THE EFFECTS OF CONCEPT MAPPING AND QUESTIONING ON STUDENTS' ORGANIZATION AND RETENTION OF SCIENCE KNOWLEDGE WHILE USING INTERACTIVE INFORMATIONAL READ-ALOUDS

A Dissertation

by

JAIME LEIGH BERRY

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2011

Major Subject: Curriculum and Instruction

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Approved by:

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ABSTRACT

The Effects of Concept Mapping and Questioning on Students' Organization and Retention of Science Knowledge While Using Interactive Read-Alouds. (August 2011)

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According to recent assessment data, there is an urgent need to improve students' knowledge of science. It has been suggested that the infusion of reading activities including concept mapping, questioning and interactive read-alouds can help students in learning science concepts. Little or no research has combined these methods to examine its effect on learning. The purpose of this study was to examine and compare concept mapping and questioning on students' organization and retention of science knowledge when used with interactive informational read-alouds of science trade books. This study included 58 third grade students from four homogenous classes who were assigned to either a concept mapping group (experimental group) or a questioning with writing group (comparison group). With the same teacher, the school science specialist, the students completed an eight day unit regarding "soil formation" comprised of read-alouds, discussions and reading comprehension activities. (There were no hands-on, laboratory experiments.) Students were assessed on different types of knowledge.

Data were analyzed using a mixed model ANOVA design to determine both within-factors (repeated measure), to show growth, and between-factors, to determine the difference between the two groups. The concept mapping group (experimental group) performed significantly higher than the questioning with writing group (comparison) on (a) relational vocabulary assessment (measuring relational knowledge); (b) multiple-choice assessment (measuring students' ability to identify key ideas); and (c) writing assessment (measuring students' relational thinking, students' ability to retain and recall key information and students' ability to use domain knowledge). The concept mapping group maintained these gains in a delayed assessment. The groups did not differ on individual word knowledge as measured by a matching assessment.

Recommendations are provided for teachers and researchers including using concept mapping in teaching science concepts to elementary students in conjunction with science text reading, as well as incorporating technology with computer-generated concept maps using *Inspiration* software.

DEDICATION

This is dedicated to my mother, Sandra, whose dream finally came true.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

We live in a society with the need for advanced science skills (Pearson, Moje & Greenleaf, 2010) however the latest assessment data casts doubt on whether our students are being adequately prepared for this goal.

The National Assessment of Educational Progress (NAEP, 2009) conducts a nationwide assessment in the areas of Math, Reading, and Science to determine the performances levels of our students. According to the 2009 NAEP National Report of Science, 29% of fourth grade students in the United States performed *below* the basic level while only 39% performed *at* the basic level. Only 28% of students performed *at* the proficient level and only 1% of students performed *at* the advanced level. Students in grade eight had similar results with 38% of students performing *below* basic and 33% performing *at* the basic level. Only 28% of the students performed *at* the proficient level and only 1% performed *at* the advanced level. In total, the majority of students are performing either at the below basic level or basic level at a time when advanced science skills are a prerequisite to be successful in a high-technology society. Researchers also suggest that United States' students are performing behind students in other developed and developing countries (Bybee, McCrae, & Laurie, 2009; Fensham, 2009).

This dissertation follows the style of *Reading & Writing Quarterly*.

To consider comparisons across countries, the Programme for International Assessment (PISA) was created by the Organization for Economic Cooperation and Development (Bybee, et al., 2009). This test is administered every three years to 15-year-old students from participating countries to assess their knowledge and skills of Reading, Math and Science Literacy. In the 2009 assessment, 28 countries out of 65 countries (OECD and non-OECD countries) scored higher than the United States reinforcing the need to strengthen our science instruction in order to be competitive in a global society. Many researchers have pondered why students are having difficulty in learning science concepts.

Some researchers have suggested that the nature of scientific text can be a barrier for students learning science. Convergent research (Pearson et al, 2010; Heller & Greenleaf, 2007) indicates a need for explicit literacy strategies within content area instruction, particularly science, for students to gain proficiency with understanding challenging texts. Despite overlap, every discipline and genre of writing comes with its unique literacy, and science is particularly challenging (Fang, 2006). Proficient skills in science and reading are a prerequisite to be productive members of society. First of all, individuals must be able to use scientific processes in everyday decision-making and must possess the scientific background knowledge to make sound decisions (National Standards, 1996). Next, individuals must have the literacy tools to read and comprehend informational articles about current scientific topics that affect their lives (e.g. salmonella, cancer research) (Draper, 2011). In addition, many individuals will have roles in society that require science and literacy skills including teachers, engineers, scientists, and researchers (National Standards, 1996). However, current instructional practices, in which reading and content instruction are typically separated, often leave students unable to handle the more challenging demands of content texts (Shanahan & Shanahan, 2008).

Additionally, among content texts, the nature of scientific text in particular can be challenging for students (Van de Broek, 2010; Conderman & Elf, 2007) because of its organizational structure and its often *inconsiderate* writing style which can include an abundant amount of information while assuming too much prior knowledge (Armbruster & Anderson 1988; Abadiano & Turner, 2002). In addition, there is often a large amount of irrelevant information (Abadiano & Turner, 2002) in science texts. However, incorporating a repertoire of metacognitive reading strategies can be beneficial to students. For example, Michalsky, Mevarch and Haibi (2009) found that infusing literacy instructional strategies, including concept mapping, questioning techniques and making connections, had a positive impact on science performance.

While the integration of science and reading instruction has shown to yield benefits which are further summarized in the literature review, there is much debate on which instructional practices are the most effective in learning science concepts including the following: informational text (informational trade books); interactive read-alouds; graphic organizers, specifically concept maps; and questioning. The review of literature will examine previous research on these instructional practices.

Rationale for the Study

The integration of science and reading instruction can increase academic performance in both domains (Michalsky, Mevarch & Haibi, 2009). In this study the instructional framework included the following instructional practices: informational text (informational trade books), interactive read-alouds, concept mapping and concept questioning. Selection of the elements was based on proven empirical evidence of their effectiveness on learning (Robinson, Katayama, Beth, Hsieh & Vanderveen, 2006; Oliver, 2009; Heisey & Kucan, 2010).

Informational text. Informational text is imperative in science instruction. There has been a heightened interest in the use of informational trade books in teaching science concepts as an effective supplement or substitution for textbooks (Schroeder, Mckeough, Graham, Stock & Bisanz, 2009; Fang & Wei, 2010; Donovan & Smolkin, 2003). This can be attributed to the limitations and drawbacks of textbooks including their ineffective use of graphics and visual representations (Slough, McTigue, Kim & Jennings, 2010; Lee, 2010), readability (Hiebert, 2005) and text organization (Armbruster, 1986). Informational trade books focus on a topic of study and include formal language patterns, examples and rich illustrations that can aide in students' understanding especially of vocabulary (Saul & Dieckman, 2005). They have been shown to benefit students in their learning of science concepts (Heisey & Kucan, 2010) and they can capitalize on children's curiosity and interests about the world (Duke, 2003; Palmer & Stewart, 2003). Use of such texts has been proven to motivate reluctant readers (Smolkin & Donovan, 2003; Abadiano & Turner, 2002). In fact, they have been shown to foster motivation and engagement in literacy and nonfiction (Guthrie, 1997; Guthrie & McCann, 1997). Informational trade books are effective tool for introducing vocabulary because terms are simplified through the use of examples and illustrations. Furthermore, exposure to informational text, especially in the primary grades, prepares students to utilize this genre in later grades.

Interactive read-alouds. In *Becoming a Nation of Readers* (Anderson, Hiebert, Wilkinson & Scott, 1985), published by the National Academy of Education and the Center for the Study of Reading, it was stated that "the single most important activity for building the knowledge required for eventual success in reading is reading aloud to children" (p.33). There has been a vast amount of research on the benefits of reading aloud to children (Beck & McKeown, 2001b; Beck, McKeown, & Kucan, 2002). Recently, there has been an increase of recommendations for the use of conversation or "discussion" during the read-aloud process, also referred to as interactive read-alouds.

Interactive read-alouds have been shown to be useful in teaching science concepts especially when working with low struggling readers (Heisey & Kucan, 2010; Smolkin & Donovan, 2003). The interaction allows students to make interpretations, offer suggestions and ask questions (Heisey & Kucan, 2010). This format can be used in conjunction with informational trade books.

Graphic organizers. Ausubel (1963), a cognitive psychologist, created graphic organizers to help students in their facilitation of learning. He suggested that learning takes place by the assimilation of new concepts and propositions into existing concepts and propositional frameworks, also referred to as their cognitive structure (Ausubel, 1963; Novak & Canas, 2008). When the cognitive structure expands by the addition of new information, learning takes place. The graphic organizer was created to provide learners with a *meaningful framework* for connecting existing knowledge to new knowledge (Ausubel, 1963; Kim, Vaughn, Wanzek, & Wei, 2004).

There have been a substantial number of studies on the beneficial use of graphic organizers on learning, especially in content areas including science, math, and social studies (DiCecco & Gleason, 2002; Alvermann & Boothby, 1983; Braselton & Decker, 1994; Jang, 2010). There have also been several cognitive theories associated with the effectiveness of this instructional tool including: visual argument (Waller, 1981); dual coding theory (Paivio, 1986; Paivio, 2006); cognitive load theory (Sweller, 1993; Sweller, 2006); and conjoint-retention hypothesis theory (Kulhavy, Lee & Caterino, 1985). These theories will be further discussed in the literature review.

Concept maps, a specific type of graphic organizer, have been shown repeatedly to aid students' understanding of informational text and to promote deeper levels of learning (Jang, 2010; Kern, 2008; Schaal, Bogner, Girwidz, 2009; Robinson, Katayama, Beth, Hsieh & Vanderveen, 2006; DiCecco & Gleason, 2002). Novak, created the concept map as a tool to represent students' understanding and meaning of science concepts and prepositions (Novak & Godwin, 1984; Novak, 2005). The main goal of this graphic tool is to organize and represent knowledge (Novak & Godwin, 1984; Novak & Canas, 2006).

Questioning. The use of teacher-generated questioning has proven to have positive effects on comprehension (Harvey & Goudvis, 2007). First of all, the use of questioning can promote student understanding by focusing attention of the important details including the author's purpose (Miller, 2002). This instructional strategy can be beneficial to clarifying meaning as well minimizing students' misinterpretation of information (Miller, 2002; Heilman, Blair & Rupley). Questioning can also aide in activating prior knowledge by activating students' experiential and conceptual backgrounds (Heilman, Blair & Rupley, 2002) promoting deep processing of information (McKeown & Beck, 1993).

Raphael (1984) suggests there are two types of sources of information for answering questions: "in the book" and "in the reader's head". The source of "in the book" refers to "right there" questions (answer in easily found in text) and "think and search" (answer in different parts of text). The other source, "in the reader's head" refers to "author and you" (answer in not in text; background knowledge is used) and "on my own" (answer is not in story; background knowledge is used).

But yet, there have been several criticisms to using questioning as an instructional method (Feldt, et al., 2002). First, students may search for important ideas to memorize instead of making connections and increasing relational knowledge (Cook & Mayer, 1983). Secondly, some of the questions that may be used, especially publisher-provided, fail to promote higher cognitive levels (Feldt, et al., 2002).

However, effective questioning has also been shown to promote students' understanding (Heisey & Kucan, 2010; Walker, 2005; Lloyd, 2004; Fisher, Flood, Lapp & Frey, 2004; Shearer, 1997) but most questions are not designed to promote connections between ideas in the same manner as concept mapping.

Purpose of the Study

The study included 58 students enrolled in four third-grade classes. The objective of this study was to compare the effectiveness of reading activities including concept mapping and comprehension questions in association with interactive read-alouds in the organization and retention of different types of science information.

Research Questions

The following are the research questions used in this study:

a). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' performance on a test of relational vocabulary?

b). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' ability to identify key ideas on a multiple-choice test?

c). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' individual word knowledge as measured by a vocabulary matching test?

d). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' clarity of written expression as measured by a holistically scored writing test?

Definition of Terms

The following definitions are offered for terms used in this study.

Graphic organizers. Graphic organizers are visual instructional tools that help students organize ideas and concepts (Ausubel, 1963). They are also referred to as advanced graphic organizers, and adjunct displays. There are a variety of types of graphic organizers including concept maps, venn diagrams, sequencing chart and KWL charts.

Concept maps. Concept maps were created by Novak to help assess students' learning of science concepts. Concept maps consist of shapes with lines that connect the shapes by prepositions. The concept map has been shown to be conducive to relational learning as well as helping lessen cognitive load (Novak & Godwin, 1984).

Interactive read-alouds. Interactive read-alouds are read-alouds with the use of "discussion" or talk (Beck & McKeown, 2001; Smolkin & Donovan, 2003). In an interactive-read-aloud, a teacher models the reading process while engaging the students in discussion through sharing and posing questions (Smolkin & Donovan, 2003; Beck & McKeown, 2001a). Key features in an interactive read-aloud include the following: interaction; modeling of the reading process; and the use of talking.

Informational text. Informational text is text that is content-specific. This can include textbooks, journal articles and informational trade books. For the purpose of this study, the following science informational trade books focusing on soil formation were used: *Sand and Soil: Earth's Building Blocks* by Beth Gurney; *Without Soil* by Ashley Chase and Marco Bravo; *Dirt* by Nancy Goodman; *Soil Erosion and How to Prevent It* by Natalie Hyde (2010); *Erosion* by Becky Olien (2001); *Minerals* by Rebecca Faulkner (2007); *Wiggling Worms at Work* by Wendy Pfeffer (2003); and *Composting: Nature's Recyclers* (2002) by Michael Koontz.

Informational trade books. Informational trade books are picture books that are content specific. Informational trade books are different than textbooks in several ways. Unlike textbooks that are written by multiple authors, informational trade books are usually written by one author (Smolkin, McTigue, Donovan, & Coleman, 2008). They also have been shown to be more interesting than textbooks in learning information by the use of reader-friendly language and aesthetic graphics (Schroeder, et al., 2009; Smolkin, et al., 2008). As an advantageous tool for learning, there has been increase in the using this genre in the teaching of content areas of science and social studies (Saul & Dieckman, 2005.

