 2

Comprehension. The secondary goal of this research was to explore any subsequent depth of vocabulary knowledge effects on multiple-choice comprehension measures. Beck and McKeown (1991) state that multiple-choice tests provide a "relative range" of a student's lexicon and tend to show a relationship to reading comprehension and intelligence. A particular strength of such a test is its usefulness in comparing growth and development among peers. On the other hand, Cronbach (1942) argues that multiple-choice tests are poor measurements for depth of vocabulary knowledge. Further, Cronbach states that students can have a vague or partial depth of vocabulary knowledge, yet perform well on comprehension measures. However, it is the shared understanding of these two perspectives that is useful to the present study. The purpose in this study was to determine if depth of vocabulary knowledge could be improved to a level that improved comprehension. It is Beck and McKeown's relative range of a student's lexicon and Cronbach's (1942) correlation that partial vocabulary knowledge can yield high performance on comprehension measures that speak to the incremental development noted across vocabulary measures in the present study. Though significant increases resulted from guided interactive read-aloud and think-alouds, those increases were incremental. If strategic incremental vocabulary increases have the potential to improve science comprehension for fourth grade, perhaps even more robust results could be gained by revisiting science pedagogy in the primary grades.

Results revealed that all groups improved their scores over two time periods, posttest and a 2-week delayed posttest. The treatment and treatment-plus groups' scores significantly increased at posttest and slightly increased and sustained that gain 2 weeks later. Additionally, a large multivariate effect size of .46 was noted. The effect sizes for depth of vocabulary knowledge ranged from $\eta^2 = .08$ to $\eta^2 = .13$. It seems that even small vocabulary effect sizes map to comprehension gains. The common instructional conditions shared by the treatment and treatment-plus groups seemingly influenced vocabulary acquisition and development to a level that improved comprehension outcomes. The integration of listening, speaking, reading, writing, viewing, and visually representing appears to strengthen depth of targeted science vocabulary to a level that both improved and sustained comprehension as demonstrated by scores on this measure. Both treatment groups used guided interactive instruction using basal science textbooks. Guided interactive read-alouds provided a system for processing the science terms while the think-alouds from teacher to students and peer to peer developed the listening and speaking processes by clarifying, summarizing, and questioning. Further, listening and speaking events were visually represented through written responses which require students to continue working with the same knowledge, but in different ways. Accordingly, multiple-choice measures offer students contextual prompts, which are acts of organizing students' thoughts in a certain direction. Students did not have to organize thoughts but instead were responding to an existing system of thought. Though many students scored at an association or comprehension word knowledge level, it seems that even partial knowledge discerned context to a level that allowed students to correctly answer (Stahl, 1986). The nature of these instructional conditions is highly contextual in that the treatment and treatment-plus groups continually worked with the same knowledge in different ways (multiple opportunities and multiple contexts). An added strength resides in the language arts processes, especially speaking and listening. If subscribing to Piaget's (1952) unitary cognitive construct, the increase on comprehension measures would be an anticipated outcome. Piaget's theory purports that the mental systems are not separate but are a melting pot of sorts from which emerges a cognitive knowing. Thus, comprehension improvement may be a gestalt from the rich context of guided interactive read-alouds and think-alouds. These increases could not be assessed from vocabulary measures because vocabulary tasks required students to organize, store, and retrieve information without the benefit of context. This is in line with Stahl's (1986) association and comprehension levels of word knowledge, which indicate that students can associate a word with other words and not understand it and or, in other cases, have a shared but general understanding of the word. Still, students formulate correct answers 50% of the time. Supporting this stance is the connectionist model which asserts that the definition gleaned from multiple exposures in the same context connected with information in working memory provides the discernment necessary for correctly answering multiple-choice questions. One study of students' depth of vocabulary knowledge, as measured by a multiple-choice comprehension measure, revealed an average score of 50%, analogous to Dale's (1965) vague contextual association of the word. Additionally, and in keeping with Beck, McKeown, and Kucan's (2002) relative range of a student's lexicon and Cronbach's partial knowledge (1942) theories, Kame'eui et al. (1987) added that, "Partial conceptual knowledge allows for erroneous characteristics or even missing characteristics but formulates some meaning" (p. 133).

Limitations and Future Research

Results offer a first insight into the incremental development of science vocabulary and subsequent effects on comprehension. These outcomes suggest that guided interactive vocabulary instruction using basal science textbooks positively influences the acquisition and development of science terms. While the effect sizes are small, they are proportionate to the incremental nature of vocabulary development. However, caution must be exercised when interpreting data outcomes. Limitations to valid and reliable outcomes might include assessment mortality, generalizations to different demographic compositions, time constraints on lessons, duration of science unit, familiarity of pretest on dependent measures, and unexpected teacher absences.

First, assessment mortality manifested in that not everyone completed measures for all three phases. This resulted in the elimination of several vocabulary and comprehension scores. Definitions, examples, and characteristics vocabulary measures as well as multiple-choice comprehension measures were assessed over a 2-day period for each of three testing times, pretest, posttest, and delayed posttest. Some students missed one day of a 2-day testing period while others were absent on both days of an entire testing phase. Because the scores represented incremental growth for the duration of the study, incomplete scores for students who fell into these categories were eliminated.

Second, while demographic compositions reflect those of the district in which the participating school resides, the participants are predominantly Caucasian and the school is considered a 5/5 level school. This school shares common characteristics found in other 5/5 level schools in the state of Mississippi. Thus, generalizability of results to different demographic compositions must be tempered by similarities in ethnic makeup and school level, which is somewhat representative of socioeconomic status.

Third, while the treatment and control groups worked with one text, the nonfiction text sets for the treatment-plus groups were supplemental to the basal science textbook. This created time pressures for the treatment-plus teachers. Though guided lessons were implemented, students and teachers in the treatment-plus group often appeared hurried and less focused when using nonfiction text sets in addition to basal science textbooks. This may temper interpretation of results for the treatment-plus group. Future studies should further delineate treatment and treatment-plus groups by assigning one group the textbook read-aloud and think-aloud and the other group informational texts only. This would further discern the roles of speaking and listening and their influence on depth of vocabulary knowledge and subsequent comprehension. Moreover, guided interactive vocabulary read-alouds and think-alouds should be developed using nonfiction text sets only. To be more discerning about this type of instruction in conjunction with text, lessons might be centered around one kind of text per group. Clearer relationships between guided interactive instruction and the type of text used could be better represented by not sharing the same text.

Fourth, the duration of the science unit posed a challenge in that it lasted for such a short period (12 days). Ideally, the present study would have spanned a semester or a full year. The school under study was not familiar with the research process and was somewhat hesitant; thus, it was decided that the duration of the study would be for one science unit.

Fifth, pretest, posttest, and delayed posttest are the same tests. While it is possible that familiarity with the pretest primed students' thoughts to attend to specific words or to relate a word in context to a scenario from the text, all participants were equally exposed to each vocabulary word and each multiple-choice item and, importantly, there were no measurable differences between groups at pretest.

Sixth, one of the science teachers had unexpected surgery. Consequently, two classes under the leadership of this teacher were designated as the control group. The lesson plans for the control group were of a traditional nature and could easily be implemented by a substitute teacher or another classroom teacher. From videotaped accounts, lessons were implemented as designed. However, an additional limitation may have occurred. During the 2-week interval between posttest and delayed posttest, students were not to receive or participate in any instructional activities that might be associated with the completed science unit. Nevertheless, several different substitute teachers were hired to teach the control group classes. Constant change in leadership posed difficulty in ensuring that control group students did not duplicate lessons from the previous 2 weeks. The control group's significant increase from posttest to delayed posttest posits concern that lessons may have been unknowingly repeated by substitute teachers during this 2-week hiatus from the previous unit.

Notwithstanding these limitations, this study expanded the research base on reading aloud and thinking aloud with nonfiction text (Brabham & Lynch-Brown, 2002), maximizing and integrating language arts with the language of science (Fang, 2006; Williams et al., 2005), and assessing depth of vocabulary knowledge (Cronbach, 1942; Dale, 1965), and subsequent effects of improved depth of vocabulary knowledge on comprehension (Beck & McKeown, 1994). Additionally, this design demonstrated that guided interactive reading produces variances in learning outcomes.

While understanding the processes associated with how children acquire and develop vocabulary in any given context is important, understanding the expertise and role of the teacher in facilitating this transaction is of equal importance. Just as the process of vocabulary development is incremental and multidimensional so, too, are the growth and development of the teacher professionally. Historically, professional development has been comprised of isolated staff development sessions without much thought to long- or short-term goals.

Teacher professional growth and development emerged as key factors that seemingly influenced the acquisition and development of vocabulary in this study. It was evident from teacher comments during and after this study that teachers are interested in the processes of reading and thinking aloud, fostering a deeper conceptual knowledge of the content, and discovering how best to develop those skills in teaching their students. One of the key components important to this study is teacher experience in working with content area knowledge. For example, the primary source of content area science knowledge came from the basal science textbook as was noted in the statement, "We were not aware of some of the information in the scripts." The "information" to which the teachers referred was not located in the textbook but rather integrated into the guided scripts from sources other than the textbook. The authors of the text presumed the student's prior knowledge and experience with the concepts and vocabulary under study. However, it is these missing components that offer the foundational constructs from which the science vocabulary can be conceptualized. This example does not appear to be isolated as indicated by Kragler et al. (2005).

> If textbooks are the primary tools that teachers use to teach science and social studies, it is going to be very difficult for teachers to provide the necessary assistance to help students effectively comprehend these materials in their current form. (Kragler et al., 2005, p. 258)

At first inspection, the temptation may be to rid classes of basal science textbooks or to insist that teachers take additional course work in a content area. Alternately, a focus on the incremental and strategic development of in-service teachers might yield teachers well-skilled in the language of teaching science. In this study, the language of teaching infuses and integrates listening, speaking, reading, writing, viewing, and visual representation with the language of science. Effective translation of these strategies to the classroom may require a different orientation from current professional development policies and practices reflect.

Additionally, science is not an emphasized component of primary and secondary grade curricula as Duke (2000) and Yopp and Yopp (2006) point out. Duke (2000) and Yopp and Yopp (2006) surveyed primary classes for the presence of and subsequent use of informational text but found few books that qualified as informational or expository text and fewer teachers who used it. If the aforementioned studies indicate a pattern for school curricula, it is not unexpected that students in fourth grade would be unfamiliar with science concepts and vocabulary. Future studies might focus on developing teachers' understanding of the language of teaching science--primary through secondary grades.

Recommendations for Policy and Practice

The results of this study are hopefully enlightening and suggest that students who receive guided interactive vocabulary instruction are more likely to deeply process science vocabulary and are also more likely to show sustained improvement on comprehension measures than students who did not receive guided interactive vocabulary. The integration of the language of science with the language arts processes may be an effective way to foster the acquisition and development of science concepts and vocabulary. Students who received this type of instruction applied, discussed, and grappled with specific vocabulary words, increasing integration into long-term memory.

Additionally, the present study responded to some of the concerns marked in the literature. First, the orientation of previous research has revolved around the effectiveness of teaching words directly or through wide reading

(Nagy & Herman,1987; Nagy & Scott, 2000), the effectiveness of one particular strategy over another (Nagy, 2004; Schwartz & Raphael, 1985; Stahl, 1986), what it means to know a word (Cronbach, 1942; Dale, 1965), and how to evaluate or assess knowing a word (Anderson & Freebody,1981; Nagy & Scott, 2000). The present study embedded the receptive language processes of reading, listening, and viewing with their expressive language counterparts: writing, speaking, and visual representation throughout the science unit. It was this embedding, tempered by multiple opportunities for cognitive, linguistic, and verbal peer and teacher mediation (the language of teaching) in the form of read-alouds and think-alouds that provided a mental infrastructure to integrate new vocabulary words into long-term memory. This study sought to infuse elements from current vocabulary research to create a balanced and incremental approach to deeply processing science vocabulary.

Focus sessions at the conclusion of the study suggested that teachers need time to strategically explore the language of teaching in the language arts and in their respective content areas. It was on this pivotal point that teachers seemed to struggle the most. Teachers grappled with depth of content knowledge, how to model thinking aloud, and when and how to prompt students to write, speak, or visually present. Knowledge of content allows teachers to monitor student thinking, clear up misconceptions, and attend to characteristics and attributes that are foundational to deep comprehension. Teachers must know how to model the critical thinking processes and scaffold children through those processes. This dimension necessitates further exploration into a systematic professional residency designed to develop and strengthen the language of teaching in-services for teachers. Fostering sophisticated classroom management, instruction, assessment, and planning requires strategic planning, personal motivation, and, to some degree, a professional mentor. An involved professional who scaffolds and supports development is an important consideration for sustained personal and professional growth. This is yet another argument for classifying teaching as a profession and not merely a job.

In conclusion, vocabulary acquisition and development are incremental (Stahl & Fairbanks, 1986), interrelated, and multidimensional. The strategic infusion of the language arts processes with content area science propelled by systematic implementation appears to promote the incremental, interrelatedness, and multidimensional components necessary for the acquisition and development of content area vocabulary. While the language of science and content of science are important, so, too, is the effectiveness of the teacher. Synthesizing the integrated and dependent nature of the language of science and language arts processes is the key in preparing and developing the minds of our children and the key to assisting teachers in professional and personal development as lifelong learners.