Questioning. For purpose of this study, written teacher-generated questioning consisted of comprehension questions regarding science instruction. Students in this group were asked questions pertaining to soil. For example, one question asked was the following: *"What do you know about soil?"*. Students were given time to write down their response to each question.

Concept mapping group. The concept mapping group is the experimental group (treatment group) in this study. Participants in this group participated in concept mapping during their science instruction.

Comparison group. Comparison groups are composed of participants similar (e.g. intelligence, demographics, age) to participants in the experimental group but participate in a different type of instruction. The comparison group refers to the students that participated in the use of questioning during their science instruction.

CHAPTER II

REVIEW OF LITERATURE

This chapter is organized into six sections. The first section is a review of research on the integration of science and literacy. The second section examines literature on the use of interactive read-alouds. Next, informational text and its use in early grades will be examined. Then, the fourth section will discuss interactive informational read-alouds. Next, is an investigation on the use of graphic organizers. The last section examines the use of concept maps as a tool for learning.

Integration of Science and Literacy

The integration of reading and science is not a new concept. In fact, scientists have integrated the two for centuries (Pearson, Moje, Greenleaf, 2010). To help students to experience science in its true state, then teachers must provide a learning environment that promotes the integration of science and literacy.

With the increase of scientific epidemics from salmonella illnesses (Draper, 2011) to cloning (Rupley & Slough 2011), it has never been such a crucial time than now for one to be scientifically knowledgeable or as Fang and Wei (2010) term, a “scientifically literate citizen”.

The National Science Education Standards define science literacy as the following:

> Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict

> natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of the sources and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately.
>
> Individuals will display their scientific literacy in different ways, such as appropriately using technical terms, or applying scientific concepts and processes. And individuals often will have differences in literacy in different domains, such as more understanding of life-science concepts and words, and less understanding of physical-science concepts and words. (Science Standards, 1996, pp. 2)

As evidenced above, a key factor in the preceding definition is the need for "literacy" skills. One must be able to read and most importantly understand text, articles, and journals to learn about scientific phenomena. Scientific literacy also implies that one must be able to write and communicate effectively to make informed decisions. Accordingly, researchers have suggested that literacy is an integral part of learning science (Shanahan & Shanahan, 2008). Furthermore, they have suggested that the use of metacognitive reading practices such as using graphic organizers and incorporating informational trade books can help in learning science concepts. These instructional practices will be discussed in further sections in this literature review.

Researchers and educators deem the integration of reading with science or other academic domains (e.g., math, social studies) as, "content area literacy" (Romance & Vitale, 2001; Moss, 2005). The idea of content area literacy has been around as early as 1925, when Gray conducted a study regarding literacy and study skills by content area (Vacca, 2002; & Moss, 2005). Gray surveyed 250 teachers in grades 4-6 to examine the types of reading used in different subject areas such as literature or history. He found that reading and study skills varied according to the subject (Vacca, 2002) suggesting that every content area has its own unique set of literacy skills. Interestingly, the first textbook devoted to content area literacy was published in 1970 by Herber which stressed that reading skills must be adapted to the content area subject they are studying (Vacca, 2002).

Several previous studies have examined the impact of science content area literacy on students' learning of science (e.g., Fang & Wei, 2010; Romance & Vitale, 2001) and are therefore pertinent to the current study. Most recently, Fang and Wei (2010) examined the impact of reading strategies on learning science concepts with middle school students. Students were divided into either an inquiry-based science group or an inquiry-based science plus reading group. The inquiry-based science group was comprised of traditional science instruction including making observations, predicting, planning investigations and interpreting data. The inquiry-based plus reading group had a similar type of instruction as the other group but included reading strategy instruction and a home science reading program integrated in the curriculum. They found that participants in the inquiry-based plus reading group outperformed participants in the comparison group in vocabulary and comprehension as measured by the GMRT.

Previously, Romance and Vitale's (2001) findings of the benefit of literacy for learning science were consistent with Fang and Wei's results but focused on elementary students. Romance and Vitale (2001) reported their findings over a 5-year period with students in grades 2-5 over the implementation of a program called *In-depth Expanded Applications of Science* (IDEAS). The IDEAS model replaced the traditional reading/language arts model with a daily two-hour block comprised of in-depth science concept instruction including the following: concept-focused teaching; hands-on activities; utilization of science process skills; enhanced reading of trade books science materials; concept mapping instruction; and journal writing. They found results that were consistent over the five year program favoring the IDEA program in both science understanding as measured by the Metropolitan Achievement Test-Science as well as reading, as measured by the Iowa Test of Basic Skills-Reading and the Stanford Achievement Tests-Reading. They also found students exhibited more positive attitudes and self-confidence toward both science and reading.

Additionally, Morrow, Pressley, Smith & Smith (1997) found similar results when they investigated the impact of a literature-based program integrated into literacy and science instruction on third grade students' achievement. Students were assigned to one of three groups: control, literature-based, literature-based with science. Reading and science instruction in the control group consisted of basal materials and workbooks for reading instruction and science textbooks and workbooks for science instruction. This followed their traditional model of instruction for reading and science. Reading instruction for the literature-based group consisted of the following: literacy centers containing different books with a variety of genres; teacher guided literacy activities such as retelling and writing; and independent reading and writing periods. Their science instruction was identical to that of the control group. The reading instruction for the third group, literature-based with science was identical to the literature-based group. The science instruction consisted of students reading trade books that were aligned with the textbook chapter topics and students writing narrative stories embedded with science facts. They found that participants in the literature-based with science group scored significantly better on all literacy measurements than students in the literature-based group. Students in the literature-based group performed significantly higher on all literacy measures except for the standardized reading than students in the control group. In the test of science facts and vocabulary, the literature-based with science group scored significantly higher than the literature-based group and the control group.

In summary, these three highlighted studies document the benefit of integrating reading and science instruction on student achievement. However, unfortunately, not every teacher has embraced this practice. Next, we will examine some barriers facing teachers in the integration of science and reading.

Barriers to Integrating Science and Literacy

Some teachers of content area subjects are reluctant to see their role as a "reading" teacher. They view that teaching reading is "somebody else's job" (Donahue, 2003). Even English teachers think of themselves as experts in teaching literature and writing but few view themselves the same way in teaching reading (Ericson, 2001). Many in fact, feel that teaching reading skills is the role of elementary teachers (Donahue, 2003; Alger, 2007). But yet even with this in mind, teachers, especially middle and high school teachers, are need to teach content area material but are challenged by students' difficulty in reading challenging text important to the content area studying.

Technical in nature, these content area textbooks, especially in science, provide little guidance on how to incorporate reading instruction. This warrants the need for staff development to share explicit strategies for teachers how to effectively incorporate reading strategies (Draper, 2011). There has also been an increase in teaching content area literacy practices to pre-service teachers by providing courses. But unfortunately, one area of concern is the textbooks used in these courses. Draper (2011) conducted a study examining nine textbooks used in methods courses for pre-service teachers on content area literacy. Draper found that, although the authors stressed the importance of content area literacy, they provided little or no explanations on how to incorporate effective literacy practices in content area subjects.

Another barrier facing teachers is the lack of resources and time needed to effectively integrate science and literacy (Pearson et al., 2010). With the pressure of high-stakes testing, teachers feel compelled to focus on one subject area -- whether it be science or reading. No Child Left Behind (NCLB) has been accredited to decreasing the amount of time devoted to science instruction by placing emphasis on promoting reading and math (cite needed). In a 2008 national survey, it was discovered that the majority of schools across the United States had decreased their science instructional time by 15 minutes due to the NCLB promotion of reading and math (Pearson et al., 2010). School districts and teachers felt pressured to increase their focus on reading and math and in result, decreased their attention on other content areas including science (Pearson et al., 2010). This trend will prove detrimental to our students facing a future with a prerequisite of advanced science skills which demand scientific communication skills.

There is a strong urgency to build content area literacy into our classrooms from the elementary to the secondary schools but many are faced with barriers as previously discussed. As an education community, we need to continue efforts to stress the importance of content area literacy and its impact on student learning through advocacy, staff development and continued research.

An instructional practice that has shown to have additive benefits to learning is the use of read-alouds. This topic is examined in the following sections.

Interactive Read-Aloud

Read-alouds have been a wide-spread practice in classrooms as well as homes for centuries (Beck & McKeown, 2001b). This practice has shown to be beneficial to learning (Tease, 2003). *Becoming a Nation of Readers* (Anderson, Hiebert, Wilkinson & Scott, 1985) issued by the National Academy of Education and the Center for the Study of Reading concluded that "the single most important activity for building the knowledge required for eventual success in reading is reading aloud to children" (p. 33). Recently, there has been an increase in the use of conversation or discussion with the use of read-alouds, also referred to as "interactive read-alouds" which will be further discussed in the following sections.

In an interactive-read-aloud, a teacher models the reading process while engaging students in discussion through sharing and posing questions (Smolkin & Donovan, 2003; Beck & McKeown, 2001b). Another definition of an interactive read-aloud is by Fountas and Pinnell (2007), "A teaching context in which students are actively listening and responding to an oral reading of a text" (p. 47). There are several key features in an interactive read-aloud including: interaction; modeling of the reading process; and the use of talking. These topics will be examined in the following sections.

Interaction. As a "dialogic" discussion, an interactive read-aloud serves several purposes. First, students are provided an opportunity to make connections with the text. Through this cognitive process, a student makes a connection to self, other texts, or to the world (Harvey & Goudvis, 2007). According to Rosenblatt (1978) reading is a transactional process. Also referred to as the "transactional view", Rosenblatt proposed that a reader must transact with the text to make meaning (Morrison & Wlodarcyzk, 2009; Rosenblatt, 1978). Text may have different meanings for different individuals because each reader brings his or her own background knowledge and personal experiences that shape the meaning of the text (Rosenblatt, 1978).

Next, the use of questioning is used in this interactive process. Using questioning strategies has been shown to help increase comprehension because it engages the reader as well as ensures students' understanding of the text (Harvey & Goudvis, 2007). Questioning is used during and after reading a text. Table 1 is found in Beck, McKeown, Sandora, Kucan and Worthy (1996) and outlines the suggested goals and associated questions for an interactive read-aloud. For example, to help initiate discussion of the text, a teacher may ask "What is the author trying to say?" or "What is the author's message?" If a student submits a vague response or reveals a misinterpretation, the teacher is recommended to ask follow-up questions. For example, the teacher may respond, "Is that all the author wanted us to know?" (Beck & McKeown, 2001b). This follow-up question encourages the students to dig a little deeper. The next goal is to help students focus on the author's message. To facilitate this goal, the teacher may ask "That's what the author says, but what does it mean?" This question is an extension of the first question. This is a great opportunity to assess students' understanding of the author's message. Is the student able to go beyond the superficiality of the text? Are they able to reference concrete examples taken from the text? The next goal is helping students link information. By asking questions, "How does that connect with what the author already told us?" or "What information has the author added here that connects to or fits in with____________?", the students are given an opportunity to share how new knowledge fits in with their own personal schema or background knowledge. It also aides the teacher in assessing the students' interpretation of the text.

Beck (et al., 1996) suggests the next goal as identifying difficulties with the way the author has presented information or ideas. This goal is facilitated by asking “Does that make sense?” or “Did the author explain that clearly? What’s missing?”. In these questions, the students are self-monitoring their own learning by asking themselves if they have a clear understanding of the author’s message and if not, what is needed to clarify their understanding. Lastly, it is imperative to encourage students to refer to the back to the text when they misinterpret the message. This also helps them in making inferences. This goal is led by asking “Did the author tell us that?”. This question guides the student in “reading between the lines” or understanding that they misinterpreted the text.

The use of questioning in an interactive read-aloud engages the student by encouraging the sharing of ideas. It also helps in increasing comprehension by provoking students to think deeper about the text. In addition, it provides an opportunity for teachers to assess students’ understanding of text and to guide them if and when meaning breaks down.

Table 1
Suggested Questions for Interactive Read-Alouds

Goal	Questions
Initiate discussion	What is the author trying to say? What is the author's message? What is the author talking about?
Help students focus on the author's message.	That's what the author says, but what does it mean?
Help students link information.	How does that connect with what the author already told us? How does that fit with what the author already told us? What information has the author added here that connects to or fits in with _________________?
Identify difficulties with the way the author has presented information or ideas.	Does that make sense? Is that said in a clear way? Did the author explain that clearly? Why or why not? What's missing? What do we need to figure out or find out?
Encourage students to refer to the text either because they've misinterpreted a text statement or to help them recognize that they've made an inference.	Did the author tell us that? Did the author give us the answer to that?

Table taken from Beck (et al., 1996).

Modeling of reading strategies. Next, I examine another integral part of interactive read-alouds which is the modeling of reading strategies.

As previously mentioned, interactive read-alouds provides a useful opportunity for teachers to model reading strategies that proficient readers use (Smolkin & Donovan, 2001). One important subset of these strategies includes metacognitive strategies because they help the reader monitor and regulate their own cognitive process (Loxterman, Beck, McKeown, 1994). Examples of metacognitive strategies include the following: locating where meaning breaks down; making inferences; identifying implicit ideas in a text; as well as including strategies of rereading; backward and forward searching strategies; and self-questioning (Loxterman, et al., 1994; Hedin & Conderman, 2010; Oster, 2001). These metacognitive strategies are essential to learning because they allow learners to assess their own level of comprehension and adjust strategies as needed (Oster, 2001).

Talking and comprehension of text. Another component to interactive read-alouds is the process of "talk" which I examined in reference to its impact on comprehension of text. The activity of "talk" is used through questioning and modeling of reading strategies. These processes during the reading of a text have been shown to have beneficial effects (Beck & McKeown, 2001b). Loxterman et al. (1994) examined the use of student talk on students' recall of a social studies textbook passage on sixth-grade students. Students were assigned to one of two groups. One group read the text, stopped at predetermined places in the text and talked about what they had read as a group. The participants in the second group read the textbook passage silently. The researchers found that students in the first group who talked during the reading had better recall of the text information than the second group who did not talk. Furthermore, their differences were maintained a week later in a delayed assessment.

A similar study was conducted by Kucan and Beck (2003) examining the impact on talk on seventh grade students on informational text. There were two conditions used in this study. One condition consisted of an individual student and an investigator. The second condition consisted of seven students and an investigator. The purpose of these conditions was to support students' effort to comprehend ideas of informational text by talking about the text while reading (Kucan & Beck, 2003). The investigators used prompts to elicit talk from students including having students explain their own understanding. They found that students had significant gains from the pre-test time-point to the post-test time-point. Interestingly, there was not a significance found between the groups on the recall measure, but the participants in the group condition increased their use of “intellectual talk”. The researchers transcribed the students’ discussions during the reading and categorized them into four categories: personal, textual, intellectual and none. The found that participants in the individual condition spent 11% of the time using personal talk versus 5% for participants in the group condition. Next, they found that participants in the individual condition spent 82% of the time using textual talk while the participants in the group condition spent 46%. Then, the participants in the individual condition spent 3% using intellectual talk while the participants in the group spent 34% of the time in intellectual talk. Lastly, the “none category” represented students who declined to respond -- which it was 58% for the participants in the individual group and only 15% for the participants in the group condition. These results indicate the value of group “talk” or discussion during reading text. These studies reinforce the beneficial effect of the process of “talk” in interactive read-alouds including strengthening comprehension of text and sharing of ideas regarding the text.

Informational Text

By the time students are in middle school, the majority of text is informational in nature. Researchers have suggested that informational text is more difficult than narrative text for students to comprehend. In fact, according to Conderman and Elf (2007) the same students who can read chapter books at grade level, cannot independently understand the written text found in informational sources including textbooks, trade books and informational magazines. The reading skills and strategies are different than those applied to narrative texts. As Van den Broek (2010) suggests, texts, specifically science text, differs from narrative because it requires different demands on working memory, comprehension strategies and the use of background knowledge.

Moving from the process to the materials of learning, informational text is a large component to teaching content area subjects, and such texts are endowed with characteristics that are unique from narrative texts. In the following section I first examine the nature of informational text and then investigate current use of informational text in the primary grades. In addition, I look at the benefits of using informational text, specifically in combination with the use of interactive read-alouds.

Accordingly, literacy experts (e.g., Pearson et al., 2010) cite that a major barrier to effective science instruction is the poor quality of texts available for science instruction. The nature of scientific text can be challenging for students (Van de Broek, 2010; Conderman & Elf, 2007) because of its organizational structure and its *inconsiderate* style such as including an abundant amount of information and assuming too much prior knowledge (Armbuster & Anderson, 1988; Adaiano & Turner, 2002). In addition, there is often a large amount of irrelevant information (Adaiano & Turner, 2002).

Other factors contributing to the difficulty and complexity of informational text is its organization of text, and its *"low-cohesion*" nature (Robinson, Katayama, Beth Hsieh & Vanderveen, 2006; Best, Rowe, Ozuru, & McNamera, 2005). Low-cohesion text can be defined as text that presents too much information with too little detail, utilizing loosely connected statements and poor integration or connectedness with previous sections of the text (O'Reilly & McNamara, 2007). Informational text is also challenging because content is unfamiliar to readers. The ideas are presented using complex, abstract relationships in comparison to simple sequence of events found in narrative text (Williams, Hall, Lauer, Stafford, DeSisto, & deCani, 2005). With the complexity of this genre, researchers have suggested that early exposure to informational text can benefit students in later years.

Informational text in the primary grades. Incorporating informational text is not an option but a necessity for teachers of primary students. By the time students reach sixth grade, 75% of their reading will be from informational texts (Moss, 2005). In addition, many of their assessments by grade four will require them to understand and comprehend informational text. For example, The National Assessment of Educational Progress, which assesses students' reading achievement in grades 3-8, 50% of the grade four test contained informational text (Moss, 2005).

It is evident that students need early exposure to informational text to help them prepare for later grade levels. Duke (2000) brought awareness to the educational community on the importance of informational text as well as the scarcity of informational text in the primary grades. In her landmark study that shed light on the country's use of instructional text in the primary grades, she investigated the time spent with informational text and found only 3.6 minutes was the average time spent per day on this genre. Jeong, Gaffney & Choi (2010) extended Duke's study with grades 2-4. They found consistent results with one minute spent on instructional text in grade 1 with an increase to only 16 minutes in grades 3 and 4.

In addition, in an earlier survey conducted by Pressley, Rankin and Yokoi (1996), they examined the type of instructional materials for reading used by teachers who were nominated for promoting literacy. Only 6% of their classroom reading materials was informational in nature while 73% were narrative in nature. Unfortunately, the results have shown this practice to negatively affect students by providing little or no exposure to informational text (Duke, 2003). It has been suggested that the scarcity of informational text may be associated with the decline in reading achievement after third grade (Ness, 2011; Chall, Jacobs & Baldwin, 1990). This decline has also been referred to as the "fourth-grade slump" (Jeong, Gaffney, Choi, 2010). Around fourth grade, there is an increase of informational text and some fourth graders are unprepared to comprehend this informational text and experience a decrease in reading achievement (Ness, 2011). With this evidence, there is a strong need for primary teachers to incorporate informational text in their curriculum. Not only has the use of informational text been shown to help students cognitively, it has been shown to help students' motivation, as is described in the next section.

Motivation and engagement. One of the key goals in selecting text is capturing the attention of its readers (Saul & Dieckman, 2005). Informational text has been shown to help motivate students including struggling readers because it capitalizes on children's curiosity and interests about the world (Duke, 2000). Morrow, Pressley, Smith and Smith (1997) directly examined the impact on incorporating informational literature into science instruction. They interviewed students who were taught either by traditional standards using science textbooks without the use of informational literature and students who were taught science using informational literature (trade books). Of relevance to this study, students who had traditional instruction reported disliking science and found instruction boring. In contrast, students who were taught science using informational literature (trade books) reported enjoying science. This finding reinforces the concept that using informational text including trade books can help motivate students in science.

Informational Interactive Read-Alouds

Researchers have also embraced the positive impact of trade books (in contrast to textbooks) and have combined this literature genre with interactive read-alouds which provides promising effects on students learning science concepts. I will examine the findings in the next section. Recently, Heisey & Kucan (2010) examined the use of informational interactive read-alouds on first and second grade students in learning science concepts. The purpose of this study was to see if there was a difference between students who were engaged in a teacher-led discussion during a read-aloud and students who were engaged in discussion after read-alouds. The findings showed that students who participated in the teacher-led discussion during the read-aloud performed significantly higher than students who participated in the teacher led discussions after the read-aloud. They also had higher gains from the pre-test time point to the post-test time point. Similar results were found in an earlier study conducted by Oyler (1996) in her investigation of first grade students and their interaction with teacher read-alouds of science informational text. She concluded that students benefitted from the process by sharing personal connections and asking questions to clarify their own understanding. In addition, students shared their "expertise" of their newly acquired knowledge. As shown the use of informational interactive read-alouds can be a powerful vehicle in students' learning of science concepts.

Graphic Organizers

Another promising instructional practice in teaching science concepts is the use of graphic organizers (Asan, 2007; Anderson & Huang, 1989; Jang, 2010). In the next section I present the background behind graphic organizers, examine recent studies on this instructional tool and specifically investigate the use of a specific type of graphic organizer, concept maps. Known by a variety of terms, including adjunct displays, advanced organizers, knowledge maps and story maps, graphic organizers has been defined as an instructional tool to help students organize concepts (Kim, Vaughn, Wanzek & Wei, 2004). Its visual and spatial design elements including lines, arrows and spatial organization highlight key concepts that help facilitate learning (Kim, et al., 2004). Graphic organizers come in a variety of format designs including semantic maps, venn diagrams, concept maps and semantic feature analysis. Cognitive psychologist, Ausubel (1963) created this tool to assist students in their use of expository text (Robinson, Katayama, Beth, Hsieh, and Vanderveen, 2006).

Background history of graphic organizers. Ausubel has been considered the originator of designing and using graphic organizers. Ausubel proposed that a learner's existing knowledge or cognitive structure influences his or her learning (Kim, Vaughn, Wanzek, & Wei, 2004). Furthermore, learning takes place by the assimilation of new concepts, expanding and strengthening the cognitive structure (Novak & Canas, 2006; Kim et al., 2004). To help in this process, graphic organizers provide a framework for relating existing knowledge to new information (Ausubel, 1963; Kim et al., 2004). Researchers (DiCecco & Gleason, 2002; McCrudden, Schraw, & Lehman, 2009; Alvermann and Boothby, 1983) have used this visual tool on helping students in content area literacy, and I summarize two pertinent studies below.

DiCecco & Gleason (2002) examined the use of graphic organizers with middle school students identified as learning disabled. Students were assigned to either an experimental group (using a graphic organizer) or a comparison group (without the use of a graphic organizer). Students in the experimental group completed a partial graphic organizer after reading social studies text. Participants in the comparison group read the same text but without the use of a graphic organizer. The intervention lasted twenty days. They found that participants using the graphic organizer had higher relational knowledge as assessed by a written measurement designed by the researchers by including more relational statements.

Similar results were found with a study conducted by McCrudden, Schraw and Lehman (2009) in which they examined the use of cause-and-effect relationships using adjunct displays (causal diagram), a type of graphic organizer, on science text comprehension with undergraduate students. The undergraduate students were undergraduate majors from a western university. Approximately 64% were juniors, while 8% were sophomores and 28% were seniors. Students were assigned to one of three conditions: diagram (adjunct display), list (outline) or text-only. After reading the text, students in the diagram condition studied a completed adjunct display created by the researchers. This adjunct display showed the cause and effect sequence of kidney stone formation. Participants in the list condition studied a completed outline created by the researchers while students in the text-only condition reread the text. Students were then administered assessments. The researchers reported the participants who used the adjunct display answered more problem-solving transfer items correctly and answered more question about transitive relationships about cause-and-effect than participants in the other two groups. Furthermore, students in the list (outline) group also answered more problem-solving transfer items correctly and answered more questions about transitive relations about cause-and-effect than participants in the text-only group. This reinforces the notion that graphic organizers can be an effective tool in aiding students in their learning.

Concept Mapping

As previously mentioned, there are a variety of graphic organizers that have been shown to aide in learning. Concept maps have gained attention in its use of helping students learning science concepts.

As an extension of the graphic organizer, Novak designed the concept map as a tool to show students' understanding and meaning of science concepts and prepositions (Novak & Canas, 2006). The main goal of this graphical tool is to organize and represent knowledge (Novak & Canas, 2008). In using a concept map, a teacher selects a certain topic to be mapped (Novak & Gowin, 1984). The students have an opportunity to identify their own key concepts. Then students draw lines to connect and show relationships between the concepts. Linking words or phrases are used to define these connections. For example if making a concept map on soil, the linking word "are" would connect "soil" to "layers of soil". Or the phrase "is made up of" can be used to connect "soil" to "broken parts of rocks". The use of concept mapping can be a promising strategy for promoting reading comprehension of informational text. An advantage to concept mapping is that it can be used as a pre-reading, during reading and/or a post reading activity (Oliver, 2009).

Alvermann and Boothby (1983) conducted a study with fourth grade students using concept maps in learning social studies informational text. Students were assigned to either an experimental condition, using concept maps or to a comparison condition without the use of concept maps. Students in the experimental condition were shown a partially-constructed concept map created by the researchers. Participants were told to study the graphic organizer and to remember as many details as they could. Then the participants read the social studies passage. Participants in the comparison condition reread the passage without being shown a graphic organizer. Then, both groups were assessed. The researchers reported that the students using the concept mapping had a higher retention of key ideas than students who did not use a concept map as measured by written recall. The written recall was scored by two independent judges.

Assan (2007) found similar results with his examination of the use of concept mapping on fifth grade science students. Students were assigned to either an experimental group using a concept map or a comparison group without the use of concept map. Both groups covered the same material as outlined in the class textbook. In addition to covering the same instructional material as the comparison group, using *Inspiration*, a computer-based program created by Helfgott and Westhaver in 1987, students in the experimental group constructed individual concept maps with concepts from a class list created during discussion. After a five-day instructional period, students were assessed. The researchers reported that participants in the experimental group recalled more key ideas than the participants in the comparison group as measured by a multiple-choice assessment. These studies reinforce the use of concept mapping as a tool for learning science concepts, especially in recalling key ideas and relational knowledge.

Theoretical Background of Concept Mapping

There have been several cognitive theories explaining the effectiveness of concept mapping on learning. These theories include: cognitive-load theory; dual coding theory; and visual argument. I will examine these theories starting with cognitive load theory.

Cognitive load theory. Cognitive load theory suggests that working capacity is limited and stresses that optimum learning occurs when working memory is kept to a minimum (Sweller, 2006; Leslie, Low, Jin & Sweller, 2011). According to Sweller (2006), cognitive load is composed of three components: intrinsic load, extraneous load, and germane load (Leslie et al., 2011). Intrinsic load refers to the difficulty of the content to be learned and cannot be altered except by changing what is to be learned or increasing the expertise or knowledge of the learners (Leslie et al, 2011; Sweller, 1993). Extraneous load refers to the cognitive load induced by the instructional design of the materials presented (Sweller, 1993). Germane load refers to the cognitive load caused by "effortful" learning due to working memory resources required to deal with intrinsic load (Sweller, 1993). Instructional procedures should strive to decrease cognitive load to allow more working memory to deal with intrinsic load (Sweller, 1993; Leslie et al, 2011). Researchers have suggested that the use of graphic organizers such as concept mapping can help in managing intrinsic load by reducing extraneous load and increasing germane load through its organization of concepts in a cohesive design providing space for the working memory to learn new information (Vekiri, 2002).