APPENDIX A

PERMISSION LETTER OF SCHOOL DISTRICT

Jones County Schools

Thomas C. Prine
Superintendent of Education
5204 HWY 11 North
Ellisville, MS 39437
Telephone (601) 649-5201
Fax (601) 649-1613

September 19, 2007

University of Southern Mississippi
Institutional Review Board
Human Subject Protection Review Committee
118 College Drive
#5147
Hattiesburg, MS 39406-0001

To Whom It May Concern:

This is to confirm that permission has been granted to Ms. Tania Hanna to work with fourth grade students at South Jones Elementary under conditions listed on the attached letter.

Sincerely,

Thomas C. Prine
Superintendent of Education
Jones County Schools

TCP/pa

Attachment

March 26, 2007

Mr. Thomas Prine
Jones County School Board Members
5204 Highway 11 North
Ellisville, MS 39437

Dear Mr. Prine and School Board Members:

My name is Tania Hanna and I am a doctoral candidate at the University of Southern Mississippi. I have been in contact with Bob Herrington at South Jones Elementary and have discussed the possibility of collaborating with fourth-grade science teachers to enhance vocabulary development.

Research shows that fourth grade is a time of transition for most elementary school students. So noticeable is this transition that it is aptly called the "fourth-grade slump." One reason associated with this slump is that a typical fourth-grade curriculum requires students to read and comprehend vocabulary dense science and social studies text.

One way of decreasing the effects of this slump is to employ effective content vocabulary instructional strategies. With this in mind, I am requesting permission to conduct an instructional intervention with fourth-grade students at South Jones Elementary.

The intervention will take place during the regular science class period and will last for 3 weeks. Pretest and posttest vocabulary assessment data will be collected as well as an end-of-the-unit chapter test. The intervention is designed to increase content area vocabulary knowledge which will be an asset when taking the cumulative test in fifth grade.

One fourth-grade teacher will be trained to employ the use of informational trade books as a vocabulary support to traditional science text while the other fourth-grade teacher will follow pre-selected teaching strategies from the teacher's manual. Trade books used for this intervention will be given to the participating class.

I appreciate the opportunity to work with the administrators, teachers, and students. Thank you for taking the time to consider this request.

Sincerely,

Tania Hanna, M.Ed.

APPENDIX B

APPROVAL OF THE UNIVERSITY OF SOUTHERN MISSISSIPPI INSTITUTIONAL REVIEW BOARD

The University of
Southern Mississippi

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

TO: Tania H. Hanna
405 S Court Street
Hattiesburg, MS 39401

FROM: Lawrence A. Hosman, Ph.D.
HSPRC Chair

PROTOCOL NUMBER: 27091802
PROJECT TITLE: The Effects of Nonfiction Interactive Read-Aloud on the Acquisition and Develoment of Content Area Science Depth of Vocabulary Knowledge and Comprehension

Enclosed is The University of Southern Mississippi Human Subjects Protection Review Committee Notice of Committee Action taken on the above referenced project proposal. If I can be of further assistance, contact me at (601) 266-4279 FAX at (601) 266-4275, or you can e-mail me at Lawrence.Hosman@usm.edu. Good luck with vour research.

The University of Southern Mississippi

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **27091802**
PROJECT TITLE: **The Effects of Nonfiction Interactive Read-Aloud on the Acquisition and Development of Content Area Science Depth of Vocabulary Knowledge and Comprehension**
PROPOSED PROJECT DATES: **09/24/07 to 10/19/07**
PROJECT TYPE: **Dissertation or Thesis**
PRINCIPAL INVESTIGATORS: **Tania H. Hanna**
COLLEGE/DIVISION: **College of Education & Psychology**
DEPARTMENT: **Curriculum, Instruction, & Special Education**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF APPROVAL: **09/24/07 to 09/23/08**

Lawrence A. Hosman

Lawrence A. Hosman, Ph.D.
HSPRC Chair

9-24-07
Date

HUMAN SUBJECTS REVIEW FORM
UNIVERSITY OF SOUTHERN MISSISSIPPI
(SUBMIT THIS FORM IN DUPLICATE)

Protocol # 27091802
(office use only)

Name Tania H. Hanna Phone 601-319-2714

E-Mail Address blh@c-gate.net

Mailing Address 405 S Court Street
(address to receive information regarding this application)

College/Division College of Education and Psychology Dept CISE

Department Box # 5057 Phone 601-266-5546

Proposed Project Dates: From September 24, 2007 To October 19, 2007
(specific month, day and year of the beginning and ending dates of full project, not just data collection)

Title The Effects of Nonfiction Interactive Read-Alouds on the Acquisition and Development of Content Area Science Depth of Vocabulary Knowledge and Comprehension

Funding Agencies or Research Sponsors ______

Grant Number (when applicable) ______

______ New Project

x Dissertation or Thesis

______ Renewal or Continuation: Protocol # ______

______ Change in Previously Approved Project: Protocol # ______

[signature] 9-12-08
Principal Investigator Date

[signature] 9/12/07
Advisor Date

[signature] 9-12-07
Department Chair Date

RECOMMENDATION OF HSPRC MEMBER

______ Category I, Exempt under Subpart A, Section 46.101 ( ) ( ), 45CFR46.

X Category II, Expedited Review, Subpart A, Section 46.110 and Subparagraph (b).

/ Category III, Full Committee Review.

[signature]
HSPRC College/Division Member DATE

Lawrence A. Hosman 9-24-07
HSPRC Chair DATE

THE UNIVERSITY OF SOUTHERN MISSISSIPPI
INSTITUTIONAL REVIEW BOARD
ADVERSE EFFECT REPORT

This form should be used to report single adverse effects. Incident reports (i.e., reports of problems involving the conduct of the study or patient participation, including problems with the recruitment and/or consent processes and any deviations from the approved protocol) should be described in a letter. Return this form to the IRB Coordinator, The University of Southern Mississippi, 118 College Drive # 5147, Hattiesburg, Mississippi 39406-0001.

Principal Investigator:		Phone:	
IRB Approval #:			
Study title:			
Adverse Effect (3-4 words):			
Date of adverse effect:		Subject's initials or Study ID #	

Additional details/description of effect and treatment, if any. (A detailed report may be attached.)

Adverse effect appears to be (check one):	Directly related to the research Indirectly related to the research Unrelated to the research

Research involved the use of a:		
Was use of procedure intended to directly benefit subject?	Yes	No
Was subject enrolled at a USM site?	Yes	No
Has this type of adverse effect been reported before?	Yes	No
Is this type of effect likely to occur again?	Yes	No
Is the effect adequately described in the protocol and consent form?	Yes	No*
* If not, are changes needed in the protocol and/or consent form?	Yes**	No

** If so, a modification application should accompany this report.

What other agencies (e.g., sponsors) have been notified of this adverse effect?

Signature of Principal Investigator	Date

APPENDIX C

PERMISSION OF PARENT

FOR GUIDED VOCABULARY PROJECT

September 25, 2007

Dear Parents:

We at USM are very interested in helping students become successful readers. In order to help students become successful readers, we conduct research projects to improve teaching and learning for children. For this project, your child's fourth-grade teacher will use science textbooks and nonfiction texts related to the topic of study. The teacher may also read materials aloud, ask discussion questions, and ask for written responses to improve your child's comprehension of the science text.

For this specific project, researchers will ask students to respond to vocabulary words from their science textbooks by writing or drawing pictures. This information will be collected three times to help us better understand how children learn words. This vocabulary research project will take place during the regular science period over the course of 3 weeks. Before the vocabulary project begins, students will be asked to write down and draw a picture of what they know about each of 13 words. During the study students will read their science text silently, read and discuss the science text with their teacher, or read and discuss their science textbook and nonfiction texts with their teacher. After the study, students will be assessed twice, once immediately after the unit of study and once 3 weeks after the study concludes.

This research project is done in cooperation with the classroom teacher of your son or daughter and Mr. Herrington and has been approved by Mr. Thomas Prine, Superintendent of Jones County Schools. Your child's participation in the project is voluntary, and participation may stop at any time he or she wishes to no longer participate. Student responses are confidential and are limited to the researcher(s) involved. Additionally, measures will be taken to maintain student anonymity.

If you have any questions concerning the research project, at any time during or after the sessions begin, feel free to call me (Tania Hanna) at 601-266-5546 or Dr. Dana Thames (601-266-5247).

I sincerely appreciate your taking the time to read this letter. If you agree that it is okay for your child to participate in the vocabulary research project, sign this form and return it to the classroom teacher by October 2, 2007.

Sincerely,

Tania Hanna, M.Ed.

PARENT PERMISSION FORM
(PLEASE SIGN AND RETURN TO YOUR CHILD'S TEACHER)

I have read the attached letter and understand that the purpose of this study/research project is to determine the influence of interactive read-alouds using different science texts on students' vocabulary knowledge and comprehension.

Yes, I ________________________ (your name), give permission for my child,________________________ (your child's name), to participate in this vocabulary research project conducted by Tania Hanna.

I understand that I may withdraw my child from the study at any time that I or my child deems appropriate.

Signature of Parent____

Date:________________________________

APPENDIX D

INFORMED CONSENT FOR GUIDED VOCABULARY PROJECT

STUDENT PERMISSION FORM

USM wants to learn more about how children learn vocabulary words. Researchers from USM will visit your classroom several times over the course of 5 weeks. They will give you some words and you will write what you know about those words. Then, you will read about those words in your science books. Last, the researchers will ask you to write what you know about those words.

If you want to work with us, sign your name below. If you decide later that you do not want to work with us, that is okay too. By working with us, you help us learn about how children learn new words.

I ________________________ (student's name), agree to participate in the vocabulary study about how children learn words. Someone has read or I have read the words above and I understand what it says. I also understand that I can decide not to participate at any time.

________________________________ ____________________

Signature of Witness Date

APPENDIX E

TEACHER PERMISSION LETTER

USM wants to learn more about how children learn vocabulary words. Researchers from USM will visit your classroom several times over the course of 5 weeks. Teacher participation and implementation are important components for this study.

I understand that the purpose of this study/research project is to determine the influence of interactive read-alouds using different science texts on students' vocabulary knowledge and comprehension.

Yes, I ___________________________ (your name), give permission for research to be conducted in my classroom.

Sincerely,
Tania Hanna, M. Ed.

APPENDIX F

CONCEPT OF DEFINITION CARDS

What is an environment?

(1)

Give examples of an environment

(2)

environment

(3)

Explain what an environment is like.

(4)

Draw pictures that help explain this word.

What is a climate?

(1)

Give examples of a climate.

(2)

climate

(3)

Tell me what a climate is like?

(4)

Draw a symbol (picture).

What is oxygen?

Give examples of oxygen.

(1)

(2)

oxygen

(3)

(4)

What is oxygen like?

Draw a symbol (picture) that helps explain this word.

What is a shelter?

Give examples of shelter.

(1)

(2)

shelter

(3)

(4)

Explain what shelter is like.

Draw pictures that help explain this word.

What is metamorphosis? | **Give examples of metamorphosis.**

(1)

(2)

meta-
morphosis

(3)

(4)

What is metamorphosis like? | **Draw a symbol (picture) that helps explain what this word means.**

What is adaptation? | **Give examples of adaptation.**

(1)

(2)

adaptation

(3)

(4)

Explain what adaptation is like? | **Draw a symbol (picture) that helps explain what this word means.**

What is camouflage?

Give examples of camouflage.

(1)

(2)

camouflage

(3)

(4)

Explain what camouflage is like.

Draw a picture that helps explain this word.

What is mimicry?

Give examples of mimicry.
Give nonexamples of mimicry.

(1)

(2)

mimicry

(3)

(4)

What is mimicry like?

Draw a symbol (picture) that helps explain what this word means.

What is an instinct?

Give examples of instinct.
Give nonexamples of instinct.

(1)

(2)

instinct

(3)

(4)

Explain what instinct is like.

Draw a picture that helps explain this word.

What is migration?

Give examples of migration.
Give nonexamples of migration.

(1)

(2)

migration

(3)

(4)

What is migration like?

Draw a picture that helps explain this word.

What is hibernation?

Give examples of hibernation.
Give nonexamples of hibernation.

(1)

(2)

hibernation

(3)

(4)

Explain what hibernation is like?

Draw a picture that helps explain this word.

What is behavior?

Give examples of behavior.
Give nonexamples of behavior.

(1)

(2)

behavior

(3)

(4)

What is behavior like?

Draw a symbol (picture) that helps explain this word.

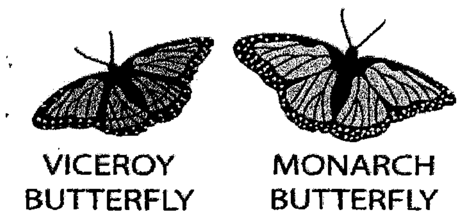
APPENDIX G

MULTIPLE-CHOICE ASSESSMENT

SCIENCE UNIT: ANIMAL GROWTH AND ADAPTATIONS

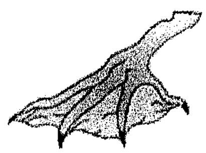
1. Birds know that the monarch butterfly has a horrible taste. The viceroy butterfly, however, tastes good to birds.

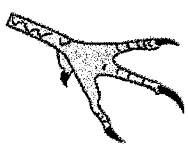
   What type of adaptation does the viceroy butterfly have that protects it from birds?