Consistent with this theory was a study conducted by Stull and Mayer (2007). This study compared the use of author-constructed graphic organizers with the use of learner-created graphic organizers on college students learning biology concepts from informational text. This study focused on the ongoing debate between the activity theory and the cognitive load theory on the effectiveness of student learning. They concluded that students using the author-created graphic organizers performed higher on a transfer test than students who constructed a graphic organizer after reading informational text. This study is aligned with the cognitive load theory because the graphic representations of information allowed the learner to engage in generative processing while not having to engage in extraneous processing (Stull & Mayer, 2007).

Dual coding theory. Another cognitive theory that has been associated with graphic organizers is dual coding theory (Vekiri, 2002). Paivio posits that in the dual coding theory, cognition involves the activity of separate subsystems, a verbal system specifically for dealing with language and a nonverbal system specifically for dealing with nonlinguistic information (Paivio, 2006). These systems consist of representational units, logogens and imagens that are activated when an individual recognizes or thinks about words or things (Vekiri, 2002; Paivio, 2006). According to this theory, the verbal and nonverbal systems are both associated with language. But the two systems process visual and verbal information separately (Vekiri, 2002).

According to Paivio (2006) illustrations and other visual representations such as graphic organization may benefit instruction by providing an opportunity for learners to store information in two forms of memory representation, linguistic and visual (Vekiri, 2002). This may also provide learners with two modes to memorize information (Paivio, 2006). Another advantage to learning, Paivio suggests in regards to dual coding theory, is that learners are more likely to remember concrete than abstract information (Vekiri, 2002). In addition, visual and verbal units are processed differently. Visual information, referred to as imagens are processed simultaneously while verbal units are processed serially (Vekiri, 2002).

Consistent with this theory is a study conducted by Purnell & Solman (1991) in which they investigated high school students learning technical material. There were three groups in this study. Group one was given a passage that contained text with an illustration. In group two, the original text was the passage was rewritten so that it had the same information as the illustration but with no illustration. Group three was given the same rewritten passage as group two as well as an illustration (content of the illustration was repeated through both text and illustration). Participants were given five minutes to read their passage. After five minutes, the passages were taken up by the researchers and assessed. They found that students who studied information with text with related illustrations (group three) outperformed students in content measures. According to the researchers, comprehension may have been higher for this group in associated with dual coding theory because the number of memory codes available as well as the interconnections formed between verbal and nonverbal units resulted in better recall of content.

Visual Argument Theory. A third cognitive theory that has been associated with the use of concept maps is the Visual Argument Theory. This theory proposes graphical representations communicate information more effectively than text reducing the learner's cognitive effort while interpreting the information (Tzeng, 2010; Robinson & Kiewra, 1995; Vekiri, 2002). This theory posits that using graphical representations such as concept maps can increase computational efficiency. By placing concepts close together, it allows the learner to locate information easily reducing cognitive effort (Vekiri, 2002). By using a graphic organizer such as concept mapping, Robinson & Kiewra (1995) stresses "it can heighten reader awareness of conceptual relations or text structure better than text alone" (p. 97).

Consistent with this theory was a study conducted by Winn (1991) in which he reported that using graphical representations of tree diagrams were more effective in aiding students in identifying inferences about relationships between concepts. Similar results were found by a study conducted by Robinson and Kiewra (1995) in which they examined the use of graphic organizers, outlines, and text-alone on undergraduates in learning educational psychology concepts. Students were assigned to one of the three conditions: graphic organizers, outlines, or text-alone. In the study, students studied either text with graphic organizers, text with outlines or text-alone. One day later, students reviewed their respective materials for 15 minutes and were assessed. They reported that the participants who studied the text with the graphic organizers performed significantly higher in measures that assessed hierarchical and coordinate relations as measure by written essays than participants in the other conditions.

In conclusion, the use of graphic organizers specifically concept maps can be advantageous in teaching science concepts. Several theories including visual argument, dual coding theory and cognitive load theory have explained the additive effects of graphic organizers on learning concepts especially in the area of science.

Conclusion

In this literature review, we examined a variety of educational topics. First I reviewed the importance of integrating science and reading as well as implementation barriers. Then we examined the use of interactive read-alouds and its impact on learning. Next, I reviewed recent research on informational text. Lastly, I examined the use of graphic organizers, specifically concept maps on learning.

Therefore, each instructional practice studied in the literature review has been proven to be beneficial to learning. However, little or no research has combined these instructional practices to examine its effect on students' learning of science concepts.

CHAPTER III

METHODOLOGY

Purpose of the Study

The following empirical evidence has been shown to help students in reading and science: the integration of reading and science (Pearson, Moje, & Greenleaf, 2010; Reveles & Brown, 2008; Shanahan & Shanahan, 2008); informational text (Palmer & Stewart, 2003; Saul & Dieckman, 2005; Smolkin & Donovan, 2003); interactive informational read-alouds (Heisey & Kucan, 2010; Smolkin & Donovan, 2003; Fisher, Flood, Lapp & Frey, 2004; Smolkin, McTigue, Donovan, & Coleman, 2008); questioning (Heisey & Kucan, 2010; Lloyd, 2004; Fisher, Flood, Lapp & Frey, 2004); comprehension questioning with writing (Harvey, 1998); and concept mapping (Oliver, 2009; Novak & Gowin, 1984; Schmid & Telaro, 1990). But little or no research has combined these methods to examine its affect on students' learning, or more specifically look at the type of learning that these methods benefit. This study compared the degree of learning that occurred when using the comprehension strategy techniques using interactive read-alouds of informational trade books with either one of the following additional instructional practices: a) concept mapping or b) using comprehension questions (teacher-generated). The types of learning that were measured were: a) relational thinking as measured by a relational vocabulary assessment; b) identification of key concepts as measured by a multiple-choice assessment; c) individual word knowledge as measured by a matching vocabulary assessment; and d) relational thinking, students' ability to retain and recall key information and student's ability to use domain knowledge as measured by a written assessment. These were measured by four comprehension measures: a multiple-choice test; a matching vocabulary test; a relational vocabulary test; and a writing assessment.

Participants

Third grade students from four comparably-grouped heterogeneous self-contained classroom participated in this study. Classes were academically balanced by a grouping procedure conducted by the teachers at the end of the prior academic year. Students' reading levels were assessed using the Developmental Reading Assessment (2005) used to determine their placement in the following categories: "high" (students who read at a reading level higher than 30); "high-average (students who read at a level 30); average (students who read at a level 28); low-average (students who read at a level 24); and below average (students who read below a 24). The students were equally distributed among the five categories. Then teachers selected a set number from each category to make a balanced class. For example, if each class had approximately fifteen students, then the teacher should have three from each of the five categories. Recent assessments of students' text levels validated that the classes were balanced. The classes were self-contained in which they had the same teacher for all subjects.

The 58 participants (total number in the four classrooms) were enrolled in an urban area elementary school, located near a major metropolitan area in the southwestern United States which serves a range of low–income and middle-income neighborhoods. Demographically this school was comprised of 49.3% Hispanic; 41.2% African-

American; 7.7% White; 1.5% American Indian; 0.3% Economically Disadvantaged, as measured by participation in the federal criteria (i.e., using income requirements) free-lunch program was 75.6% and Limited English Proficiency, as measured by students who score below benchmark in English Proficiency Assessments was 29.8%. There were 29 participants in the concept mapping group and 29 participants in the comparison group.

Parent permission for student participation was obtained through a parent permission form. Students had to return the form signed by a guardian/parent in order to participate. An informational letter that included basic information about the study was given to all potential participants. There was also a section for parents to agree for their student to be videotaped during the study. The participants were students who returned their consent forms. All students who were asked to participate brought back their signed permission forms and participated in this study.

The school participated in a partnership with a local university. Through this program, participating schools sent teachers to weekly workshops to learn instructional science methods. The trainings were taught by university instructors. Approximately one teacher from each campus was chosen to participate. By participating, the school was given access to a web-based program that contained lesson ideas, assessments, and resources for teachers and staff to utilize. All the resources were aligned with state standards. Select measures developed by the university partnership were used in this study. The university involved with this partnership conducted a study with fifth grade students at this school investigating the effectiveness of their program on students' learning of science concepts. The current study and the study conducted by the university did not involve the same students.

Grouping Assignment

There were two treatments in this study. In the *concept mapping intervention*, students participated in interactive informational read-alouds preceded and followed by concept mapping activities. The second treatment was the *comparison intervention*, in which students participated in interactive informational read-alouds preceded by a comprehension questioning with a writing activity in which students responded in writing to comprehension questions. Intact classes received one of two interventions/ treatments. The length of both interventions was the same.

A ten- item multiple-choice test was administered to the students a week prior to the study. This test assessed the students' background knowledge related to the topic of "soil". Average scores for background knowledge on the multiple-choice test were calculated for each class. The four classes were then sorted into two groups – lower and higher background knowledge. One class from each group (high and low) was randomly assigned to the concept mapping group. The remaining two classes were assigned to the comparison group.

Timeline

Parents received consent letters that contained information about the study, their child's role in the study and permission to participate and were returned within 4 days. The letters are available in Appendix A. The guest teacher received training two one-hour sessions on consecutive days one week before the treatment began. During this time period, she also had an opportunity to practice both concept mapping (for the concept mapping classrooms) and administering writing with comprehension questions (for the comparison classrooms) in a field classroom in the same school with feedback from the trainer. On November 23rd all participants were given a pre-test over the formation of soil, as previously discussed. Based on the results of the multiple-choice pre-test, classes were assigned to conditions. During November 30th to December 9th, the guest teacher delivered lessons using interactive informational read-alouds over the formation of soil. The concept mapping group participated in a concept mapping exercise before and after the interactive informational read-aloud. The comparison group participated in a comprehension questioning with writing activity also before and after the interactive informational read-alouds. On December 10th, all participants were assessed in an immediate post-test using the same format of assessments as the pretest: relational vocabulary, multiple-choice, matching vocabulary, and a written assessment (responding on questions). On December 15th students were assessed using a delayed post-test with its format the same as the pretest and immediate post-test using the same four types of assessments. These assessments are thoroughly discussed in the assessment section of this chapter. Table 2 lists the timeline for the study.

Table 2

Timeline for Study

Dates	Action
November 18th	Parent Informational & Consent Letters Sent Home and Received by November 22nd
November 22nd, 23rd	Teacher Training
November 23rd	Pre-test over Formation of Soil
November 30th-December 9th	Instructional Lessons delivered by guest teacher to both concept mapping and comparison groups
December 10th	Immediate Post-test
December 15th	Delayed Post-test

Materials

Selection of books for interactive informational read-alouds. The use of informational interactive read-alouds has been shown to be advantageous in learning information including in science (Smolkin & Donovan, 2003; Heisey & Kucan, 2010). As discussed earlier in the literature review, using an interactive informational type of read-aloud invites students to interact, share connections, ask questions and share their own ideas (Smolkin & Donovan, 2003). Based on the recommendations of the National Science Teachers Association (NSTA), books were identified for possible use in the study. To make the final selection of books to be used for this study, a meeting was held with the school's science instructional coach, literacy instructional coach, and four third grade science teachers to make the final selection. Selection criteria included vocabulary and content and illustrations of the books. For vocabulary criteria, selection was based on the use of content-related words. For content and illustrations criteria, selection was based on the accurate depictions of content and illustrations.

The books were read in their entirety within a single class session and are listed within Table 3. If the treatment procedures exceeded the limits of the class period, they were completed on the next day, prior to the introduction of the next trade book in the planned sequence of lessons.

Table 3

Informational Interactive Text Set for the Read-alouds

Title	**Author**	**Date & Publisher**	**Topic Content**	**Vocabulary Terms to be Introduced**
Sand and Soil: Earth's Building Blocks	Beth Gurney	Crabtree (2004)	Overview of soil: Composition of soil; Types of soil layers; Soil Scientists	• Soil • Sand • Nutrients • Sand formation • Organisms in Soil
Without Soil	Ashley Chase & Marco Bravo	Delta Education-Developed at the Lawrence Hall of Science and Graduate School of Education at the University of Cal at Berkeley (2007)	Discussed the importance of soil	• Earthworm • Vitamins • Shelter • Predator • Protect • Root • Isopod
Dirt	Nancy Goodman	National Geographic Society (2007)	Discusses dirt; How does the Earth help things grow; Who lives in dirt	• Dirt • Humus • Silt • Clay • Decomposers

Table 3 *Continued*

Title	**Author**	**Date & Publisher**	**Topic Content**	**Vocabulary Terms to be Introduced**
Soil Erosion and How to Prevent It	Natalie Hyde	Crabtree (2010)	Discusses weathering; how individuals can prevent soil erosion	• Erosion • Weathering • Sediment • Global Warming
Erosion	Becky Olien	Coughlan (2001)	Types of Erosion; Natural Landmarks; Helping fight erosion	• Wind Erosion • Ice Erosion • Soil Erosion • Conservation
Minerals	Rebecca Faulkner	Heineman-Raintree (2007)	Explains how minerals form; Types of minerals	• Minerals • Elements • Atoms • Properties
Wiggling Worms at Work	Wendy Pfeffer	Harper Collins (2003)	How worms interact with Earth; how worms help plants and soil	• Cocoon • Burrows
Composting: Nature's Recyclers	Michael Koontz	Picture Window Books (2002)	Overview of composting	• Composting • Compost • Decompose • Decomposers • Bacteria • Fungi

Elmo P10 digital visual presenters/document camera. Elmo P10 Digital Visual Presenters/Document cameras were standard for every classroom in the district. The document camera function was employed in this study during the interactive informational read-alouds. This allowed all students to see the book and the text along with the guest teacher as well as view the illustrations. This tool is a mounted camera attached to a digital projector. To use this tool, the teacher placed a book face up on the flat surface and the images were projected onto a large screen.

Assessments

Participants in both the concept mapping group and comparison group were assessed using a pre-test, post-test and delayed post-test procedure. The assessments consisted of the following: a multiple-choice, a vocabulary matching test, a relational vocabulary test, and a written assessment. The measures included both written and oral modalities and were designed so that the influence of word decoding skills was minimized. The reason for multiple assessments was to measure different types of learning which will be further discussed in the next section. Table 4 lists the type of test that will be used for pre-test, post-test and delayed post-test.

Table 4
Assessments

Pre-Test	**Post-Test**	**Delayed Post-Test**	**Time Students have to Complete Test**
a) Multiple-Choice	a) Multiple-Choice	a) Multiple-Choice	15 Minutes
b) Matching Vocabulary Test	b) Matching Vocabulary Test	b) Matching Vocabulary Test	15 Minutes
c) Relational Vocabulary Test (oral)	c) Relational Vocabulary Test (oral)	c) Relational Vocabulary Test (oral)	15 Minutes
d) Writing Assessment	d) Writing Assessment	d) Writing Assessment	15 Minutes

Multiple-choice test. This 10-item test assessed key ideas, explicit information and indirectly assessed students' vocabulary knowledge. Using a multiple-choice format, student had four answer choices to choose from for each question. The teacher read-aloud the questions and answer choices for each question. The students were given fifteen minutes to complete. A copy of this assessment can be found in Appendix B.

Matching vocabulary test. The matching vocabulary test consisted of ten terms and thirteen definitions. Participants matched key terms with their definitions. For example, "soil" would be matched with the definition "consisting of layers that are made of parts of rock". The teacher read-aloud the terms and answer choices. This assessed individual vocabulary word learning. The students were given fifteen minutes to complete. A copy of this assessment can be found in Appendix B.

Relational vocabulary test. In this assessment task, participants were given three related terms and they had to provide an explanation as how these were related. For example, in the terms “humus, topsoil, subsoil”, the explanation would be that they are all layers of soil”. This assessment was administered individually in an oral format that was administered by the researcher which allowed for query of answers. The students did not see the words. This format was modeled on the Relational Vocabulary test from the “Test of Oral Language Development, Intermediate, Edition 4” (Newcomer & Hammil, 2008). There were ten items in this assessment. The students were given fifteen minutes to complete. A copy of this assessment can be accessed in Appendix B.

Writing assessment. Another type of assessment commonly used to assess comprehension is writing (Montelongo, Herter, Ansaldo, Hatter, 2010; Klein, 2000; DiCecco & Gleason, 2002). The purpose of a writing assessment was to assess students’ conceptual thinking, retaining and recalling information and how students use domain knowledge (DiCecco & Gleason, 2002). The essay prompt was on the following two questions: 1) “If you were able to play in a large pile of dirt, or soil, what kind would you like best?” and 2) “Write about why you can do certain things with sandy soil”. It required an explanatory response. The essay prompts were given in a standardized method using a script to ensure there is consistency for all groups. Students were given fifteen minutes to respond to the prompt. Blind scoring procedures were used by removing any identifiable information of the student participant including name or his or her teacher’s name. A rubric from the university partnership (discussed earlier) was used to assess the writing assessments (see Appendix B). The scoring of the writing assessments was modeled after the state writing assessment scoring system in which students' writing are scored from a one (lowest) to a four (highest). If a student received a "one", then he or she was given 25 points. If a student received a "two", then he or she was given 50 points. If a student was given a "three", then he or she was given 75 points. Lastly, if a student received a "four", then he or she was given 100 points.

Reliability of assessments. It is imperative to check for reliability of the assessments when conducting a data analysis. Reliability means that the assessment should consistently reflect the construct it is measuring (Fields, 2005; Fields & Hole, 2003). An effective way to check for reliability is to use split-half reliability which randomly divides the data set into two (Fields, 2005). Then, a score for each participant is calculated based on each half of the scale. If the scale is reliable, the participant's score on one half of the scale should be similar to the score on the other half creating a perfect correlation (Fields, 2005). Though a problem with this method is that there are multiple ways that data can be divided which can result in different results (Salkind, 2000). Cronbach created a measure to help improve this method referred to as Cronbach's alpha (Salkind, 2000; Fields & Hole, 2003; Fields, 2005). Cronbach recommended dividing the data in every possible way and then finding the correlation for each division (Dugard, Todman, & Staines, 2010; Fields & Hole, 2003). Cronbach's alpha procedure was used to establish inter-item reliability. According to Nunnally (1978) .70 and higher is acceptable. The inter-item reliability scores for the multiple-choice assessment were the following: .77 for the pretest; .91 for the post-test; and .86 for the delayed post-test. The inter-item reliability scores for the matching vocabulary test were the following: .72 for the pretest; .89 for the post-test; and .81 for the delayed post-test. The inter-item reliability scores for the relational vocabulary test were the following: .71 for the pretest; .87 for the post-test; and .77 for the delayed post-test.

Training scorers of relationship scoring for writing assessment. Two scorers, the school's science instructional coach and the literacy instructional coach, were trained in the relationship scoring procedure. During the training, five essays were scored using a rubric from the university partnership (discussed earlier) to assess inter-rater reliability. The essays were written by students who did not participate in the study. The inter-rater reliability for the five essays was 100%.

Pilot study. In order to assess the reliability of the assessments, a pilot study (N=19) was conducted with a class of 3rd grade students from the same school district as the study participants. The participants in the pilot study were assessed with the same pre-tests as the students in the study. There was not a significant difference between the performance of the students in the pilot study and the performance of the students in the study in all four assessments (relational vocabulary, multiple-choice, matching vocabulary, writing assessment).

Guest teacher. All instructional lessons were taught by a guest teacher for both the concept mapping and the comparison groups. The guest teacher was the school's instructional science coach. The use of a guest teacher minimized "teacher effects" by ensuring that varying levels of teacher experience, quality, or education were held constant throughout the study. She was unaware which classes were included in the treatment group and which classes were included in the comparison group.

The guest teacher has been teaching for nine years prior to this academic year. She has taught three years in fourth grade and four years in fifth grade. She has taught math and science in both grade levels and has held the position as science coach for two previous years. She holds a Bachelor's Degree in Interdisciplinary Studies. She has continued to further her science education knowledge through continuing credit hours at a local community college. As a science instructional coach, she met with classroom teachers on a regular basis discussing instructional strategies, and curriculum topics.

Instructional procedures. Participants in both groups were instructed during eight consecutive daily lessons. All lessons were 45 minutes long and focused on concepts associated with soil presented in the selected trade books. A new, but related, concept was introduced each day (see Table 5).

Table 5
Concepts for Each Day

Day	Concept
1	Soil
2	Soil Formation
3	Dirt
4	Erosion
5	Types of Erosions
6	Minerals
7	Composting
8	Decomposers

Table 6 lists the components of each daily lesson. Each lesson was structured around four activities: “pre-reading”, “vocabulary introduction”, “interactive informational read-aloud”, and post-reading”. The following chart provides descriptions of each activity.

Table 6
Lessons for Day 1

Day 1		
Activity	**Concept mapping Group**	**Comparison Group**
Pre-Reading	Lesson /Concept Introduction: **Soil** **<u>Concept Mapping</u>** Students wrote terms on index cards associated with "soil". If a student did not write a word during the first minute, the teacher used a prompt. For example the teacher may say, "***Write down any word or words that come to your mind when you hear the word soil".*** The cards were placed on the front board next to the word "soil". Lines connected terms using "connecting words" to show the relationships between the words and the concept of "soil formation".	Lesson /Concept Introduction: **Soil** **<u>Comprehension Questioning with Writing</u>** Students wrote on an individual piece of paper for 3 minutes over the topic of soil. The teacher gave the directions. She stated, ***"What do you know about soil?" Please write in sentence format. There is not a required length. Please write as much as you can".*** The writing with comprehension questions was collected by the teacher for data collection purposes.

Table 6 Continued

Activity	Concept mapping Group	Comparison Group
Vocabulary Introduction	Teacher introduced vocabulary selected from text that were used in the interactive informational read-aloud **<u>Terms:</u>** Soil, sand, nutrients, sand formation, organisms found in soil	
Interactive Informational Read-aloud: *Sand & Soil: Earth's Building Blocks*	**<u>Prediction:</u>** Teacher showed the cover, title, table of contents using the Elmo document camera. Students had an opportunity to share what they thought the book was about. **<u>Reading of Text:</u>** Teacher read pgs. 1-20. **<u>During –Reading Questions:</u>** The teacher asked the following questions: 1. What is the difference between sand and soil? 2. Is there more than one type of soil? **<u>Reading of Text:</u>** Teacher finished the book. **<u>After-Reading Questions:</u>** 1. What was the author's purpose in writing this book?	

Table 6: Continued

Activity	Concept mapping Group	Comparison Group
Post-Reading Activities	**Class Constructed Concept Mapping** Student had an opportunity to add to the class concept map. The teacher asked the students if there are any additions or changes to the concept map. If so, students had an opportunity to add words or make suggestions for changes.	**Comprehension Question with Writing Activity** The teacher asked the following questions taken from the text used in the Interactive informational read-aloud: ***"Why is soil important?"*** ***"What are the different types of soil?"***
	Pre-Generated Concept Mapping Students were given a pre-generated concept map that was 90% completed by the researcher. The teacher gave directions and called out the words in the word bank and the words found in the visual diagrams. The teacher informed the students that the maps (class constructed concept map and the pre-generated concept map) may look different because they may have different words.	The students spent 5 minutes writing on answering these questions independently on their piece of paper. Writing was collected for data collection purposes.

Answering Protocols

When students are asked questions, the teacher used an answering protocol. When a student responded with an incorrect answer, the teacher asked the student to clarify or explain their justification for their answer. If a student failed to give a plausible response, the teacher asked for a volunteer to help answer the question. If the student responded with a correct answer, the student had to justify their answer. Then, the teacher continued on to the next question.

Defining the Activities

The following section will describe each activity that is listed in the table above. Activities are listed and are sub-categorized by "concept mapping" and "comparison" groups.

Pre-reading. In this phase, the teacher introduced the concept of the day to both the concept mapping group and the comparison group. The concept mapping and comparison group participated in different pre-reading activities which are listed below.

Concept Mapping Group

Class created concept maps. Participants in the concept mapping group created a class concept map as group with the teacher. The first one, created on Day 1, centered on the concept of "soil" and was displayed on a wall in the classroom for the entire unit. Starting on Day 2, a new map was created each day focusing on the specific concept for the day (see Table 5). As previously discussed these concepts were terms associated with "soil". Each day students were given two index cards. The teacher stated the concept of the day. Then, students were given an opportunity to write words associated with the concept.

For example, on the fourth day, the concept was “erosion”. Students brainstormed words that were related to “erosion”. If students had difficulty with the word “erosion”, then the teacher would define the word and use it an example. For example, the teacher may say, *“Erosion is the wearing away of Earth’s soil resources. A word that comes to mind when I think of the word “erosion” is “ice” because it is a type of “erosion”. So I will write the word “ice” on my index card*.” After approximately three minutes, the teacher called on students who wanted to share the words they have written. In order to be chosen, students had to raise their hands. The teacher would select a student, who would share his or her word that is associated with “erosion”. Then the student was asked how it related to the concept. If the student failed to justify his or her answer, then the teacher would call on another student to help him or her. If the word was an acceptable answer, such as “weathering”, then the teacher would place the card (with the correct answer) in the proper relationship to the index card “erosion”. Next, the teacher would explain how concept maps show relationships by using “connecting words” between the concept and term(s) associated with the concept. For example, if the student chose “wind erosion”. The connecting words would be “type of” for the concept term of “erosion”. So the teacher would draw a line connecting “wind erosion” to “erosion” and will write “type of” on the line. This took approximately 8 minutes. The teacher stopped the activity after 8 minutes had passed or five words have been added. Each day, to document progress, the researcher would take a picture of the class created concept map during the pre-reading phase.

Comparison Group

Comprehension questioning with writing. Participants in the comparison group participated in a comprehension questioning with writing activity. The students were given three minutes to write everything they know about the concept for the day. For example, on Day 4, students responded to the following question, “What do you know about erosion?” They wrote their response on a sheet of paper that was collected daily for data collection purposes.

Interactive Informational Read-alouds

The concept mapping and comparison group participated in the same format of interactive informational read-alouds. This activity included using the same text and the same questions posed by the teacher before-, during-, and -after reading. Video-taping was used to check for fidelity.

Each instructional day, a new informational trade book was read to the students. The teacher showed the cover, table of contents and title using the Elmo document camera. Then students predicted what they thought the book was about. Then the teacher read a specific number of pages (see Table of Procedures in Appendix D). During the interactive informational read-aloud, students were encouraged to engage in discussion about the text through questioning and making connections (Smolkin & Donovan, 2001). After reading the predetermined number of pages, the teacher stopped and asked questions that were related to the text. The teacher gave the students an opportunity to share their responses. Then the teacher read the rest of the book. Then after reading the text, the teacher asked additional questions related to the text. Students were be given a chance to respond to the questions.

Post Reading Activities

Concept mapping. There were two different types of concept maps. The first was a class created concept map that was used as both a pre-reading and post-reading activity. The second was a pre-generated concept map that was used as a post-reading activity. The pre-generated concept map had a predetermined group of words and phrases listed in a word bank. Both are briefly discussed in the following section.

Concept Mapping

Class created concept mapping. After participating in the interactive informational read- aloud, the students had an opportunity to make additions, and/or modifications the class created concept map that was started as a pre-reading activity. If a student wanted to add a word, then the teacher gave him or her index card and he or she wrote the word and found its location on the class concept map. Then they drew a line to show its connection and wrote in the connecting words. Pictures of the class created concept map were taken after the post-reading phase for data collection purposes.