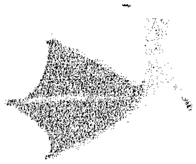


_____ a. acclimation
_____ b. shape camouflage
_____ c. environmental change
_____ d. mimicry

2. Which bird's feet are adapted for grabbing prey, such as rabbits?

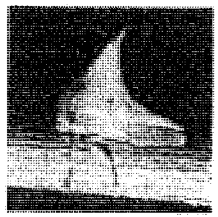
_____ a. 

_____ b. 

_____ c. 

_____ d. 

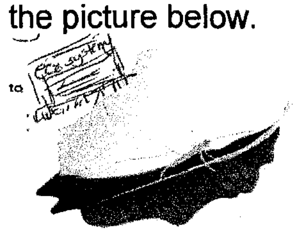
3. Look in the picture for an insect. Look closely at the thorn on the stem. The thorn is actually an insect—the thorn bug.



How does this adaptation help the thorn bug survive?

______ a. predators think the bug is a sharp thorn, not an insect.
______ b. It has large teeth to bite predators.
______ c. It makes a loud noise to scare predators away.
______ d. The thorn bug releases a chemical that keeps predators away.

4. Look at the leaf butterfly in the picture below.

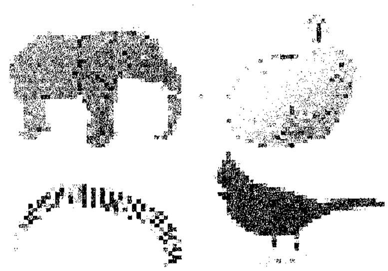


What type of adaptation does the leaf butterfly have to protect it from predators?

______ a. shape camouflage
______ b. mimicry
______ c. protective coloration
______ d. poison chemicals

5. Which organism uses protective coloration to help avoid predators?

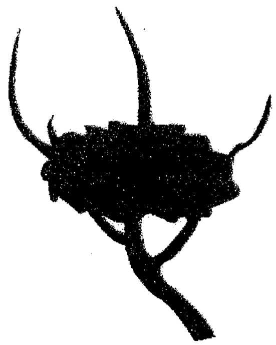
______ a. snowshoe hare
______ b. monarch larvae
______ c. cardinal
______ d. elephant



6. Which of the following helps an animal hide from predators?

_____ a. evolution
_____ b. adaptation
_____ c. camouflage
_____ d. acclimation

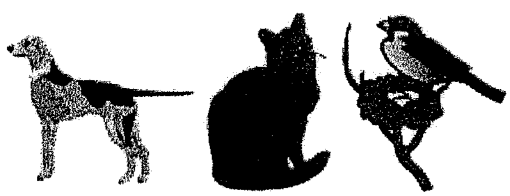
7. A bird builds a nest that is similar in size, shape, and materials in the nest it was born in.



What type of behavior is this?

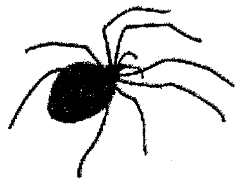
_____ a. habit
_____ b. mimicry
_____ c. inherited trait
_____ d. learned behavior

8. Which of the following is a learned behavior?



_____ a. a dog sitting after its owner gives it a hand signal
_____ b. a young bird building the same type of nest as its parents
_____ c. a cat purring as it rubs its head on a hard surface.
_____ d. a white-tailed deer raising its tail to warn of danger.

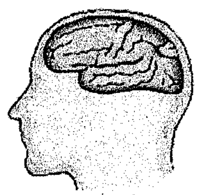
9. All orb-weaver spiders spin spiral, wheel-shaped webs. They do this because



_____ a. the spiral web is the best one for catching flies.
_____ b. environmental conditions cause them to spin spiral webs.
_____ c. it is an inherited trait.
_____ d. they learned how to do it from their parents.

10. What is an advantage of learned behavior over inherited behavior?

_____ a. It can be modified or changed.
_____ b. It is more useful.
_____ c, You don't need to study or practice it.
_____ d. You never forget it.

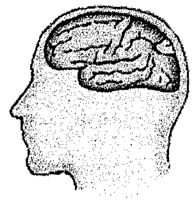


11. An octopus can open a jar to get food inside after it has been shown how. Most species of octopus will instinctively shoot ink out to make a "smokescreen" to get away from predators.

How would you classify these behaviors?

_____ a. Both opening a jar and shooting ink are inherited behaviors.
_____ b. Opening the jar is an inherited behavior, shooting ink is learned.
_____ c. Opening the jar is a learned behavior, shooting ink is an inherited one.
_____ d. Both opening a jar and shooting ink are learned behaviors.

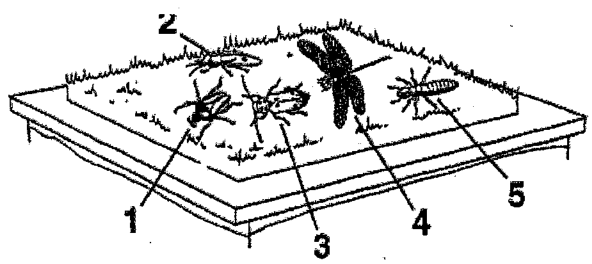
12. People learn some things and do other things by instinct.



Which is an example of instinct?

_____ a. swallowing food
_____ b. speaking to your friends
_____ c. driving a car
_____ d. reading a newspaper

13. Joshua and Wynona wanted to see how the color of an insect might affect survival. They placed a patch of artificial green grass on the table. One by one they placed five fake insects onto the grass. Insect 1 is bright red, Insect 2 is brown. Insect 3 is green, Insect 4 is blue, and Insect 5 is tan. Joshua and Wynona pretend that they are hungry birds who want their lunch. They both stand 5 feet in front of the grass area and slowly walk further away from it. Some of the insects become less noticeable the farther away they walk.



If Joshua and Wynona are about 20 feet away from the grass, which insect do you think they would most likely eat if they were birds?

_____ a. 1
_____ b. 2
_____ c. 3
_____ d. 5

14. Which insect do you think would have the greatest chance of survival?

_____ a. 1
_____ b. 2
_____ c. 3
_____ d. 4

15. What did Joshua and Wynona probably conclude about the relationship between insects and their color?

_____ a. The better they blend in, the less chances they have of surviving
_____ b. It has no effect upon their survival.
_____ c. The better they blend in, the greater chance they have of surviving
_____ d. Bright colors make them less visible.

16. When a winter storm is coming, animals often look for ____________.

_____ a. drinking water
_____ b. a partner
_____ c. shelter
_____ d. food

17. When preparing to hibernate, animals must

_____ a. grow a thinner coat
_____ b. lose weight
_____ c. eat extra food
_____ d. breathe faster

18. When one animal looks like another to protect itself, this adaptation is called

_____ a. migration
_____ b. mimicry
_____ c. camouflage
_____ d. instinct

19. The young of many insects and amphibians change to adults by going through a process called

_____ a. metamorphosis
_____ b. migration
_____ c. mimicry
_____ d. instinct

20. Every thing around an animal, including its predators, is part of an animal's

_____ a. camouflage
_____ b. shelter
_____ c. environment
_____ d. climate

21. Hot, temperate, mild, and cold are words that describe an animal's

_____ a. migration
_____ b. climate
_____ c. hibernation
_____ d. shelter

22. Pencils, paper, desks, children, and teacher are all parts of a(an)

_____ a. oxygen
_____ b. environment
_____ c. climate
_____ d. needs

From *Brainchild, Grade 4* (2007) and *McGraw Hill-Science Test Preparation Practice, Grade 4 (1976).*

APPENDIX H

INSTRUCTIONS TO PARTICIPANTS:

TRAINING FOURTH GRADES HOW TO USE CONCEPT CARDS

The investigator and researcher assistants will follow these procedures to introduce and review Concept of Definition Cards. These procedures are as follows:

1. The research team will establish rapport with the students.

2. The research team will explain to the students that fourth graders can help people learn more about how children learn. The researchers will explain that this procedure is not a test and that it is all right if they do not know much about the vocabulary word, asking that the students answer each prompt to the best of their knowledge and assuring them that understanding how students think about science words will help with the project.

3. The researchers will hand out copies of vocabulary packets.

4. Students will put their names and the name of their science teacher at the top of the page.

5. One or more of the research team will first explain the elements of the Concept of Definition Cards and then have students complete a series of cards for 11 words in the unit. Explain that a Concept of Definition Card is a way to help us understand what students already know about certain words. Tell them that the card is divided into four rectangles with an oval in the middle that tells them the word for that card. Draw the card on the board. Say, "You will model what you think about when you create a concept card." Prompt them to create the same card at their desks. Students will write down answers at your prompting. Say, "The word in the middle of the card is *insect.*" I read the word and then look in the first box to see what information it asks for. It asks for a definition. I ask myself what the definition of an insect is and I write the definition down. You do not have to know the dictionary definition. This is a student-friendly definition so you get to use your own words. Even if you only know a little bit, write it down. The second box, the box in the upper right-hand corner, asks me what it is like. I think of words that describe insects and I write them down. Then, I go to the bottom of the card in the lower left-hand corner and I read what it asks me to do. It asks me to give examples

of the word. What are some examples of an insect? Write them down." Ask if everyone understands. Explain that each card has one word. Tell them that they will know some of the words and some of the words will not be familiar to them. Tell them that it is okay to leave a box blank. If they have difficulty with a box, tell them to move to the other boxes and cards. After they have completed all 10 cards, they can come back to the words that are difficult. Explain that you will do the same thing the next day with 10 new words.

6. Researchers will instruct students where to turn in their packet upon completion. The researchers will determine that each paper has a child's name and the teacher's name at the top of the page, thanking each student for helping with the project.

7. The investigator and research assistants will repeat the process on Day 2 of pretest data collection. Also, they will review Day 1 of posttest and delayed response test.

APPENDIX I

GUIDED INTERACTIVE VOCABULARY INSTRUCTIONAL SCRIPTS

Lesson 1, Day 1

Introduction
The teacher will introduce the unit, **Animal Growth and Adaptations**, explaining that students will be working with books that teach them how animals and plants grow and change in response to their environment.

Say, "The first book we will use is our textbook. Turn in your textbook to page 36. Do you see the box under the chapter number? It says, 'Vocabulary Preview.' Let's read these words together."

The teacher will read all of the words and explain that the author of the textbook uses the first five vocabulary words in Lesson 1, the next three words in Lesson 2, and the last three words in Lesson 3.

The following are the Targeted Vocabulary Words in Lessons 1 through 3:

Environment   Climate   Oxygen   Shelter   Metamorphosis

Before Reading
The teacher will preview Chapter 2. On page 36, the author gives us some fast facts about different animals. Pages 38-39 give us an experiment to do. Pages 40-45 explain the first five vocabulary words from our vocabulary bank on the first page of the unit. Let's read the title on page 40: **How Animals Meet Their Needs**. These numbers are in big, black, bold letters so that makes me think that all of the pages in this lesson might talk about how animals meet their needs.

"Let's look now at the words in red: **Where Animals Meet Their Needs, The Need for the Right Climate, The Need for Oxygen, The Need for Food, The Need for Water, The Need for Shelter, Animals and Their Young**. Do you see the author's pattern? [Call on students to present the pattern.] Now turn back to page 36. Let's revisit the Fast Facts." [Read through each of the fast facts.]

Materials
Students will need their notebooks or a section of the notebook at this point that can be used throughout this unit. They will be mapping words and interacting with prompts. They will also need pencils and calculators.

During Reading
Turn to page 40. Read page 40 out loud to the end of the page. Go back into the text and call attention to the word **environment** and its definition. Have students repeat the definition from the text. Have this definition written on the board also to be able to refer to it multiple times.

Say, "These words are related to each another, and a good way to show how words are related is to map them out. It helps our brains to see the relationship between words."

Review by demonstrating on the board or a poster the idea of mapping (students will need this vocabulary map to be visible in the classroom at all times).

Begin a Concept Map for these words. With **environment** at the top of the map, have two categories—one listed to the right and one to the left. The first extension to the right is named **nonliving things**. The left is named **living things**. Explain that the author uses the words "everything that surrounds and affects an animal" when defining what an **environment** is.

Say, "With what the author said, I tried to create a picture of an **environment** in my head, but I didn't have enough information. So I read some more. The author added that 'everything' includes plants and other animals in the area, as well as the rocks, soil, air, and water. I am able to create a picture in my head of plants, animals, rocks, soil, air, and water, but I still don't understand **how** plants, animals, rocks, soil, air, and water create an **environment** or what they have to do with an **environment**. I need more information. "The last sentence says, '**everything, both living and nonliving, is part of an *environment*.**' To understand this, I need to know, what makes something **living**. Living things need energy, grow, reproduce, and have the ability to respond to changes inside themselves, and—Key—they have cells—tiny, invisible factories that have special jobs. Some living things have just one cell, and some—like you—have billions! Can you give me some examples of living things?

Anticipate certain student responses—**animals** and **people**. Let's try a few: Is a tiger **living** or **nonliving**? What makes you think that? Did you ask yourself if a tiger needs to grow, needs energy (food), need to reproduce, and can change if it has to? Did you ask yourself if a tiger is made up of cells? Then you asked the right questions to decide if a tiger is a living or nonliving thing. How about a roach? How about bacteria? Yes to all. What about a plant? Yes, they are made of cells.

How about a rock? Ask yourself. Does a rock have cells? Does it need to grow? Does it need oxygen?"

Add the students' responses to the map.

Ask, “Can you give me some examples of **nonliving** things?”