Pre-generated concept mapping. After participating in the class concept map graphic organizer, participants in the concept mapping group were given a sheet that contained a pre-generated concept map with a word bank. Following the theory of gradual release of responsibility (Pearson & Gallager, 1983), in which responsibility shifts from the teacher to the students, the complexity of the task increased between lessons. On the first two days, the concept map was 90% completed with graphic visuals of circles drawn and the text supplied. On day 3 & 4, it was 75% completed. On Days 5& 6, it was 50% completed and on Day 7 & 8, it was only 25% completed. For example, on Day 3, students had to fill out 25% of the concept map. The words were provided a word bank below the concept map. Students could use the class created concept map on the board as a resource.

Comparison

Comprehension questioning with writing. Students in the comparison group participated in a comprehension questioning with writing activity. The students were given a sheet of paper. The teacher wrote a question on the front board. The question was derived from the text that was used in the interactive informational read-aloud and highlighted explicit learning. Using the categorization of questioning posed by Raphael (1984) in QAR, these were "right there" questions. "Right there" questions are located in a single place in the text. As Raphael (1984) suggest words in the question are often "right there" the same sentence. Then the teacher read the question(s) aloud to the students. The students had five minutes to answer the question in writing. The writing pieces were collected by the teacher for data collection purposes.

Day One for Concept Mapping and Comparison Group

The next section is an in-depth view of Day One for both the concept mapping and comparison groups. The teacher followed the answering protocol discussed earlier in the chapter. Scripted pieces in the next section are for example purposes only. These were used for the purpose of training the guest teacher. However, for the actual instruction, the teacher was not expected to follow the wording of a script.

Procedures for concept mapping group. The guest teacher had the following materials ready prior to the lesson: index cards, marker, and the book: *Sand and Soil: Earth's Building Blocks*. The teacher wrote the following on the white board in front of the classroom: *soil*, *sand*, *nutrients*, *sand formation* and *organisms in soil*. The teacher welcomed the students and informed them that they would be starting a unit on the formation of soil. Then the teacher passed out index cards. The teacher asked them to brainstorm words that reminded them of the term "soil". The students had 3 minutes to write one word or phrase associated with "soil". The teacher wrote the word "soil" on an index card and placed it on the center of the board using a magnet. Then, the teacher asked for students to raise their hand if they wanted to share their words that they wrote. The teacher called on a student that has his or her hand raised who then shared his or her response. Refer to the section on answering protocols.

Then, the teacher explained how concept maps are used to show connections. ***"In using concept maps we use lines to show our connections. So I will place your index card to the right of the word "soil".*** The teacher took the index card from the student and placed it in reference to the word soil. Then the teacher stated, ***"Then I will draw a line to show its connection".*** The teacher used a marker to draw a straight line connecting the word soil to the word "ground". The teacher continued, ***"The next thing that we need to do is write how it is connected. So what word should we use to show the connection? "The soil ____ground".*** The students responded with the word "is".

Then, the teacher stated, ***"So we would write the word "is" to show the connection".*** Then the teacher wrote the word "is" on the line that she drew connecting "soil" and "ground". This eliminated students using words that are not associated with soil such as "car" or "candy".

Students continued sharing their words. The teacher placed the cards on the board. The student had to draw the connection using "linking verbs" to identify the relationship. After a total of ten minutes passed, (approximately five examples) the teacher stopped the activity.

Vocabulary introduction. The teacher read the words on the board that she had written before the lesson started. These words (or phrases) were found in the book that they read. The following words were: *soil*, *sand*, *nutrients*, *sand formation*, and *organisms in soil*. The teacher read the words aloud to the students. Then the teacher had the students repeat the words. The teachers informed the students to listen for these words or phrases when they participated in the read-aloud.

Interactive informational read-aloud. Then the teacher started an interactive informational read-aloud using the book *Sand and Soil: Earth's Building Blocks* by Beth Gurney (2005). The teacher introduced the book. She then prompted the students to make a prediction about what they think the book will be about.

"Looking at the pictures and the title, what do you think this book will be about?" The teacher placed the book on the Elmo document camera and showed the front cover. Then she pointed at the title. Then she showed the students the cover page and the table of contents. As she pointed to each section, she read the words aloud to the students. For each page, the teacher paused approximately 5 seconds. The teacher called on volunteers to raise their hand who wanted to share what they thought the book was about. Then the teacher called on a student who raised his or her hand. The student responded, ***"I think it is about sand and soil and maybe lizards".*** The teacher responded, ***"Explain why you think the book will be about sand, soil and lizards".*** The student stated, ***"Well the title is Sand and soil and there is a lizard on the cover".*** The teacher responded, ***"Good observations. Would anybody else like to share their predictions?".*** The teacher called on another student. The student responded, ***"I think it will be about sand and soil too".*** The teacher responded, ***"Let's read and find out".***

The teacher read pages 4-11. During the read-aloud, students were given the opportunity to ask questions and make connections by raising their hand. After reading page 11 the teacher stopped and asked questions about the text.

She then asked, ***"Can somebody raise their hand and tell me what the term soil means?"*** Then, the teacher called on a student who had their hand raised. The student shared their response with the class. The student responded, ***"Soil is important to plants. They help them grow".*** The teacher responded, ***"You are right. Would anybody else like to add anything?".*** The teacher called on another student. The student responded, ***"Soil is found on the ground and has roots".*** The teacher responded, ***"You are correct. Soil is found in the ground and it has roots that are connected to the plants".***

Then, the teacher asked another question. ***"Would somebody like to raise their hand and answer this question: Is there more than one type of soil?*** The teacher called on a student that had his or her hand raised. The student responded, ***"Yes, there are sand***

and silt". The teacher responded, ***"Correct, there are more than one type of soil. Sand and silt are two types. Can somebody name the other type of soil?".*** The teacher called on another student. The student responded ***"clay".*** The teacher responded, ***"Good job. Yes, clay is another type of soil. So clay, sand and silt are all different types of soil."***

Then the teacher continued the informational read-aloud. The teacher read the rest of the book. After the read-aloud, the teacher asked additional questions to have students think deeper about the text.

The teacher then asked ***"Can somebody raise their hand and tell the class the author's purpose in writing this book?"*** The teacher selected a student that has his or her hand raised. The student shared his or her response. The student responded, ***"They wrote the book to tell us about soil".*** The teacher responded, ***"Correct, authors write informational books to help us learn about different types of topics. Would anybody else like to add anythin*g?"** The teacher calls on another student. The student responded, ***"The author wanted us to know that soil was important for things to grow".*** The teacher responded, ***"Yes, you are correct. The author explained how soil is essential to plants".***

After calling on two students, the teacher continued to the next question. ***Can somebody raise their hand and share why soil is important to the Earth?*** The teacher called on a student that had his or her hand raised. The student responded, ***"Soil helps plants that have food we eat grow".*** The teacher responded, ***"Soil does help plants. What types of plants contain food that we eat?".*** The students responded, ***"Tomatoes, and corn".*** The teacher responded, ***"Yes, tomatoes and corn both need soil to help***

them grow. What animals eat plants that we rely on everyday?" The teacher selected a student. The student responded, ***"Cows. They give us milk and hamburgers are made from them".*** The teacher responded, ***"Good thinking. Yes, cows eat plant products. So soil impacts us in the way because if they do not have enough food to eat, then they will not be able to produce milk or survive to provide meat such as hamburgers or steaks".***

Post-Reading. The students had an opportunity to add and/or modify the class created concept map. ***"Would somebody like to raise their hand and share any topics that we should add to our concept map?*** The teacher called on three students. The students gave their responses and then wrote the words on the index cards. For example, Hannah stated "organisms of soil". Then, she wrote the word down on the index card. Then the teacher asked ***"Where should we put the card?*** The teacher called on a student. Student responded to the left or right (any direction is acceptable). Then teacher asked ***"What connecting word or words should we use to show a relationship?*** The teacher selected a student to respond.

Then the students had an opportunity to work on a pre-generated concept map. The teacher passed out copies of pre-generated concept maps. Students were given an opportunity to complete the pre-generated concept map using a word bank.

This activity took ten minutes, and then the teacher ended the lesson and let the students know that they will continue their study on the formation of soil the next day.

Procedures for Comparison Group

The teacher had the following materials ready: marker, and the book: *Sand and Soil: Earth's Building Blocks*. The teacher wrote the following on the white board in front of the classroom: *soil, sand, nutrients, sand formation*, and *organisms in soil*. These words were used in the vocabulary introduction. The teacher welcomed the students and informed them that they would be starting a unit on the formation of soil. Then, the teacher passed out a sheet of paper to every student. Then students did a comprehension questioning activity with writing for three minutes. In this quick write, students wrote as much as they knew about soil.

Vocabulary instruction. The teachers read the words on the board. These words were found in the book that they read. The following words were: *soil, sand, nutrients, sand formation*, and *organisms in soil*. Then the teacher had the students repeat the words. The teacher informed the students to listen for these words when they participated in the read-aloud.

Interactive informational read-aloud. Then the teacher moved into an informational interactive read-aloud using the book ***Sand and Soil: Earth's Building Blocks*** by Beth Gurney. The teacher introduced the book. She then prompted the students to make a prediction about what they thought the book would be about. ***"Looking at the pictures and the title, what do you think this book will be about?"*** The teacher placed the book on the Elmo document camera and showed the front cover. Then she pointed at the title. Then she showed the students the following pages in this order: cover page, and the table of contents. The teacher paused for five seconds for each page. The teacher called on volunteers who raised their hand who wanted to share what they thought the book was about. Then the teacher called on a student who raised his or her hand.

After students had been given an opportunity to share ideas and predictions, the teacher started the interactive informational read-aloud. The teacher read pages 4-11. After reading page 11 teacher stopped and asked questions about the text.

She then asked, ***"Can somebody raise their hand and tell me what the term soil means?"*** Then, the teacher called on a student who had their hand raised. Then, the teacher asked the second question. **"*Would somebody like to raise their hand and answer this question? Is there more than one type of soil?*** The teacher called on a student with his or her hand raised.

Then the teacher continued the interactive informational read-aloud. The teacher read the rest of the book. After the read-aloud, the teacher asked several questions to have students think deeper about the text.

The teacher asked ***"Can somebody raise their hand and tell the class the author's purpose in writing this book?"*** The teacher called on a student that had his or her hand raised. Then, the teacher asked, ***"Can somebody raise their hand and share why soil is important to the Earth?"*** The teacher called on a student with his or her hand raised.

Post-reading activity. The teacher started the post-reading activity of answering comprehension questions using writing. These questions were from the book that was used in the interactive informational read-aloud. The teacher wrote the two questions on the front board. Then she passed out a piece of paper to each student. Then the teacher read the questions to the students.

"I want to write as much as you can about the following questions. You will have 5 minutes to write:

1. Why is soil important?

2. What are the characteristics of soil?"

The students had five minutes to write. After five minutes, the teacher collected the students' written responses. Then the teacher let the students know that they would continue their study on the formation of soil the next day.

Fidelity Measures

Video-taping. All lessons were video-taped. The purpose of the video recording was to provide a fidelity measure between the two conditions and among the different classrooms within the treatment condition. The students were familiar with the use of videotaping of instruction due to the district's National Teaching Certification Program which required teacher candidates to videotape their lessons. In addition, the use of videotaping was used for staff development purposes on a regular basis.

A checklist was created aligned with the teacher script to ensure teacher fidelity of both treatment and comparison instruction. A copy of the checklist can be found in Appendix C. The checklist was used during the lesson by the researcher as well as during the viewing of videotapes of the lessons. The school's literacy coach was trained in the relationship scoring procedure. During the training, two checklists were scored to assess inter-rater reliability. The inter-rater reliability was 100%. If there was disagreement on the checklists, there was discussion between the disputed scores. The checklists indicated that fidelity was maintained between the concept mapping group and the comparison group.

Teacher Training

Training of the guest teacher took place over two days. Instruction on how to implement concept maps and writing with questioning was discussed shared. The guest teacher had the opportunity to practice to ensure understanding of the implementation of procedures. She utilized both the concept map graphic organizer and questioning with writing activity on a group of fourth grade students to practice after the second day of training. She was observed and evaluated to ensure she was implementing the concept mapping and administering a question with writing activity effectively and with fidelity. Feedback was also given.

Research Questions

The following are the research questions used in this study:

a). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' performance on a test of relational vocabulary?

b). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' ability to identify key ideas on a multiple-choice test?

c). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' individual word knowledge as measured by a vocabulary matching test?

d). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' clarity of written expression as measured by a holistically scored writing test?

Data was analyzed using a mixed-ANOVA model to analyze both within-factors (repeated measure), to show growth, and between-factors, to determine differences between the two groups (Fields, 2005). The significance level was set at .05, a priori. This was analyzed to determine the effect of the activities on different types of learning.

Significance of the Study

The impact of the study can have implications for future research. Data obtained from this study may show how concept mapping and/or writing affect students' types of learning. This information can be used to increase teacher knowledge about how students learn best. This can have implications for staff development for schools and universities.

CHAPTER IV

RESULTS

Analysis of Data

Data was analyzed using a mixed-ANOVA model to analyze both within-factors (repeated measure), to show growth within groups, and between-factors, to determine differences between the two groups (Fields, 2005). The significance level was set at .05, a priori. There were four types of assessments administered to participants: a) a relational vocabulary assessment; b) a matching vocabulary assessment; c) a multiple-choice assessment; and d) a writing assessment. A brief description of the four assessments is shown below.

Confidence intervals. In order to assess the accuracy of the sample mean as an estimate of the mean in a population, it is imperative to calculate the boundaries within which we think the true value of the mean will fall (Fields, 2005). For this study, 95% confidence intervals were calculated. This means that 95% of the time, the true value of the population mean will be within the upper and lower boundaries (Fields, 2005; Fields & Hole, 2003). If the interval is small, then most likely the sample mean is close to the true mean (Fields, 2005; Fields & Hole, 2003). In contrast, if the confidence interval is large, then the sample mean could be very different than true mean (Fields, 2005; Fields & Hole, 2003).

Fidelity of checklist and inter-rater reliability. A checklist was created aligned with the teacher script to ensure teacher fidelity of both treatment and comparison instruction. A copy of the checklist can be found in Appendix C. The checklist was used during the lesson by the researcher as well as during the viewing of videotapes of the lessons. The school's literacy coach was trained in the relationship scoring procedure. During the training, two checklists were scored to assess inter-rater reliability. The inter-rater reliability was 100%. The checklists indicated that fidelity was maintained between the concept mapping group and the comparison group. There was not a significant difference in fidelity between the concept mapping group and the comparison group. For the concept mapping group, 97% of the lessons covered the items in the checklist. For the comparison group, 98% of the lessons covered the items in the checklist.

Relational Vocabulary Assessment

The purpose of this assessment was to assess students' relational vocabulary knowledge. Participants were given three related terms and had to provide an explanation of how they were related. It was given individually in an oral format which allowed the examiner to query for ambiguous answers.

Multiple-Choice Assessment

This assessment assessed key ideas, explicit information and indirectly assessed students' vocabulary knowledge regarding soil formation. Following a multiple-choice format, students were given four answer choices to choose from for each question. There were ten questions for students to complete.

Matching Vocabulary Assessment

The purpose of the matching vocabulary assessment was to assess individual vocabulary word learning. The students were given ten vocabulary terms and fourteen definitions. Students were to correctly pair the vocabulary term to its correct definition.

Writing Assessment

The purpose of the writing assessment was to assess students' conceptual thinking, retaining and recalling information as well as how students use domain knowledge (DiCecco & Gleason, 2002). The essay prompt was on the following two questions: 1) "If you were able to play in a large pile of dirt, soil, what kind would you like best?" and 2) "Write about why you can do certain things with sandy soil". Students were given fifteen minutes to respond to the writing prompts.

Assumptions. As previously stated, this study used a mixed model, repeated measures-ANOVA to analyze both within-groups factors as well as between-groups factors. In ANOVA analysis, it is imperative to have homogeneity of variances between conditions when analyzing data (Field, 2005). Sphericity is a condition of compound symmetry which holds true when both the variances across conditions are equal, also referred to *as homogeneity of variance assumption*. To measure sphericity, one can take each pair of treatment levels scores and calculate the differences between each pair of scores to determine equality of variances. Using SPSS, the program uses the Mauchly's Test to check for the equivalences of variances. If the tests are not significant (i.e., having a probability of less than .05), the F-ratio can be reported as "sphericity assumed" (Heck, Thomas, & Tabata, 2010; Fields, 2005).

If there is not equality of variances, then one has "violated sphericity". The effect of violating sphericity is a loss of power, increasing the probability of a Type II error because the test statistic, *F*-ratio, simply cannot be assumed to have an *F*-distribution (Fields & Hole, 2003). Type II errors occur when a test fails to reject a false null hypothesis (Heck, Thomas, Tabata, 2010). If sphericity is violated, then there are corrections that can be applied to produce a valid *F*-ratio. SPSS uses the Greenhouse-Geisser correction and the Huynh-Feldt correction (Fields & Hole, 2003). Greenhouse-Geisser is recommended to be applied when sphericity estimates are less than .75 (Fields, 2005). When sphericity estimates are greater than .75, then it is recommended to use the Huynh-Feldt correction (Fields, 2005). Another option when violating sphericity is to use a multivariate approach (MANOVA) because they are not dependent upon the assumptions of sphericity (Heck, et al., 2010; Fields, 2005).

I will present the results individually by outcome measures in the order of the following: relational vocabulary, multiple-choice, matching vocabulary and writing. Then for each outcome measure, I will present the data analysis in the following order: means, between-factor analysis and within-factor analysis. In addition to measures of significance, I will also report effect sizes in the form of partial eta squared.

Relational Vocabulary

Mean scores. The mean scores and standard deviations for both the concept mapping (i.e., experimental) and comparison group were computed for the pre-test, post-test and delayed post-test and are summarized in Table 7.

Table 7
Mean Scores for the Concept Mapping Group and the Comparison Group for the Relational Vocabulary Assessment

		Pre-Test		Post-Test		Delayed Post-Test	
Group	N	M	SD	M	SD	M	SD
Concept Mapping	29	9.31	6.50	93.80	9.03	88.97	7.24
Comparison	29	10.00	5.98	82.76	14.12	77.24	11.30

The confidence intervals for the Concept Mapping Group and the Comparison group for the Relational Vocabulary at the different time-points (pre-test, post-test and delayed post-test) are summarized in Table 8.

Table 8
Confidence Intervals for the Concept Mapping Group and the Comparison Group for the Relational Vocabulary Assessment

	Pre-Test	Post-Test	Delayed Post-Test
Group	95% CI	95% CI	95% CI
Concept Mapping	[6.99, 11.64]	[89.39, 98.20]	[85.43, 92.50]
Comparison	[7.68, 12.32]	[78.35, 87.17]	[73.52, 80.77]

The mean scores and confidence intervals for the Concept Mapping Group and the Comparison Group for the Relational Vocabulary Assessment are displayed in Figure 1.

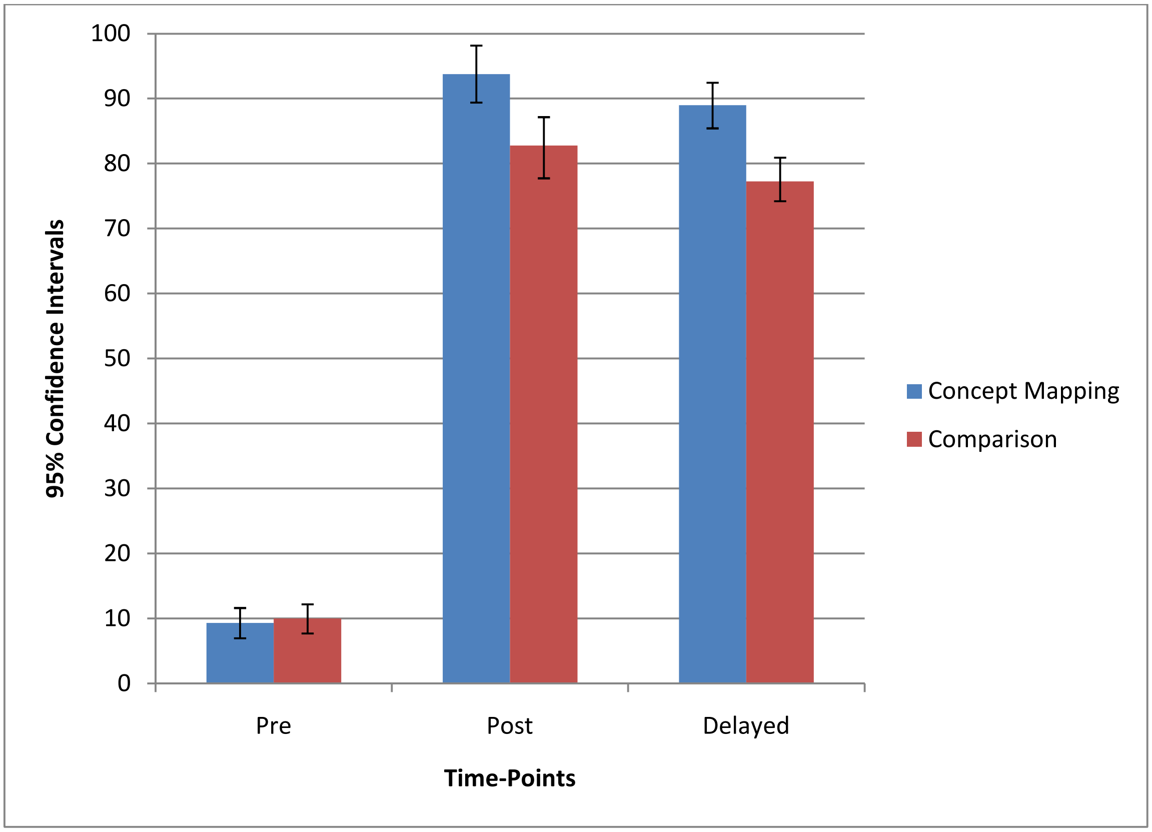

Figure1. Confidence Intervals for Concept Mapping and Comparison Group at Different Time-Points for the Relational Vocabulary Assessment.

Between-Factors Analysis for Relational Vocabulary

The purpose of the between-factors analysis was to determine if there was a significant difference between the performance of the concept mapping group and the performance of the comparison group. I first performed an overall ANOVA and then follow-up tests using the Sidak procedure to determine at which time-points the two groups differed. Regarding sphericity, the Mauchly's Test for this analysis was not significant, $W=.953$, $\chi^2(2)=2.632$, $p=.268$, therefore I assumed sphericity which meant that the variances were equivalent. In other words, the difference between variances of the conditions was not significantly different (Field, 2005).

Between-factors effect. There was an overall significant difference between the concept mapping and comparison group, $F(1, 56) = 11.28$, $p = .001$; Partial $\eta^2 = .168$. The between-factors effect for the relational vocabulary assessment is summarized in Table 9.

Table 9
Table of Between-Factors Effect for the Relational Vocabulary Assessment

Source	df	MS	F	ρ	Partial η^2
Intercept	1	633620.69	3034.80	<.001	.982
Groups	1	2354.02	11.28	.001	.168
Error	56	208.79			

Mean differences between-factors. Next, in order to determine if there was a difference between the concept mapping and comparison group at each time-point, I analyzed the between-factors at each time point. The two groups did not differ significantly at the pre-test time-point. At the post-test time-point, the concept mapping group scored higher ($p = .001$) than the comparison group by 11.03 points. At the delayed post-test time-point, the concept mapping group again scored higher ($p = < .001$) than the comparison group by 11.72 points.

Within-Factor Analysis of Relational Vocabulary

In a repeated-measure model, as stated earlier, within-factors were analyzed because the same individuals participated in all conditions (Fields, 2005). In this study, within-factors were analyzed to determine if there was a significant difference between the different time-points (pre-test to post-test; pre-test to delayed post-test; and post test-to delayed post-test). In other words, in this study, the within factor analysis measured the extent of learning, or growth, over time within each group.

Analysis of variance. I computed an analysis of variance to determine if there was an overall difference of the assessment scores at different time-points. The results are summarized in table 10 and documented that there was a significant difference in the scores across time-points, $F(2, 112) = 3689.65$, $\rho = < .001$. There was also a significant interaction between the groups and time-points, $F(2, 112) = 23.22$, $\rho = < .001$. There was also a significant between group (concept mapping and teacher questioning) by within group (pre-test, post-test, delayed post-test) interaction. Figure 2 indicates that the effects of concept mapping and teacher questioning had impacted the test performances differently on the post test and delayed post tests. As can be seen in Figure 2, the lines indicating the initial rates of learning between the pre-test and the post test were not parallel, indicating indicating that the slope of the line segment was steeper between the relevant time-points showing a higher learning rate for the concept mapping treatment group, as indicated by the non parallel (slightly divergent) lines representing the changes for the two groups between the pre and post tests. As indicated by the nearly parallel lines between the post test and delayed post test mean scores, both groups experienced a similar decline in mean test performances between the post test and the delayed post test of the relational vocabulary assessment.

Table 10
Analysis of Variance for the Relational Vocabulary Assessment

Effect	MS	df	F	ρ
Time	112158.62	2	3689.65	<.001
Time x Groups	705.75	2	23.22	<.001
Error	30.40	112		

The interaction between the groups and the time-points is graphically represented in Figure 2 for the Relational Vocabulary Assessment.

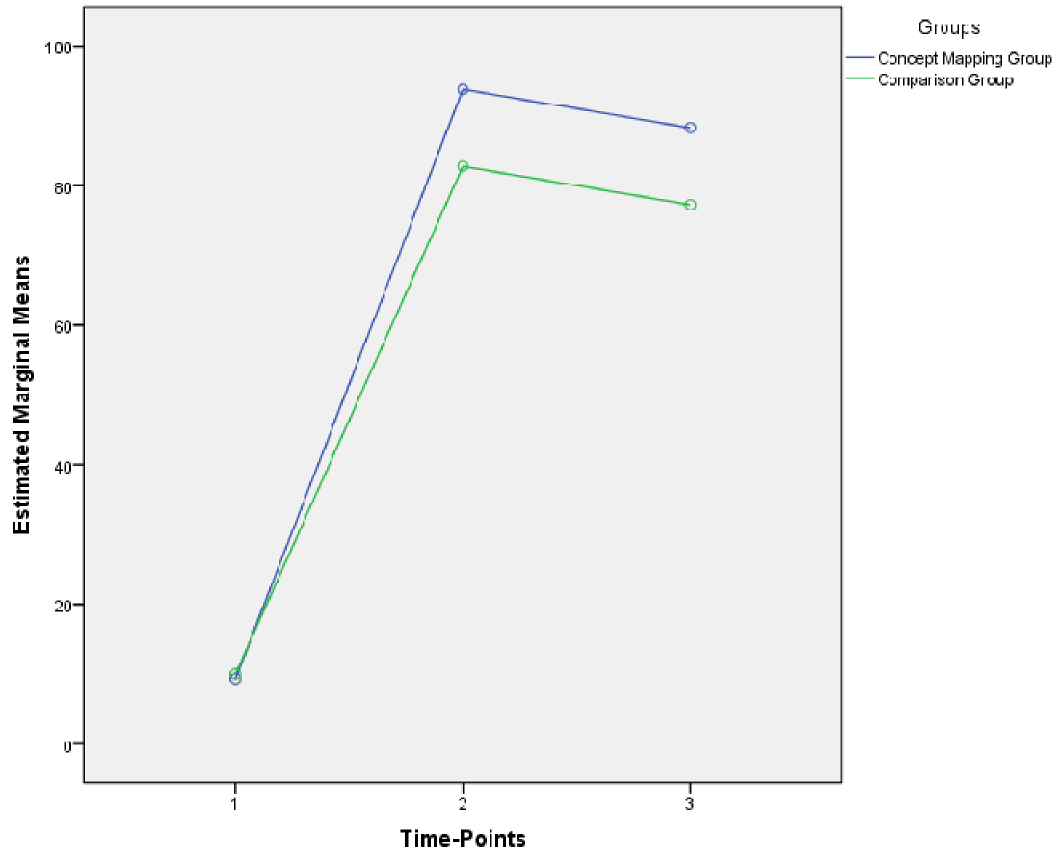

Figure 2. Graph of the Interaction Between the Groups and the Time-Points for Relational Vocabulary Assessment.