Write students’ responses on the map. Then compare and contrast what makes something living or nonliving. Find in the text where the author writes about living and nonliving elements.

Say, “So, this means that [name the list of living and nonliving things generated by the students] all these things make an **environment** an **environment**.

“The picture in my head now is a little clearer. Are you making a picture in your head of an environment? What does the picture in your head look like?

Let students give examples of what they see in their mind’s eye. Read the last question on page 40: **“What makes up an animal’s *environment?”*** Tell me what you have learned that will help you answer this question.” Write students’ responses on the board and affirm or ask them to elaborate if answers are unclear.

Allow time for students’ responses.

Say, “I know that [student’s name] had a great picture in his or her head of an **environment**. Hmmm. With what the author has told us about an **environment**, could you give me an example of an **environment**? Let’s write this word in our notebook on the first page.” [Students will write the word in their notebooks.]

Say, “Now tell me what an **environment** is.” [Wait for student responses.]

Say, “I will read Lesson 1 to you, and I want you to follow as I read.”

Read page 41. Follow the same protocol which emphasizes the word and how the author describes the word. Tell students to reread the first sentence.

Say, “If the **climate** is part of an area’s environment, where and how would we show that on our map?”

Elicit student responses and justifications for placement. They should be able to locate the response as an extension under **environment** to show it is a part of the **environment**. On the map put extensions from nonliving and living things leading to the center of the term **climate**.

Continue to read to define **climate**.

Say, “The author says that **climate** is the **average temperature and rainfall of an area over many years**. Could someone tell me what the important parts of this definition are?” Elicit **average, temperature, rainfall, area, years**.

Say, "What does **average** mean? Let's use an example from math. Let's say you have a test each Friday in March and April. There are five Fridays in March and four Fridays in April. We have nine Fridays in all. I will list your grade for each of the nine Fridays: 91, 98, 80, 70, 40, 85, 90, 75, and 99.

"We have to add all nine numbers together. Our total is 728. We divide that number by 9, and we get an AVERAGE of our grade for those nine Fridays: 81.

"Let's take this idea and apply it to our science lesson on **climates**. What would I need to figure out the average temperature? That's right! You will need to know the temperature EVERY day for about 3 years. There are 365 days in one year, so you would have 365 numbers to add together and divide by 365 to figure out the average temperature. That is a lot of numbers.

The author also says that **climate** is the average rainfall over a few years. So, we will have to collect rain (if there is any) every day for a few years to find out the average rainfall. Let's think through what he means. Let's try this out. I will give you the numbers for how much it rained each day in each month. Let's average these 12 numbers that represent the AVERAGE of all of the days in each of the 12 months. Our averages are January, 3 inches; February, 5 inches; March, 0 inches; April, 3 inches; May, 0 inches; June, 1 inch; July 1 inch; August, 6 inches; September, 4 inches; October, 8 inches; November, 2 inches; and December, 4 inches. What is the average rainfall? Did you add them up? What did you divide by? Why? Good thinking!

Now let's make a picture in your head of **climate**. **Climate** is **the average temperature and rainfall of an area over many years**. Let's review. What does average temperature mean? Tell me about average rainfall. Now write **climate** in your personal vocabulary notebook. Write the definition of **climate**. Be sure to leave room after each vocabulary word so that if we learn more about it, we can add to our definition.

"Your first word was **environment**. The second word in your personal vocabulary notebook is **climate**.

"The next sentence tells me that animals live in almost every **climate** on the earth, including those with little rainfall. The author tells me that animals live in where? (every climate on earth—including those with little rainfall).

This makes me think that there must be MANY **climates** and that they are all DIFFERENT. Hmmm. Let's keep reading. The next sentence tells me that deserts are 'natural land environments.' Make a picture of a desert in your head.

[Pause for the students to create a mental image.]

"Now look at the bottom of page 40. Did the picture in your mind look like the picture on the bottom of page 40? Mine did not. The desert picture in my mind did not have sand dunes. Instead, I saw flat, rocky ground, lots of sand, and few cacti, and a snake slithering through the sand and taking cover under a small rock. If the picture in my mind is different from the picture in my book, it could mean that there is more than one kind of desert. If desert is the name of the **environment**, then the **climate** must tell me something about what happens in that **environment**.

Let's put climate on our map under the word *environment*. Why? Because climate is a part of the environment. I want a way to help you remember that. I use maps to make a picture of how words fit together.

"What is **climate**? It is the average temperature and rainfall over time. Think of words to describe the average temperature and rainfall in the **environment** called a desert.

Elicit responses for words that describe temperature and for words that describe amount of rainfall: warm, dry, hot, dusty.

"If it is hot, dry, warm, and dusty, what animals and plants live there? Remember that these plants and animals have to live in a hot, dry, warm, and dusty climate. They had to change a body part or a behavior—or adapt—to live in the desert environment. What plants does the author list for the desert environment? Look in the third paragraph of page 41. He names cacti, bushes, or small trees as the plants in the desert. I'll bet there are some more, and I am curious to find out about them. He lists vultures, foxes, snakes, tortoises, kangaroo rats, and other small animals. These plants and animals had to "adapt" to live in the desert environment. What does "adapt" mean? (to change a body part of a behavior)

"The author uses the last paragraph to tell me that there is another **climate** that is wet and warm year-round. How do you think they figured out that the climate is wet and warm all year-round. That's right. They had to measure the rainfall and average it over time AND they had to add up each day's temperature and divide by the number of days. The author also says that different animals meet their needs in a tropical rain forest. This makes me think that we are in a DIFFERENT **environment**. This environment is called a tropical rain forest. The climate of the tropical rain forest is wet and warm all year round. The author does not tell me much here about the tropical rain forest. I will be interested to find out what the **climate** and **environment** are like in a tropical rain forest.

"Let's move to the third section of Lesson 1: **The Need for Oxygen**. The author says that animals need **oxygen**, which is **ONE of MANY gases in the air**. This tells me that there are many gases in the air and that one of those gases is named **oxygen**. Let's write this one in your vocabulary notebook. Tell me what I should write as the definition of **oxygen**, and I will write it on the board as you write it in your vocabulary notebook.

"The next sentence says that many land animals get **oxygen** by breathing air into their lungs. Do you think that applies to animals in the ocean environment? Why or why not? They come to the surface to breathe air into their lungs. Even fish get **oxygen**, but they have body parts that are "adapted" (which means?) to take **oxygen** from the water as it moves over the gills. Where would we put oxygen on our map? It doesn't fit well under climate so I will connect it with environment. The author's titles for the rest of the lessons are "Need for Oxygen, Need for Food, Need for Water, Need for Shelter, and Need to have Baby Animals. I am thinking that all of these are closely related because they all have what in common? Need? Yes, **Need** . . . so I will put need under environment and from need I will have five different but same level connections."

Add the words and lines to the map.

Under **oxygen**, draw two legs. The first leg will say land animals breathe air into their lungs. What will the second one say? That's right. Some ocean life gets oxygen when water moves over their gills. Good thinking!

"On page 42, the author tells about **The Need for Food**. The author tells us that animals need energy and materials to live and grow. Food gives us energy. Animals in the desert environment, tropical rain forest environment, or in the plains environment may eat different things but they all need energy and materials to grow.

"On page 43, the author tells about an animal's **Need for Water**. This makes me think about the **climate** in the desert **environment**, which is very hot and dry. I think that animals that live in the desert environment have had to "adapt" to hardly any rainfall. **Adapt** can mean that animals are born already changed to their environment or that they have to change a body part or a behavior. I wonder what animals do and how they adjust to get water so that they can live. The author tells us that animals sweat and pant, which makes them lose water that has to be replaced. The author tells us that some animals have changed a body part or a behavior to live in the desert environment. The kangaroo rat eats seeds that help replace the water he loses. His body also produces water to digest food. He rarely has to drink. In this **desert environment**, animals have adapted ways to get the water they need or their bodies have changed so that they don't need much water.

"Page 43 tells us about **The Need for Shelter**. The author tells us that most animals need **shelter** in their **environment**. He describes **shelter** as a place where an animal is protected from other animals or the weather. I was just wondering why animals would need protection from "other animals" and for that matter "the weather." Tell me what you think. Predators? Too cold or too hot could hurt them physically. Let's put this word in your vocabulary notebook. Write **shelter** and tell me what you think it is talking about. See if you can find the different types of **shelter** that function in different **environments**." (Desert foxes dig tunnels; foxes find hollow trees; rocks, leaves, and logs—nonliving examples).

"That is correct."

"Look on page 44. Now it is your turn. Tell me what you think the author will talk about on this page. The subheading says "Animals and Their Young." You think? Anticipate student responses. I read, "Animals of all species need to have young." Then, the author said, "without having young, all of the species would soon die and disappear." The words the author chose "soon die and disappear" make me think he wants us to know how important it is to know that animals need to have young ones.

Look at the second paragraph. The author isn't talking about animals anymore. He is talking about insects. That is correct! Insects. The first sentence names butterflies as insects. The second sentence talks about? Eggs, good thinking. Keep that in your mind. . . .The next sentence caterpillars getting bigger and bigger (called *molting*). So far, we have eggs and caterpillars in our minds. Next, the author says that the caterpillar forms a chrysalis where he "SLOWLY CHANGES" into a BUTTERFLY. Humm. In the next sentence, the author gives us the vocabulary word that tells how eggs CHANGE into caterpillars and how the caterpillar SLOWLY CHANGES into a butterfly. Tell me what the name for slowly changing over time is: **metamorphosis**. Say it again. Say **metamorphosis** to the person next to you. Now, tell that person what metamorphosis is. While it is on your mind, let's write it in your vocabulary notebook. After you write it, image a tiny little egg on a leaf. Write **egg** in your notebook. Draw an arrow pointing to the picture you drew of what happens next. Think about what we just read. Finally, draw what happens last. On the arrow that connects the caterpillar to the butterfly write: SLOW CHANGE.

Take your new knowledge and let's think about what goes through a metamorphosis. . . . Almost all insects, many invertebrates that live in water and amphibians (frogs) will go through a slow change or metamorphosis. Tell me some similarities between insects, invertebrates in water, and amphibians.

Do humans go through metamorphosis? Read the first paragraph of the second column on page 44. Sometimes the author gives us clues and we should look for those but I also like to use what I know about metamorphosis to help me answer questions. So, I think about what I know and I use the author's clues to help me figure out new words or ideas.

What clues does the author give us to answer our question?

The author tells us at the top of the second column that birds, fish, reptiles, and mammals do not go through metamorphosis. Each of you is a mammal. I am thinking of ways that mammals, fish, birds, and reptiles are the same. Hmmm. Our skin? No . . our need for oxygen? Yes, but we get oxygen differently from fish. Need for energy through food? Yes, we all need food for energy. I just thought of a really special similarity. Birds, fish, reptiles, and mammals all have babies that look just like them. Bird babies, fish babies, reptile babies, and mammal babies begin as eggs. They grow and grow and grow until they are ready to be born. When they are born or hatched, they look just like their parents so they don't have to go through metamorphosis. When insects are born, they still have to go through metamorphosis before they look like their parents.

The author also tells us that mammals take care of their young until they can find food and meet their own needs. Let's connect the first two sentences where the author talks about how important it is to have babies grow up to have more babies. Think about it. Why would mammals take care of their young? Yes, so they won't die and become extinct.

Use your map and notes to answer the five questions at the end of Lesson 1. Explain your answers to a classmate and listen while they explain their answers to you. Did both of you answer in the same way? Leave extra lines so that we can add to our answers when we use our special books.

Phase 1

Lesson 2, Day 2 (Treatment-Plus Group)
Let's review the words that the author introduced yesterday. Group B tells Group A which words we learned yesterday that we will revisit today. They are

Environment, Climate, Oxygen, Shelter, and Metamorphosis
As we work with new information and new books, we will focus on how those words go together. You have a text in front of you titled: **What is a living thing?**

Open that book to page 4. The title is "What is a Living Thing?" We learned that environment means living and nonliving things in our environment, but our textbook didn't tell us much more than that. This book has an entire page just about what? Living things. Group A read out loud what the author says in the first paragraph on page 4. He asks us a question. How would you answer the question in the first paragraph? What should you think about, look at, or look for to decide if something is living or nonliving? Look at each of the questions under the first paragraph. The author uses one word in each of the questions that I should use when I want to know if something is living or nonliving. Let's find those and write them in our notes about environment.

They are (1) air, (2) food, (3) water, (4) sunlight, (5) grow, and (6) have babies. These are important questions to ask ourselves if we want to figure out if something is living or nonliving in our environment. The author named **chair, table**, **teddy bear**, **toys**, **books**, and **computers** and he told us that these things are NOT living. They ARE in our environment but they are nonliving. Look at the last statement at the bottom of page 4. Let's do what he prompted. Find the living things in this home environment. Give 1 or 2 minutes. Write on the board. Call attention to the box on the right hand side of the page that has the answers to the prompt. So, if I asked you to tell me what an **environment** is, what would you write down? You have to ask yourself if you are in a desert environment, would your answers be different? Yes, however, you would still find living and nonliving things, but they may be a little different than the living and nonliving things at home or in the mountains, on a farm, etc. BUT, you would say it is the "nonliving and living things that surround me or an animal in this or a different location." Good job! Let's find out more to add to our knowledge and understanding about environment.

Page 6: The author began with a question. Everyone read it to me. What would you expect to read about if the question is "What do living things need? I am thinking that the author just talked about what makes a living thing a living thing so now he will again tell me what living things need. I will read this page to you. Listen for all of the needs. Write "things the living need" in your notebook. Write air, food, and water. Those are called basic needs. If you are missing one of those, then you might die. He says that we need sunlight. He used the word most so that makes me think there is an exception to that but, for the most part, most living things need sunlight. He said that they need places to live. We will talk more about "places to live" as we read. What is the main idea of this paragraph? Go back to the question at the top of the page….. "what living things need" is a good way to include everything he talked about in the paragraph. On page 7, students read the second sentence. Living things need other living things. How? Why? When he says that living things need other living things, what is he talking about? If I **need** something, I can't live without it. What can't I live without that another thing can give to me? Brainstorm answers.

Let's turn to page 10 to find the first answer to our question. The author begins with plants are living things. They can make food from light, air, and water. Do those words sound familiar? They were listed on page 6, remember? Page 11: Group A read page 11 text to Group B. What do plants do? Give off a gas. Not just any gas but one that people and animals **NEED to BREATHE**. The author tells us what it is called. It is called **oxygen**. Back to the question. What can't I live without that another thing can give me? **OXYGEN**. Tell me HOW that works. Plants make food from light, air, and water (which they can't live without!) and they give off **OXYGEN** which is one of the gases we need to breathe. Take a minute: everyone breathe in... YOU are taking in oxygen that plants have filled the air with. Now, let it out. The gas that you released when you breathed out is called carbon dioxide which is one of the gases that plants "breathe" in and use to make food.

Plants give me what I need by releasing one of the gases into the air called **oxygen**. You breathe it in and use it up. Then, you release the used up oxygen which is now called **carbon dioxide** so that the plants can use it for food. The illustrator for page 11 drew a picture that he thought showed how oxygen and plants work together. Tell me how you think he did. Why did he draw the sun? To represent the (look back one page at what living things need and decide which one would be a better fit for the sun to represent) light. Good Thinking. He also drew water to represent water. How did he show air? Look at the blue arrows. It says that plants take in the carbon dioxide that we released into the air when we exhaled. Then, the leaves turn it into the gas called oxygen, the plant lets it go into the air so that you and I can take it back in. So, this illustrator put the words in the paragraph in picture form. Give me one suggestion that he could have done to make this picture show the meaning from the paragraph in a better way. I thought about a picture of a person and an animal breathing out. Maybe, an arrow to the plant taking it in and then the person and animal breathing in the gas oxygen.

Skip over to page 14. The author talks more about air and water, two of the things we need in our environment to live. Read the second paragraph. The illustrator drew pictures of different animals (including a child to represent you and me!) to show what? What is the main idea of the pictures (what the illustrator drew)? I see a fish, a boy, a mud puppy, a plant, and an insect. What big idea do they all have in common? They are ALL living things! They all get **oxygen** in different ways. Take a look. Remember in our textbook, page 41, the author told us that there is oxygen in the water in the ocean. As the water passes over the fish's gills, the **oxygen** in the water passes into the fish's blood. Did you make a picture in your mind as I said that? How does the insect on page 14 take in **oxygen?** It "breathes" in through holes on the sides of its body. Page 15 – We all know that water is healthy but what does it actually do? Brainstorm ideas. The author tells us the big idea sentence: Your body needs water to carry oxygen and food to all its cells. If this author is right, that makes me think that if I don't have enough water then all of the cells in my body might not work very good or at all. Let's apply this thinking to the football players practicing in the hot summer sun. If their bodies are sweating and losing water...... (Students complete this thought) then, the cells may not have the water they need to do their job which is to keep your body going strong. Who knows what we call it when your cells don't have the water they need for a long period of time? Dehydration. Good job!

Page 20. Name the title of pages 20 and 21. "Growing and Changing." Teacher reads pages 20 and 21 aloud. Revisit a second time to take students through the thinking processes. Look at the first paragraph on page 20. Let's write these down so that we can get a picture of what growing and changing really are. (Make a map or visual on the board and have students copy it down in their vocabulary notebook.) The author talks about many things in this first paragraph. At first, he starts out big and says that plants and animals get bigger as they get older (kind of like people). They not only get bigger as they get older but some things change in other ways. Trees get bigger as they get older, but they also lose leaves in the fall of the year and start over in the spring. Birds get bigger as they get older and they lose their feathers and grow new ones. Some living things change because of the changes in their habitats.

Let's talk about you. You are a baby when you come into this world. However, you look like a smaller version of your mom and dad. In other words, you look like your parents when you are born. Some animals are the same way. They look just like their parents when they are born (or at least smaller versions that share many characteristics).

The author introduces us to a DIFFERENT kind of change than the one that you go through as you grow up. Let's think about some kinds of insects. Look at the bottom of pages 20 and 21. The ladybug starts out as an egg, moves to a larva, a pup, a new adult, and an adult. I see the same kind of changes occurring from caterpillars to butterflies (remember your textbook page 44). We have a name for this: **METAMORPHOSIS**. Let's take this word apart. **Meta** means many. **Morph** means to change. Put them together. It means many changes. When I think of many changes, I think of changes from little to big, from immature to mature. Write **METAMORPHOSIS** in your notebook. Write that **meta** means **many** and **morph** means **changes** and together they mean "**many** changes." Now, make a picture to help you remember that metamorphosis means that the beginning place is small and the bug, some invertebrates, and amphibians will change and change and change until it reaches the adult stage of its metamorphosis. Both of your texts say that bugs, many invertebrates, and amphibians go through metamorphosis.

Page 26: The last new word that we will revisit is **shelter**.
Teacher reads pages 26 and 27 out loud. Students follow the words as the teacher reads them.

Tell me how to talk about environment and shelters together. Remember that environment includes what? Living and nonliving things-- both of which influence us in many different ways. PAGE 4 in *What is a Biome* book--For example, there are **6** big categories of **BIOMES.** Let's imagine living in two of them. Let's say that we lived in the desert. When I think of all of the things (**environments**), living and nonliving in a desert which is called Biome, I ask myself, "how would living in a desert be different from where I live right now"? Would I live in a different kind of shelter than I do right now and if I would, why is that the case? What in the desert biome would have an effect on me that would change how I lived? Turn to page 6 (thinking out loud). I might first consider the climate in my environment biome. Look at the legend box to the right of the text. The brown color tells me what? That is correct. When I see the brown, I know that that climate is always hot. Ask: What is a climate? Weather conditions OVER TIME! So, if it is always hot and dry, how will the things that I need be affected. Remember, we are living things and we need oxygen, water, food, and shelter. Divide students into the six biome environments on page 4. In notebooks, map out or write out as they process through the below mentioned task. Each group must determine (1) how the climate affects living things in their biomes, (2) talk about oxygen, food, shelter, and water in their biome, and (3) what would have to change about them or their environment to be able to live there. There are two pages in this book that discuss each of the six biomes (begins on page 10 with forest biomes and ends on page 29 with ocean biome environments.) They can use the text to find out about their assigned biome environment. They will need to find their biome on the climate map and give features and attributes of each climate.

Each environment has different kinds of shelters to offer the animals and people that live in it based on the climate in the biome as well as other characteristics and features.

Phase 2: Lessons 4-6

Lesson 4, Day 4 or 5 (Treatment and Treatment-Plus Group)
Teacher's Edition Pages: A48- A53

Introduction

The teacher will introduce phase 2 of the unit, **Animal Adaptations: Body Parts**, explaining that students will be working with more books that teach them how animals and plants grow and change in response to their environment.

Say, "We will continue to use our textbook. Turn in your textbook to page 36. Do you see the box under the chapter number? It says, 'Vocabulary Preview.' Let's reread these words together."

The teacher will read all of the words and explain that the author of the textbook uses the first five vocabulary words in lesson 1, the next three words in Lesson 2, and the last three words in Lesson 3.

The following are the targeted Vocabulary Words in Phase 2, Lessons 4 – 6:

Adaptation Camouflage Mimicry

Before Reading:

Let's look at the title on page 48. It says (all together), **Animal Adaptations: Body Parts.** Let's think about what the author will talk about in the section. Let's take the text apart. Animal adaptations.... I know what an animal is so I need to know what adaptation is. Give me some thoughts about what it means to adapt. Student responses. (Students draw on sheet of paper images that the teacher puts on the board.) Put adaptations in the center of the board. Words that come to mind are change, to be different, or to be different for a particular reason. Let's talk about changing. Ask, "Do you mean they can change their minds?" "Habits?" "Bodies?" Let's see what the author had to say about this word and the ideas behind this word.

During Reading

Chorally read the first paragraph. Tell me what we just read. Finches look alike. Their beaks are different in size and shape. Hmm... I wonder why if they are alike why their beaks would be different sizes and shapes. Find in this paragraph the answers to this question. That is correct. Their beaks match the job it has. Let's look at the pictures of the finches. Listen carefully as you answer the following prompts:

I have a pointed beak. What will I likely eat? How do you think a pointed beak helps you eat insects? So, you mean that the birds adapted? Let's try another one. I eat large seeds. What type of beak would help with that? What characteristics would be helpful with that? How does that work? Tell me about fruits. What kind of beak would be helpful with that? Round, fat, thin, thick, sharp, blunt, why?

What formal definition did the author give? "a body part or behavior that helps an animal meet its need in its environment." Let's pay attention. A BODY part. Who remembers The Hulk? When the Hulk needed to make people pay attention, what happened to him? That is right. He ADAPTED!! How did he adapt? Tell me about the process he went through. He started to grow. What made him grow? Something happened in his environment made him change. The bad guys wouldn't listen to him when he was an everyday kind of guy. However, when he adapted, he began to change by growing bigger and bigger. The color of his body changed to green. After he adapted to accomplish his goal, his body returned to normal.

This is similar to what animals do when they can't get their needs met. Some animals actually change a body part or a behavior. HOWEVER, some animals are already made a certain way and that way is their adaptation. They don't have to change; their colors, body parts, behaviors are already made to protect them. Let's make a picture in your head of adaptation. Group A tell Group B what you see in your mind when an animal adapts. You have to use an animal. Group B tell Group A what you see in your mind when you think of adapting.

Two Kinds of Adaptations

Let's talk about the kind of adaptation that means an animal changes a body part or behavior. There are different parts that animals can adapt. Look on **page 49**. Let's chorally read what the author has said. List some body parts that birds have adapted: size of an owl's eyes and shape of a hawk's claws. Birds have the same basic needs (food, water, protection); how they meet these needs is different for each. Group A: Find an adaptation. When a member of group A names an adaptation, members from Group B will explain how it helps a bird to meet its need in its surroundings, or environment.

The author tells us what special features birds have but does not tell us HOW those features help meet the needs of the bird. So, we must put clues together about what we know, what is written, and what would be logical.

Page 50: Group A chorally read the paragraph aloud about body coverings. Group B will rephrase it in our own words. The author tells us in the first sentence that body coverings are designed to help animals survive. Let's explore what that means. Birds have ______. They are designed to __________. Let's put clues together. The author tells us some things but we have to think about those things plus other possibilities to figure out the rest. Make a two column chart on the board. Place an animal name from the text on the left side of the column. Name the adaptation that matches the animal in the second column. Tell how it helps meet its need in the third column.

Let's look at the pictures on pages 50 and 51. Draw conclusions about how these adaptations meet their needs and help them survive.

Pages 52 and 53. The author introduces two kinds of adaptations on page 51: **camouflage and mimicry**. There must be a special difference between the meanings of the two words. The teacher reads page 52 aloud. Set a purpose for student listening. Teacher tells students to follow along in the text and to make pictures in their heads of what the author has written. Students need to tell how the author defines camouflage. Pay attention to what the author says about camouflage: "an animal's **color** or **pattern** that helps it **blend in** with its surroundings." When you hear the words **color** or **pattern**, what picture did you create in your mind? [Accept responses and save them for later comparison with mimicry.] There are several pictures in my mind of animals changing from brown to green or an animal might already be white and might live in the arctic so it blends with its surroundings or its .... What word did we learn that means surroundings--both living and nonliving? Environment. That's right, now you are thinking. Good connection. Tell me reasons that blending in with your environment could be helpful? Say, "Create a picture in your head of what I am about to say." Let's pretend that we are big buck deer. It is October. Think about what color you are. Most of them are shades of light brown and gray. Their antlers are dark brown (for the most part). Tell me what colors you would see in the woods in October. I see light browns, dark browns, different color grays (old dead sticks), light green, dark green, some yellows... etc. Now, tell me about the dangers we face. That is right. Hunters want to kill us. Tell me about more dangers (other predators......).

Let's go back to our question. Finish this sentence. Camouflage is "an adaptation that helps an animal hide." Let's think about what about an animal that could be adapted. The authors name body coverings and shapes as adaptations. When the authors use the words body coverings, what does he mean? Skin? Fur? Textures? Shapes on the skin or shapes in/on the fur? The authors use a tiger's fur as an example of camouflage. The stripes on a tiger blend in with the tall grasses in their environment. I see a picture of the grasslands and I see a tiger very quietly and slowly walking through the tall grass. His stripes look like shadows from the tall grasses. Can you see that picture in your head? Let's rewind our mental movie so we can tell our neighbors about tigers and their camouflage. Group A tell Group B about the picture in your head and what makes that an example of camouflage. Take 5 minutes. Then, Group B tell Group A about what they see in their mind's eye.

The author lists a second example. Find it and read it out loud. Go. Listening ears up. Hmm, I read toads. Tell me about their adaptations. Their SKIN is an adaptation. What words were used to tell about their skin? bumpy and brownish. Let's think about things that are bumpy and brownish... I think rocks. These bumpy and brown traits make them look like pebbles. Another example is the chameleon. It doesn't change its fur or shape. It changes COLOR. Look at the picture on page 52. How long does it take to change colors? What is the purpose of changing colors? The words under the picture say that it changes color to blend in with the environment to wait for food. So, in this case, the chameleon isn't camouflaging to hide from enemies. HE IS THE ENEMY! He blends in so he can catch dinner. Because he is on the tree, what is he most likely waiting for? Insects? Good thinking!

Now, the author gives us one more word. It is mimicry (mimicree). Mimicry is different from camouflage. Mimicry IS a KIND of adaptation. If you use mimicry, you are "copycatting" another animal. You don't change your fur, skin, or the texture of your body coverings. Mimicry is when you LOOK very much like other animals or plants. Let's read out loud and talk about mimicry. The author uses what example to show us how to think about mimicry. Viceroy butterfly. Good thinking. Birds love to eat insects. So, when they see a butterfly, they might think "there's dinner." But viceroy butterflies look like monarch butterflies which taste BITTER and BAD to birds. So, birds see the viceroy and think it is a monarch and leave it alone. So copycatting/mimicry helps the viceroy stay alive--

Let's put our thoughts together to sum up what we have talked about in this section of our book.

Review

Let's review by mapping what we know. Teacher draws map on the board and students draw map on notebook paper. Go back to page 48 in our text. The author told us about adaptation on page 48. Tell me about the definition he gave. It is? ______ That is the "big idea." Center circle is adaptation. How many types of adaptations are there? Changing a body part or behavior is one kind of adaptation. Another kind of adaptation when an animal is already made or looks a certain way and it helps the animal to get its needs met. Tell me about the examples the author gave. He discusses finches. Scientists concluded that finches' beaks are different based on the kind of foods they eat. Without looking, make some mental connections. Those with thick, heavy beaks might eat?? Seeds. Those with short stubby beaks eat?? Fruit. Sharp, pointed beaks are good for? Insects. Why would this be? Where might you find insects? In and around trees... Don't you think you might have to have a pointed and sharp beak to pick insects from the trees?

Scientists tell us that these different types of beaks are adaptations. Which kind? Tell me the difference. Tell me what I should think about when I am trying to decide if this kind of adaptation is the one that I change or the kind that is already part of my body or behavior? How would I make that choice? Now, we have a way to think about making decisions about adaptations.

If I wondered what kind of adaptation a feather on a bird is, what would I need to think about? I might question about the feathers. I might ask if the feathers are already a part of the bird or if the bird changes from no feathers to feathers. That tells me something about the kind of adaptation. I might think about the usefulness of feathers to a bird. I am thinking they don't weigh very much, and they might help a bird fly, and they might keep a bird warm. I can see that feathers help meet the needs of a bird because they keep it warm, help it fly which means it can get food, get away from enemies, and find shelter. These are adaptations that the bird already has. They help get its needs met. Which needs? Shelter, food, oxygen, and water.

Mapping on Board – Students copy in their notebook

Now, let's go back to kinds of adaptations the authors talked about. Name them. They are **camouflage** and **mimicry**. Give me words that help me understand the meaning of **camouflage**. [Draw on board while students draw in notebook.]

Give me words that will help me make a picture of mimicry in my head. Great job! I will draw it in my notebook while you draw it in your notebook.

Writing
Review comprehension questions on page 53. Group A will ask Group B to orally answer questions 1, 3, and 5. Group B will ask Group A to answer questions 2 and 4.

All students put all questions and answers in their notebook for future reference.

Guided Instructions for Textbook-Plus Nonfiction Text Sets

Page 4 of the book: *What are Camouflage and Mimicry?*

Teacher reads page 4 out loud to students as they follow along. When read aloud is complete, say, "We will go back into the text to find out how the author talked about camouflage and mimicry and how the illustrator used photographs or drew pictures to show what the author was talking about. Say: "Go back into the first paragraph to find where the author talked about why and how animals use camouflage." The author tells us in the first four words what one purpose for camouflage is. It is "survival." What does the author mean when he says survival? Look at the rest of the sentence. Finding food and hiding from natural enemies tells us what the author is thinking about when using the term **survival**. Next, the paragraph says that camouflage is, "the COLOR or PATTERN located on an animal's body that allows it to blend in with a certain background. What is the "main idea" behind camouflage? The last sentence tells us that when an animal is not moving, it is difficult for other animals to see it.

Read the second paragraph to yourself. Find the third sentence. "Many animals use camouflage so predators will not see or eat them." Do you remember the word **survival**? The author used different words for the same idea to tell us more about survival.

However, he added another reason for camouflage. The last sentence of the second paragraph tells us that predators use camouflage to sneak up on their prey.

In your notebook, let's write what we know so far about adaptation camouflage. Let's write that camouflage helps animals to survive by (a) finding food, (b) hiding from enemies, and (c) sneaking up on their prey. We might say that camouflage is a way that animals change and adapt in their environment to get their need for water, shelter, oxygen, and food met.

At the bottom of page 4, the authors write about another kind of camouflage called **mimicry**. Read what the author says about mimicry to yourself. Then, the teacher reads the paragraph out loud. Animals that use mimicry are really just copycats. They blend in with their background and look like something they are not. These copycat animals look just like rocks, plants, even bird droppings!

Page 6: The first sentence tells me a lot of information. The author says that the type of camouflage an animal uses depends on the environment in which it is hiding. Remember the biomes? There are six of them: deserts, tundra, grasslands, scrublands, mountains, and forests. The environments in each of these conditions tell animals how they will change. The author says that many animals stay unseen. How? Just by having one body color. If they are in the arctic, what do you think that color would be? Why? Because the environment around them tells them what colors would make them safe from predators. Some animals are simply just a single color and that is how they are camouflaged. Other animals change their colors to blend in with their surroundings. The author and the illustrator wrote words and used photographs to show us the different ways that animals use camouflage. What words would we use to tell about the different ways animals can camouflage themselves? single tones, spots and stripes, shade shifters, and Hmm--the last box is very different from the 3 on pages 6 and 7. The box with the heading, **brilliant disguise,** is talking about a different kind of camouflage. What is it? And How does it work? Answer: Mimicry. This katydid looks like a leaf, and the sea dragon looks like seaweed. They are copycats.

Page 8-9: The author does a “COOL” thing. For each of the boxes on pages 6 and 7, the authors devote two pages to each of the topics. The heading in the first box on page 6 is “Single Tones.” The author writes more about single tone camouflage and the illustrator provides more pictures to help us understand what single tones look like in nature. On page 8, the author writes about some of the biome environments and tells us what animals in them do to camouflage with one color. Let’s read that together.

Pages 10-11: Sometimes a single color isn’t enough. Some animals use TWO TONES. Read these pages to yourself (3 minutes).

Middle of Lesson Review

Let’s review what we know so far. I will talk you through what we have learned so far. Then, you will write down what we have learned in your own words. Put this in your special science vocabulary notebook (or section of the notebook). Make sure you include the key words, define the key words, and how the key words go together. (They can make a map and come back later and put the semantic map into words.) The author started with CAMOUFLAGE and explained that there were three reasons that animals used camouflage. They use it to (a) find food, (b) hide from enemies, and (c) to sneak up on prey. Next, he wrote about a special kind of camouflage called MIMICRY which is? A COPYCAT. On the next page, he talked about the many SHADES of CAMOUFLAGE. He talked about single tones, spots and stripes, shade shifters, and the one that is different--brilliant disguises.

We spent 4 pages on the Single Tones and Two Tones way of camouflage. Page 12 is about SEEING SPOTS and STRIPES while page 14 is about EYE SPOTS. [Teacher reads out loud and simple discussion ensues.]

Page 12: The author tells us how spots and stripes work to ward off enemies.

Page 16: The INVISIBLE camouflage. [Let students have a minute to review this page. It doesn't have to be thoroughly discussed.]

Page 18: Teacher read aloud pages 18, 19, and 20-23
The author emphasizes that environment is very important to an animal being able to hide. For instance, the author says that a polar bear couldn't hide in a forest. Tell me what the author is thinking when he says that. Let's read to find out HOW animals change colors. The author chose one animal from the forest biome and two animals from the ocean biome to show how animals change according to their surroundings or environment. He told us how the forest biome chameleon changed colors and how octopus, seahorses, and fish change in the ocean biome environment.

Skip pages 20-21.

Pages 26-29: The author tells us about a special kind of camouflage called Mimicry. [Teacher reads pages 26 and 28 out loud.] On page 26, the author tells me something I didn't think about. He says that "every part of an animal that uses mimicry is special because it looks like something else." When I look at the pictures, I can better understand what he means. The slender stick (picture left) looks just like the branches. All of its parts look like some part of the branch. Look at the caterpillar in the bottom right picture. It looks just like bird droppings! All of its parts look like that. Look at the treehopper on page 27. It looks like a thorn on the plant but it is just the curved horn on their back. Look on the bottom. What does it look like to you? An algae covered rock?

Let's turn to page 30, the last page in our book. Remember when the author told us that some animals use camouflage to sneak up on prey? Well, this page shows you how. I will read it aloud and you think as I read.

Review by Writing in Notebook

Add to your notebook that the author followed his pattern and talked about SEEING SPOTS AND STRIPES, EYE SPOTS, and INVISIBLE

CAMOUFLAGE. When the author got to camouflage that changes colors, he stopped and talked about chameleons and octopus. Last, on page 26, the author talked about MIMICRY which is when animals look like something they are not.

PHASE 3

Lesson 7 (Treatment and Treatment-Plus-Intro to Last Three Words)

Animal Adaptations: Behaviors

Teachers' Edition: pages A56-A61

Introduction for both groups
Quick Review: So far, we have learned 8 new words. You name them and I will draw a map on the board showing how those words connect to each other. [Accept answers in random order.] Say: These words are related to each other. How can we show that these words are related to each other? Let's map it out. Think aloud as you read through the words. Which word represents a "bigger idea" than all the others?

The following are the Targeted Vocabulary Words in Lessons 1 through 3 and Lessons 4 through 6:

Environment	**Climate**	**Oxygen**	**Shelter**	**Metamorphosis**
Adaptation	**Camouflage**	**Mimicry**		

Teacher Models a Think-Aloud: I remember when we talked through camouflage and mimicry. Say: "There are two kinds of adaptations. Would those two words go under adaptation? But, we also learned that mimicry is a type of camouflage so we have to show camouflage over mimicry to help organize it in our brains. Doing this will help us see how these ideas are related to each other.

Ask question prompts and press them to explain the logic behind their thinking:

Questions to Think About: [The goal is for them to substantiate their answers by putting clues together to draw a logical, solid conclusion. In order to do this, they must organize what they know receptively and articulate it orally. It is the practice of the mental reorganization that creates the ability to transfer critical thinking skills to different topics.]

(1) Would you find an ADAPTATION in a CLIMATE or a CLIMATE in an ADAPTATION? (Adaptations are usually responses to the climate) What things did you think about to answer this question?)

(2) Is CAMOUFLAGE a type of MIMICRY or is MIMICRY a type of CAMOUFLAGE? (Mimicry is a type of camouflage because animals blend in with their environment by copying other animals for the purpose of protection and survival which is the underlying purpose of camouflage.)

(3) What makes CAMOUFLAGE an ADAPTATION? What makes MIMICRY An ADAPTATION? (They are both types of responses to their environments--all the living and nonliving things in their environments--and they are both types of responses to their climate which is the average weather conditions over time.) CAMOUFLAGE AND MIMICRY are two kinds of adaptations, so would those two words go under adaptation?

Would you find **OXYGEN** in an **ENVIRONMENT? Yes. Would you find oxygen in the ocean environment? Yes, as water passes through the gills of fish, oxygen is removed and used.**

How would **SHELTERS** change in response to different **ENVIRONMENTS**? What would you need to think about to answer this question. Would I **ADAPT** my **CAMOUFLAGE** if I changed **ENVIRONMENTS**? (The more similar it is to the animal's environment, the less they need to adapt.) Not much must change if the animal went from forest to woods, but from forest environment to polar region environment might require significant adaptations.

Today, we will add three new words to our discussion: **INSTINCT, MIGRATION**, and **HIBERNATION**.

You follow as I read page 56. The author tells us that monarch butterflies do what? They fly south for the winter which is where they can find food and a climate they can survive in. Have you ever wondered WHY they do this? [Say:] To answer this question, I begin to think. I wondered if there is a little voice in their head that tells them to fly south. It may not be a voice but the idea of a voice is close to what our new word means. This behavior or action is called **INSTINCT**. Instinct is a behavior (a knowing what to do and when to do it) that animals are born with. They don't learn instincts. They just know what to do. The author tells us that instinct is a kind of **ADAPTATION** to help meet their needs. Think about where that will go on our map. Let's take this idea and go back to the monarch butterfly. They have an instinct to fly south. Big Question: How is having an instinct to fly south an adaptation? How does this help monarchs survive?

Let's turn to page 57. [Teacher reads first column. Tells students:] Listen for the name of another animal that has an instinct and to listen for the reason this animal has this adaptation (instinct).

What did the author tell us? He said that Atlantic green turtles **INSTINCTIVELY** (a behavior built into its nervous system) go to Ascension Island. Ask yourself the following questions: How do they know where the island is? How do they know how to get to the island? How do they know to bury their eggs in the sand? Group A tells Group B what questions we are trying to answer as we go back into the textbook. He gave us one answer but tell me what could happen if they didn't bury their eggs on the island? Would it work if they just laid their eggs and didn't bury them? I am thinking about what I know about eggs. Usually, they have to be kept warm. I also know that there are bigger animals that love to eat eggs. I put the clues together that eggs should be warm with eggs should be hidden and I also thought if the eggs are protected, they wouldn't become turtles. If that happens many, many times, animals become extinct. This makes me think that the instinct to bury their eggs is an instinct for all the reasons we just named. Again, how do they know to bury them? Like the butterflies, turtles have a set of steps they go through and they do it instinctively. It seems like instinct is like an internal map, a special plan, that has many steps and if you don't do one of the steps then the animal may not survive. A characteristic of **INSTINCT** is that it is not taught to the animal. It is not learned by the animal. They are born knowing what to do. Sometimes, animals seem to know what to do and they do it all together. There is a name for what animals do when they move from one place to another in large groups. Let's read and find out what the word for this is. [Teacher reads second column.] Find how the author explains **MIGRATION**. It is the movement of a group of one type of animal from one region to another and back again. This is called an **INSTINCTUAL BEHAVIOR** which is a kind of **ADAPTATION.** Let's talk this through.

INSTINCTUAL BEHAVIOR is another way to talk about **MIGRATION** and **MIGRATION** is an **ADAPTATION.**

EXTINCT is not the same as INSTINCT. [Say:] "Say this with me, instinct and extinct are not the same words."

On the next page, page 58, the author explains that some animals **MIGRATE** so that their young can be safe. If you are an A, read about whales. If you are a B, read about salmon. Group A – talk to Group B about the **MIGRATION ADAPTATION** of the whale. Then Group B, talk to Group A about the migration plan of the salmon.

Let's move to page 59 where the author introduces another word: **HIBERNATION.** Make a picture of hibernation in your head. Tell me what you see. Good job!

I will read and you follow page 59. What is he trying to tell us? Tell me what you understand the difference between **hibernation** and **migration** based on what the author is telling us. So, instead of moving from one place to another, the animals that hibernate adapt in another way. Tell me about the process of **HIBERNATION**. The author tells us that hibernation is a period when an animal goes into a deep "sleep." Now, the author put quotes around **sleep**. Is this important? What is important about the word **sleep** being in quotes? This means that we must think differently about sleep than we normally do. He is calling it **sleep**, but there is something different about it. You and I sleep but we don't hibernate. What happens to an animal's body when it **HIBERNATES** or adapts to colder weather?

Turn the page to page A60. Look at the top of the page. How did the author tell us he was changing ideas? The letters of the words are larger and they are red **LEARNING BEHAVIORS.** Both of these tell us that he is going to adapt the topic. So, what can I expect when I read? I am thinking that we will still talk about **BEHAVIORS**, but it will be different from **INSTINCTUAL BEHAVIORS.** Let's read to see (a) what the author is talking about, (b) how it is like what we talked about (instinct), and (c) how it is different from what we talked about (instinct).

Read the first two paragraphs silently. Answer the questions we asked earlier. Okay, now let's see how we thought when we read.
The author is talking about _________. (learned behaviors)
How is it like instinct? ___________ (They are both behaviors)
How is it different from instinct? _______ (They are born with instincts to help them survive; some things we learn from others teaching us.)

Hunting is a behavior that tiger cubs are born with? NO. Show me where the author said they aren't born knowing how to hunt. If they aren't born with it, what word clues can we put together to figure out how the tigers know how to hunt? What science word did the author use to tell us how some animals know how to survive by watching others? The new term is **learned behavior**. Group B? Explain to Group A what you understand learned behaviors to be.

When the author said that chimps learn meanings of sounds by watching other chimps in his or her environment, what did he mean when he was talking about environment? Think about what we have learned.

The author summed it up on page A61. He said: Which sentence tells us a big idea for all that we have read? What would this paragraph look like on a semantic map? Take 5 minutes and sketch this out in your notebook. What is the author saying the big idea is? The big idea is the center point of this map.

Group B will find answers to review questions 1, 3, and 5. Group A will find answers to 2 and 4. When I call time, Group A will ask Group B the question and listen to the answer. Group B will do the same for Group A.

PHASE 3

Lesson 8 (Treatment-Plus Group: Textbook and Nonfiction Text Sets)
Lesson 8 (the day depends on how you have been pacing the lessons)

Introduction

The teacher will again introduce the unit, **Animal Adaptations: Behaviors**, explaining that students will be working with books that teach them how animals and plants grow and change in response to their environment.

[Say:] Let's revisit our textbook. Turn in your textbook to page 56. On the left side of this page, the author lists three target vocabulary words. They are **INSTINCT, MIGRATION,** and **HIBERNATION.**

On page 4 of "What is **MIGRATION?"** The author talks about **MIGRATION.** I will read as you follow the text. Let's think about *how* the author talks about migration in the first paragraph. He says that there are weather changes during the year and these changes are called **seasons**. HMM that makes me think about one of our words: CLIMATE. Can you have different seasons with ONE CLIMATE? (Yes) (If CLIMATE is the average of weather conditions over time, then it could be that the average conditions for one climate might be hot, hot summer season, cold, cold, winter season and warm, warm spring season.) What does the third sentence say about animals in relationship to the seasons? He said, "Animals must change to survive". What word have we worked with that means that animals must change to survive? **ADAPTATION.** Look at what the author is telling us. He said that some grow fur so they are protected and some hide underground. These adaptations can be done right where the animals are. They do not have to move for this to happen. Other animals, however, do what? Find in the first paragraph where the author tells us what animals that don't change do. He says, "They travel to areas where the weather is better suited to their needs." Some animals adapt right where they are and others move. When animals move to find shelter, food, water, and a safe place for their babies, we call it____? MIGRATION. When I said food, water, and a safe place (shelter), it made me think about our first book. Think back and tell me what **food, water, oxygen, and shelter** have in common. That is correct. It is **what living things need to survive.**

Read the header in the middle of page 4. It says, "***Following Instinct."*** Think back with me, an instinct is ________? (Knowing to do something without someone teaching you to do it.) I predict that this paragraph will talk about following what I know to do and not what I have learned to do. Find the sentence where the author tells us more about instincts. "Instincts are behaviors with which animals are born." Let's take what we know about instinct and migration and put them together. The author did that in the last sentence on page 4. He said that animals know how to use **mountains, stars, and odors** as guides when they move from place to place. Migration then is one kind of instinct so migration would go under instinct if we were making a thinking map to show how these words are related. Let's write that **when animals migrate they use mountains, stars, and odors** as guides in our notebook under **instinct and migrate**.

Pages 6 and 7 tell us the many different reasons that animals migrate or move from place to place. It is important that we know that there is more than one reason for animals to move from place to place. I will read page 6 out loud while you follow along and think through what the author is telling us. [Read page 6] On page 6, the author tells us (a) for some animals, winter may be too cold for them so they must migrate, (b) one place might run out of food and water during a particular season, and (c) they travel to mate or make babies. Then, the author switches what he is talking about. He tells us how often or how long migrations are. He had been talking about the REASONS animals migrate. Now, he is talking about how often and how long the migrations are. Write two connections on your thinking maps. One should read the REASONS FOR MIGRATING and the other should read HOW LONG AND HOW OFTEN. The author tells us that birds migrate TWICE A YEAR but salmon only once in a LIFETIME. However, army ants and wildebeest are always moving from place to place.

Look at the first example. He uses whales to explain one of the reasons animals migrate. Let's get Group A to read this to Group B. Group A read out loud, *The Nursery*. As you read that, I remembered that habitats are little environments and then I remembered that every environment has a climate or an average of weather conditions over time. **Teacher Oral Think-Aloud for Students**: I took what I remembered from our lessons on living things, environments, and climates and made a picture in my mind of the cold arctic waters described by the author. I thought about the adaptations that whales have so that they can live in the icy cold arctic waters. They have blubber, which is a thick fat that covers their bodies (right inside their skin.) I thought that it must be like a thick, thick, furry coat. This is how the whales are adapted to live in the cold, cold arctic CLIMATE. I don't think that I could live in that climate or the whole environment. My body is not adapted to living in those conditions.

Then, I thought about the baby whales. The author wrote that baby whales don't have "blubber jackets." So, they either have to freeze to death, adapt, or they have to live in a warmer CLIMATE. The mother whales have an instinct that tells them to move to a warmer climate to have their babies. So, this is an EXAMPLE OF ONE REASON THAT ANIMALS MIGRATE. The EXAMPLE shows that one reason for migration is to find a climate and environment that are better suited for helping babies grow up.

Look on page 7. The author gives us more EXAMPLES of the REASONS and HOW LONG AND HOW OFTEN animals migrate. As we talk about them we will add these examples of reasons to the section on our map that talks about REASONS.

Look at the butterfly on the top of page 7. Group A read "**Too Cold in Winter**" to Group B. The author makes a main idea statement that says that some birds and butterflies migrate to escape cold winters in which they couldn't possibly survive. So, their instincts tell them that they must migrate to escape the cold winters. They are in the north so they have to move to the south where it is warmer. This EXAMPLE shows that the reason for migration can be due to season changes. So, one example of a reason to migrate is to survive a season change. How long and how often? This example tells us that they migrate once a year just like winter comes for one season out of the year. Then, they migrate back when spring arrives. So, they stay in their warmer home for one season and they migrate one time during the year.

The wildebeests migrate for another reason. They tend to eat and drink up the little bit of food and water in their environment. They simply continue to move from place to place. Each time the food supply dwindles, they just migrate to a place with more food and water. The place that they leave will then grow new plants. This EXAMPLE shows that the reason for migration can be due to food and water supplies.

Group B reads to Group A "**We need food.**" Now, Group A tell Group B why wildebeests migrate, how long, and how often they migrate. (They just keep moving from place to place so they are always migrating.)

Group B reads "**Water to Land**" to Group A. Group A, in your own words, tell Group B who migrates, why they migrate, and how often they migrate. Did the author give you enough information or did you have to remember some of the information we have learned and applied that knowledge here? Group B, Group A should have told you that sea turtles and alligators (reptiles) live in the water but lay eggs on land. Amphibians (frogs) lay in the water but they live on land. Either group, amphibians or reptiles, migrate to lay their eggs. What clues from other lessons can we apply here? Is this an instinct or a behavior? What did you think about to arrive at your answer? You should have thought about what instinct means. Instinct means? Something I know to do without being taught how to do it.

Let's preview the rest of this book. We will not work through all pages but we will make mental notes about what the author is going to talk about. This will help us know what information to look for when we read. This is the same information we put in our thinking map earlier. This author has a pattern when he writes. It is a good way for us to learn how science texts are written.

Pages 8-9**:** Topic: Terns. The author talks about the **reason** that terns migrate, **how long** they migrate, and **how often** they migrate.

Pages 10-11: Topic: Canadian Geese. The author writes about the famous Canadian geese that fly in a V when they migrate. Can you guess what information the author will talk about on pages 10 and 11? He will tell us the **reason** that Canadian geese migrate, **how often**, and **how long** they migrate.

Pages 12 and 13: Topic: Salmon. The author writes about the **reason** that Salmon migrate and **how long** and **how often** they migrate.

Pages 14-15: Topic: Eels. The author writes about the **reason** that eels migrate and **how long** and **how often** they migrate.

Pages 16-17. Topic: Whales. Scan this page and tell me what the author talks about that will answer our questions. Find the **reason**(s) that whales migrate. Find **how often** and **how long** whales migrate. When you find it, hold onto your thoughts by writing them down in your vocabulary notebooks. [Have them give you the reasons mentioned in the text. Have students check against what they wrote down in their vocabulary notebooks.]

Short Written Assignment
Group A Work on This
Pages 18-19: Topic Wildebeests. All of Group A find the reasons that wildebeests migrate. Write it down and how long and how often they migrate as well as the TYPE of migration patterns they have that is different from the migration of Canadian geese.

Group B Work on This
Pages 28-29 – Sea Turtles. All of Group B find the reasons that sea turtles migrate. Write it down. Find how long and how often they migrate. Write it down.

[When groups have completed the assignments, they swap pages and Group B determines if Group A answered all of the prompts accurately or if they left important information out. This means that they will have to read the information themselves. Group A will look at Group B's answers as well.]

Extension: Many of the animals mentioned have the same TYPE of migration patterns. Example: wildebeests and army ants. Both of these groups are always on the go, moving from place to place. There are other comparable pairs in the text. Students can do Venn Diagrams to determine how these pairs are alike and different in instinct, behavior, duration of migration, and frequency of migration.

Let's turn our attention to the book titled **HIBERNATION.**

Pages 4 and 5 of the text define hibernation. Teacher reads page 4 to the students because this is the introduction to the very big category of **hibernation**. After reading out loud, revisit how the author organized the information in the text. Many areas of the world have cold winters. Already, we should think about the many different climates that have cold, cold winters. There are different degrees of cold winters.

Some animals adapt by migrating and others adapt by **hibernating.** The author tells us that hibernation is not like regular sleep. Remember how the author put "sleep" in quotations? This is what he was telling us. **Hibernation** is not like regular sleep. To hibernate, a few things have to happen. First, an animal's breathing must become more and more shallow… its heartbeat must become slower and slower and slower. This makes the animal's body cold. With the heart and breathing so slow and shallow, the animal doesn't need much food because it isn't using much energy. When it is not hibernating, the animal eats and eats and gets fatter and fatter. This fat releases a food supply to the animal when it is breathing shallow and its heart is barely beating.

Let's put what we learned about hibernation on a map in our vocabulary notebook. Find a place near migration under instinct. If you don't have room, start a new page for hibernation. Under **hibernation**, make a category that says, "**Types of Hibernation**" and a category that says, "**Characteristics of Hibernation**". Under characteristics of hibernation, put (a) slow, slow heartbeat, (b) shallow, shallow breathing, and (c) the little energy needed to hibernate comes from fat stores in the animal's body.

Look on page 5. What does the author say about "**true hibernators**"? What should you think about to determine if an animal is a true hibernator or not? The author says that **true hibernators**: (a) sleep for months and (b) body temperature drops to just above freezing.

Bears and larger animals (like raccoons) spend much time sleeping but they wake up OFTEN. Their bodies are warmer than the freezing temperature of **true hibernators**. So, bears aren't **TRUE hibernators**.

Page 5 bottom: Let's read "When is the right time?" to figure out how animals know when to **hibernate**. [Teacher reads aloud this section.] Do you know how the time begins to change as winter approaches? What happens to our days the closer we get to winter? Daylight is shorter. This tells animals that the seasons are changing. Their **INSTINCT** kicks in and they get ready to **hibernate**.

There are also different types of **hibernation**. Find the category on your map in your vocabulary notebook. Each type of hibernation is suited to the animal's body and its habitat, or home. Remember our **biome** word when we discovered what an environment is?. Here we go again. **CLIMATES** affect animals. In mild

climates where the weather changes aren't drastic, animals may hibernate for only a few weeks. The author then tells us that garter snakes hibernate for about 8 months each year! When I read that, I began to put clues together. I remembered that climates affect the length of hibernation and then I thought that 8 months is a long time. I concluded that the garter snake must be in a place where temperatures are pretty extreme. I tried to think of places that it would be really cold or hot. The first place I thought about was the arctic. I continued to read and the author told me that these snakes live in the arctic tundra. Putting clues together when I read worked for me!

Page 6 and 7- when I read the title, "**Why do animals sleep**?" I realized that ALL animals need to sleep. They would be weak if they did not sleep. On page 7, the author wrote that some animals can only take short naps because they have many enemies or predators that want them. What do you think a predator would want with another animal? That is right... to eat it. By now, we know that all animals need different amounts of regular sleep. In the middle of page 7, the author tells us? That is right. He tells us HOW **hibernation** is different from regular sleep. Let's read it together. The teacher reads and the students follow. The first paragraph tells us about regular sleep. The second paragraph tells us the **REASONS** animals go into a special kind of sleep called **hibernation**. A **hibernator,** or special kind of sleeper, can go months at a time without food. These animals, **hibernators**, don't use much energy so they can live off stored body fat. If the animal isn't eating or drinking, it doesn't need to get rid of its waste. Student group B chorally (all read orally together) reads the first passage while Group A reads the second paragraph orally.

Pages 8 and 9: For the last several pages, the author keeps writing about animals needing only a little food during **HIBERNATION**. Let's explore that a little more. We will want to add an extension to our "**Characteristics of Hibernators.**" This extension will talk about **Food and Energy of Hibernators.** Hibernators must eat large amounts of food during the late summer and early fall. They eat all day. Bushes and trees are full of nuts and berries. Which one of our words is the word to describe what animals would be doing in response to the changes in their environment? **Adaptation**. Yes, but these animals aren't adapting through camouflage and mimicry. They are adapting their behaviors. We have two kinds of behaviors. They are behaviors that we learn and those that are instinctual. Is hibernation a learned behavior or is it an instinctual behavior? Why?

Back to our **Characteristics of Hibernation**. We know that hibernators eat all day during late summer and early fall. Bushes and trees have lots of nuts and berries. Food is plentiful. How do animals know to eat so much? Remember that hibernation is instinctual. Their bodies release special chemicals called hormones that make them constantly eat. They have to pack on the weight to survive winter when food is not so plentiful.

Page 9: [Teacher reads page 9 out loud.] When they get fat, their body stores it in two places. Group A tells Group B what white fat is and what its job is. Group B tells Group A what brown fat is and what its job is. Now we know how animals get **food** to live on throughout the winter.

Pages 10 and 11: These pages tell us about **SHELTER**. Remember from our first lesson how important **SHELTER** is to animals. Tell me the **REASONS** that **SHELTER** is important to animals. So, animals have an INSTINCT to find just the right kind of **SHELTER** to meet their needs.

[Teacher reads page 10. Students must explain the role of **SHELTER**.] What are the **REASONS** the author gives for what **SHELTERS** do? Ask students to give examples of different **SHELTERS**. Talk about how some **SHELTERS** are good for some animals and others are better for other animals. Specifically discuss groundhogs (page 10) and bats (page 11).

Pages 12 and 13: Let's learn more about what it means to **hibernate.** Group A reads about **true hibernators**. Group B reads **"Low and Slow."** Take a look inside an animal's body. What is happening that we cannot see? Group A has to explain the paragraph to the class in a logical cause-effect way. They tell us about **MAMMALS** and how humans are different from animals.

MAMMALS
Let's think about what the author says about true **hibernators**. True hibernators appear dead. If you pick them up, they appear dead. These animals are considered to be **MAMMALS**--just like you and me. Being a **MAMMAL** means that your body temperature usually stays the same. However, **MAMMALS** are able to lower their body temperatures to just above freezing.

On page 13, the author becomes very detailed about what he mentioned on page 12: Free Map. [They have to put all of the information on page 13 into a map of their own design to show how these things are related and to show the details of each topic.]

Categories: **Almost Dead, Tiny Animals Can, Food and Water, and No Need To Go.** These are all attributes of **TRUE HIBERNATORS.**

Page 14 – **LIGHT HIBERNATORS**. The author talks about light sleepers or those who can wake up during the winter season. Let's think about that. What might be different about these **LIGHT SLEEPERS** from **TRUE HIBERNATORS**? I remember that the author talked through key points on the page before this one. He talked about body temperatures and smaller animals, how animals store food and water, and no need to release fluid and waste. I will read out loud and you can follow. What did we find out? Big animals are also **MAMMALS,** but they can't lower their body temperatures enough to **STAY** asleep. If we paid attention to what makes little animals more able to sleep and stay asleep, then we predict that the author will tell us why bigger animals can't stay asleep. I predict that the author will talk about **SHELTERS** for **LIGHT SLEEPERS**. I predict that the author will talk about the different ways that **LIGHT SLEEPERS** eat food. The last thing I predict the author will talk about is how **LIGHT SLEEPERS** have to urinate.

PAIR WORK

One student from Group A and one student from Group B get together to create a **Venn Diagram** comparing and contrasting the similarities and differences of **True Hibernators** and **Light Sleepers**.

[After completion, the teacher draws and talks through the Venn on the board and students compare their product with the teacher diagram.]

Pages 16 and 17: The last category of hibernators is **reptiles** and **amphibians**. We start out with a huge difference right away. Everyone find the **BIG** difference in reptiles and amphibians, and **MAMMALS.** They are **COLD-BLOODED**. What effect does it have on the body to be cold-blooded? These creatures are like chameleons, only they do it with their body temperature not their color. When their surroundings get warm, their blood gets warm. When their surroundings get cold, their blood temperature gets cold. Their blood doesn't warm from the inside like **MAMMALS**. They lie in the sun to warm up their blood.

[Teacher reads page 16 out loud. Students follow in their books.]

Let's add **COLD-BLOODED HIBERNATORS** to our list of **TYPES of HIBERNATORS.** We know that cold-blooded creatures respond to the temperature outside by matching it. What do you think might happen if it is an icy cold day? If their blood responds to the outside temperatures, their blood could freeze!! So, what did the author say snakes do to prevent their blood from freezing?

On page 17, the authors talk about cold-blooded animals such as frogs and turtles. Even though these animals are COLD-BLOODED, they act differently. Frogs and turtles hibernate at the bottom of ponds or streams.

[GROUP A reads to GROUP B. Group B listens and looks for the answer to the question: How do frogs and turtles go through the process of hibernation? Group A and B try to answer the following prompts. What do frogs and turtles do for SHELTER, OXYGEN, and FOOD during hibernation?] It seems like we have been talking about the same words but just trying to figure out what the words mean when they are put in different climates or are used on different kinds of animals.

REVIEW and putting it all together:

[Student vocabulary notebooks should be a wonderful source to review and revisit what we have focused on. Start on the first page of their notebook section and talk through what you did and what you discovered as we talked through it. Review the first 5 words in light of their notes. Seek clarification from their nonfiction books if there are missing parts to the maps. Let them find the "missing pieces" or let them elaborate more on the first and second notes. Prompt them to apply the last lessons to the first two.]

Make a BIG MAP (leave much room between parts to add animals) of **environment, climate, oxygen, shelter, metamorphosis, adaptation, camouflage, mimicry, instinct, migration, and hibernation**. Leave much room for details under each of the categories. Map and talk through what we learned about environment including the **definitions** of each word. Then, have branches from each of the words to talk through how surroundings, living and nonliving, things are affected in different types of **CLIMATES**, how **SHELTERS** are affected, and how animals ADAPT in different ways through CAMOUFLAGE and MIMICRY. Explain the connection that animals ADAPT through behaviors as well as through physical characteristics. Behavior **ADAPTATION** is **INSTINCT, MIGRATION**, and **HIBERNATION.**

Fill in under each word and develop (see previous think throughs) different examples of animals and how those animals respond (instinctually and through learned behaviors) to conditions in the **CLIMATE** by finding **SHELTER** or by Physical Adaptation or Behavioral Adaptation.

Model a Think-Aloud Example: Polar bears. They are white in color. They are mammals. They live in the arctic. Tell me about the **CLIMATE**. What color would you expect an animal to camouflage with if it lives in the arctic? Is this an instinct or an adaptation? (an **adaptation).** What kind of **adaptation** is it? (camouflage by blending in with its **environment**) Would polar bears hibernate or migrate or neither? What do you know about bears in general? Connect this to what we learned about bears and hibernation and migration.

Animal categories to attend to: Mammals- whales, terns, Canadian geese, bears, raccoons, ground squirrels, small animals (mammals) and reptiles, amphibians.

APPENDIX J

FIDELITY OF IMPLEMENTATION CHECKLIST

NO.	QUESTION	None	Some	ALL	NA
	Before Reading:				
1	Teacher reviews by recalling targeted vocabulary words: **environment, climate, oxygen, shelter, metamorphosis, adaptation, camouflage, mimicry, hibernation, migration, instinct**				
2	Teacher and students define each of the targeted vocabulary words: **environment, climate, oxygen, shelter, metamorphosis, adaptation, camouflage, mimicry, hibernation, migration, instinct**				
3	Teacher refers to and uses visual representation (**semantic map or other written medium**) of how the words relate to each other as she and the students talk through word definitions and explanations. Written Medium: Teacher involvement?____ Student only?________				
4	Teacher engages in "Making Choices" activity for each of the words by providing several examples and nonexamples of each word. Students indicated correct examples verbally or visually.				
5	Teacher prompts students to pair and share by writing words and or phrases that help one better understand each of the targeted words.				
6	Teacher and students define words using examples and characteristics, properties, or descriptions.				
	During Reading:				
7	Teacher reads textbook and/or nonfiction text aloud.				
8	During and after the read-aloud, the teacher models thinking through the text while prompting and waiting for students' responses.				

NO.	QUESTION	None	Some	ALL	NA
9	Teacher prompts students to reread individual copies of nonfiction read-aloud and has them respond in writing to the following prompts: Check all that apply. Using nonfiction text sets, describe **environment, climate, oxygen, shelter**, and **metamorphosis, adaptation, camouflage, mimicry, hibernation, migration, instinct** for each of the following: _____ *Life in the desert* _____ *Life in the forest* _____ *Life in the ocean* *Comments:*				
	After Reading:				
10	Teacher engages students in a "Word Detective" activity that encourages students to choose one of the locations below, offer clues about the **environment, climate, oxygen, shelter**, and **metamorphosis, adaptation, camouflage, mimicry, hibernation, migration, instinct** until classmates guess the location in question: _____ *Life in the desert* _____ *Life in the forest* _____ *Life in the ocean* *Comments:*				
11	Students provide examples of **environment, climate, oxygen, shelter**, and **metamorphosis, adaptation, camouflage, mimicry, hibernation, migration, instinct** for each of the following: _____ *Life in the desert* _____ *Life in the forest* _____ *Life in the ocean*				
12	Students provide descriptions of the **environment, climate, oxygen, shelter,** and **metamorphosis,** for **adaptation, camouflage, mimicry, hibernation, migration, instinct** each of the following: _____ *Life in the desert* _____ *Life in the forest* _____ *Life in the ocean*				

Total time spent on the lesson (in minutes) = _______

Comments: Indicate any out-of-the-ordinary activities (e.g., weather interruptions).

Scoring **Fidelity of Implementation:** The following values are assigned for each critical point evaluated:

ALL (2 points) **SOME** (1 point) **NONE** (0 points)

ALL______ x 2 = _____
SOME______ x 1 = _____
NONE______ x 0 = _____
Total Observed = _____ divided by the total possible points for the lesson (24)
= _____ Fidelity

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