Follow up analyses. Next, to determine if there were differences across the time-points for each group individually (comparison and concept mapping) follow-up pairwise comparisons, using the Sidak procedure, were run and results are summarized in Table 11. Significant differences were found between each time-point comparison. It is important to note that for both groups, the difference in scores was in a positive direction between the pre-test and post-test time-point comparison and between the pre-test and delayed–post test time-point comparison, but in the negative direction between post-test and delayed post test time-point comparison.

Table 11
Sidak Comparison of Mean Differences for the Concept Mapping Group and the Comparison Group for the Relational Vocabulary Assessment

Group	Time Point	Compare	Mean Difference	ρ
Concept mapping	Pre-Test	Post-Test	84.48	<.001
	Pre-Test	Delayed Post	79.66	<.001
	Post-Test	Delayed Post	-4.83	<.002
Comparison	Pre-Test	Post-Test	72.76	<.001
	Pre-Test	Delayed Post	67.24	<.001
	Post-Test	Delayed Post	-5.52	<.001

Multiple-Choice

Mean scores. The mean scores and standard deviations for both the concept mapping (i.e., experimental) and comparison group were computed for the pre-test, post-test and delayed post-test and are summarized in Table 12.

Table 12
Mean Scores for the Concept Mapping Group and the Comparison Group for the Multiple-Choice Assessment

		Pre-Test		Post-Test		Delayed Post-Test	
Group	N	M	SD	M	SD	M	SD
Concept mapping	29	43.79	13.47	90.00	10.00	86.20	11.15
Comparison	29	43.48	14.21	78.97	13.98	71.04	16.11

The confidence intervals for the Concept Mapping Group and Comparison Group for the Multiple-Choice Assessment at the different time-points (pre-test, post-test, delayed post-test) are displayed in Table 13.

Table 13
Confidence Intervals for the Concept Mapping Group and the Comparison Group for the Multiple-Choice Assessment

	Pre-Test	Post-Test	Delayed Post-Test
Group	95% CI	95% CI	95% CI
Concept mapping	[38.64, 48.94]	[85.48, 94.52]	[81.05, 91.36]
Comparison	[38.30, 48.60]	[74.45, 83.49]	[65.88, 76.19]

The mean scores and confidence intervals for the Concept Mapping Group and the Comparison Group for the Multiple-Choice Assessment are graphically displayed in Figure 3.

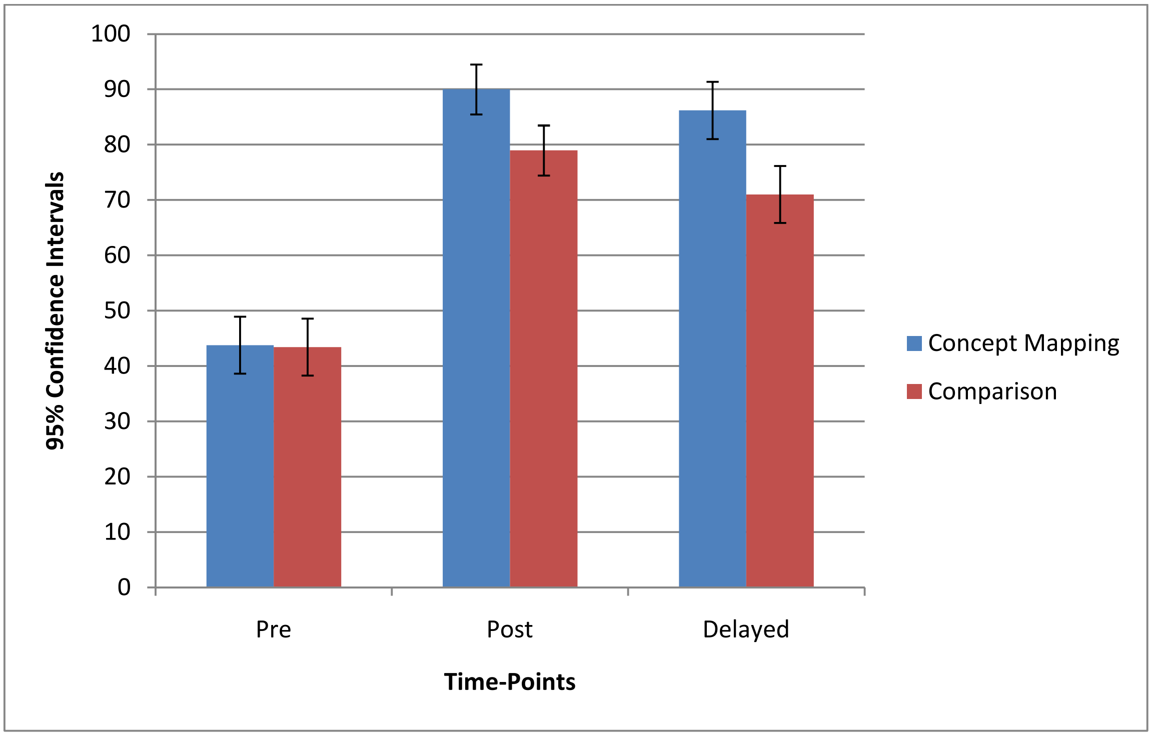

Figure 3. Confidence Intervals for Concept Mapping and Comparison Group at Different Time-Points for the Multiple-Choice Assessment.

Between-Factors Analysis for Multiple-Choice Assessment

The purpose of the between-factors analysis was to determine if there was a significant difference between the performance of the concept mapping group and the performance of the comparison group. I first performed an overall ANOVA and then follow-up tests using the Sidak procedure to determine at which time-points the two groups differed. Regarding sphericity, the Mauchly's Test for this analysis was not significant, W=.920, $\chi^2(2)$=4.606, p=.100, therefore I assumed sphericity.

Between-factors effect. There was an overall significant difference between the concept mapping and comparison group, *F*(1, 56) =7.15, p=.010; Partial η^2 =.113. The between-factors effect for the multiple-choice assessment is summarized in Table 14.

Table 14
Table of Between-Factors Effect for the Multiple-Choice Assessment

Source	df	MS	F	ρ	Partial η^2
Intercept	1	826207.47	1733.84	<.001	.969
Groups	1	2209.20	7.15	.010	.113
Error	56	476.52			

Mean differences between-factors. Next, in order to determine if there was a difference between the concept mapping and comparison group at each time point, I analyzed the between-factors at each time point. The two groups did not differ significantly at the pre-test time-point. At the post-test time-point, the concept mapping group scored higher (p=.001) than the comparison group by 11.03 points. At the delayed post-test time-point, the concept mapping group again scored higher (p=<.001) than the comparison group by 15.17 points.

Within-Factor Analysis for Multiple-Choice Assessment

Analysis of variance. Next, analysis of variance was analyzed to determine if there was an overall difference of the assessment scores at different time-points. The results are summarized in Table 15. It indicates that there was a significant difference in the scores across time-points, $F(2, 112) = 1031.77$, $\rho = < .001$. There was also a significant interaction between the groups and time-points, $F(2, 112) = 30.93$, $\rho = < .001$. There was also a significant between group (concept mapping and teacher questioning) by within group (pre-test, post-test, delayed post-test) interaction. Figure 4 indicates that the effects of concept mapping and teacher questioning had impacted the test performances differently on the post test and delayed post tests. As can be seen in Figure 4, the lines indicating the initial rates of learning between the pre-test and the post test were not parallel, indicating that the slope of the line segment was steeper between the relevant time-points showing a higher learning rate for the concept mapping treatment group, as indicated by the non parallel (slightly divergent) lines representing the changes for the two groups between the pre and post tests. As indicated by the nearly parallel lines between the post test and delayed post test mean scores, both groups experienced a similar decline in mean test performances between the post test and the delayed post test of the multiple-choice assessment.

Table 15

Analysis of Variance on the Multiple-Choice Assessment

Effect	MS	df	F	ρ
Time	28314.37	2	1031.77	<.001
Time x Groups	848.85	2	30.93	<.001
Error	27.44	112		

The interaction between the groups and the time-points are graphically shown in Figure 4 for the Multiple-Choice Assessment.

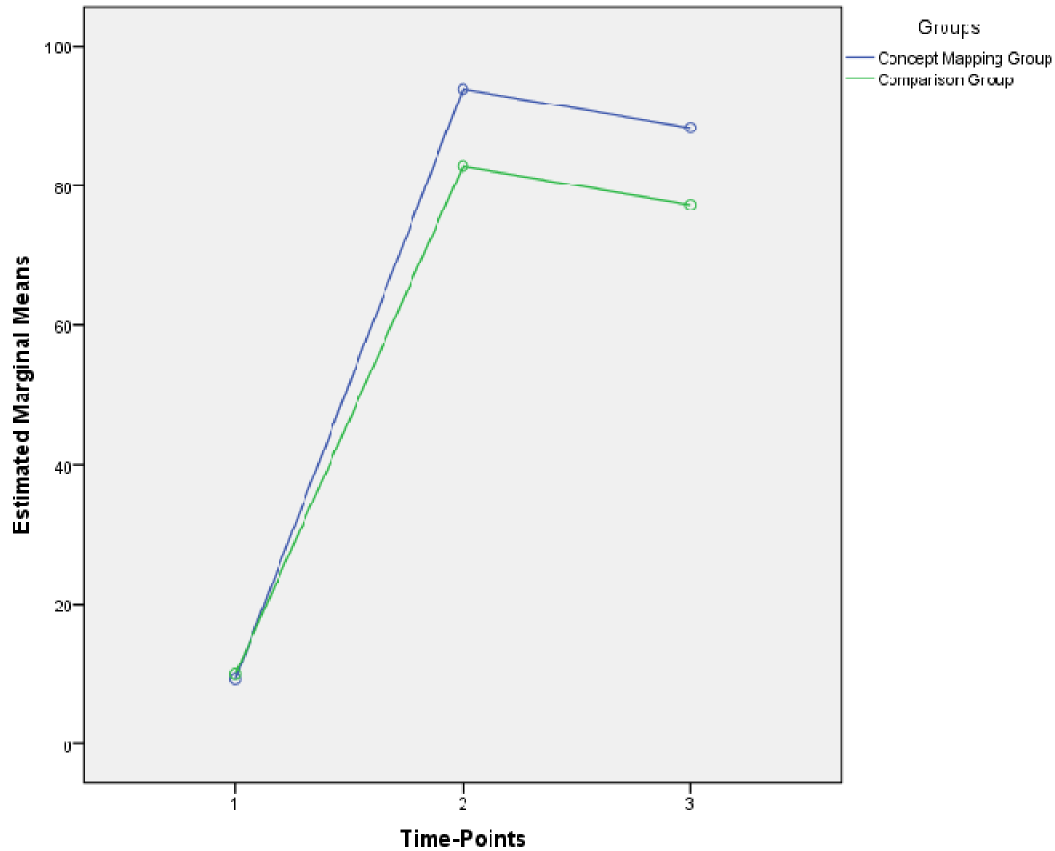

Figure 4. Graph of the Interaction Between the Groups and the Time-Points for Multiple-Choice Assessment.

Follow up analyses. Next, to determine if there were differences across the time-points for each group individually (comparison and concept mapping) follow-up pairwise comparisons, using the Sidak procedure were run and results are summarized in Table 16. Significance was found between each time-point comparison. Again, it is important to note that for both groups, the difference was in a positive direction between the pre-test and post-test time-point comparison and between the pre-test and delayed post-test time point comparison, but in the negative direction between post-test and delayed post-test time point comparison.

Table 16
Sidak Comparison of Mean Differences for the Concept Mapping Group and the Comparison Group for the Multiple-Choice Assessment

Group	Time Point	Compare	Mean Difference	ρ
Concept Mapping	Pre-Test	Post-Test	46.21	<.001
	Pre-Test	Delayed Post	42.41	<.001
	Post-Test	Delayed Post	-3.79	.008
Comparison	Pre-Test	Post-Test	35.52	<.001
	Pre-Test	Delayed Post	27.59	<.001
	Post-Test	Delayed Post	-7.93	<.001

Matching Vocabulary

Mean scores. The mean scores and standard deviations for both the concept mapping (i.e., experimental) and comparison group were computed for the pre-test, post-test and delayed post-test and are summarized in Table 17.

Table 17
Means Scores for the Concept Mapping Group and the Comparison Group for the Matching Vocabulary Assessment

		Pre-Test		Post-Test		Delayed Post-Test	
Group	N	M	SD	M	SD	M	SD
Concept mapping	29	17.59	13.54	84.14	13.50	81.03	14.23
Comparison	29	18.28	14.90	79.66	18.42	73.45	18.18

The confidence intervals for the Concept Mapping Group and the Comparison Group for the Matching Vocabulary Assessment at the different time-points (pre-test, post-test, delayed post-test) are displayed in Table 18.

Table 18
Confidence Intervals for the Concept Mapping Group and the Comparison Group for the Matching Vocabulary Assessment

Group	Pre-Test 95% CI	Post-Test 95% CI	Delayed Post-Test 95% CI
Concept mapping	[12.36, 22.81]	[78.13, 90.14]	[74.96, 87.11]
Comparison	[12.99, 23.57]	[73.65, 85.66]	[67.38, 79.52]

The mean scores and confidence intervals for the individual groups are graphically displayed in Figure 5 for the matching vocabulary assessment.

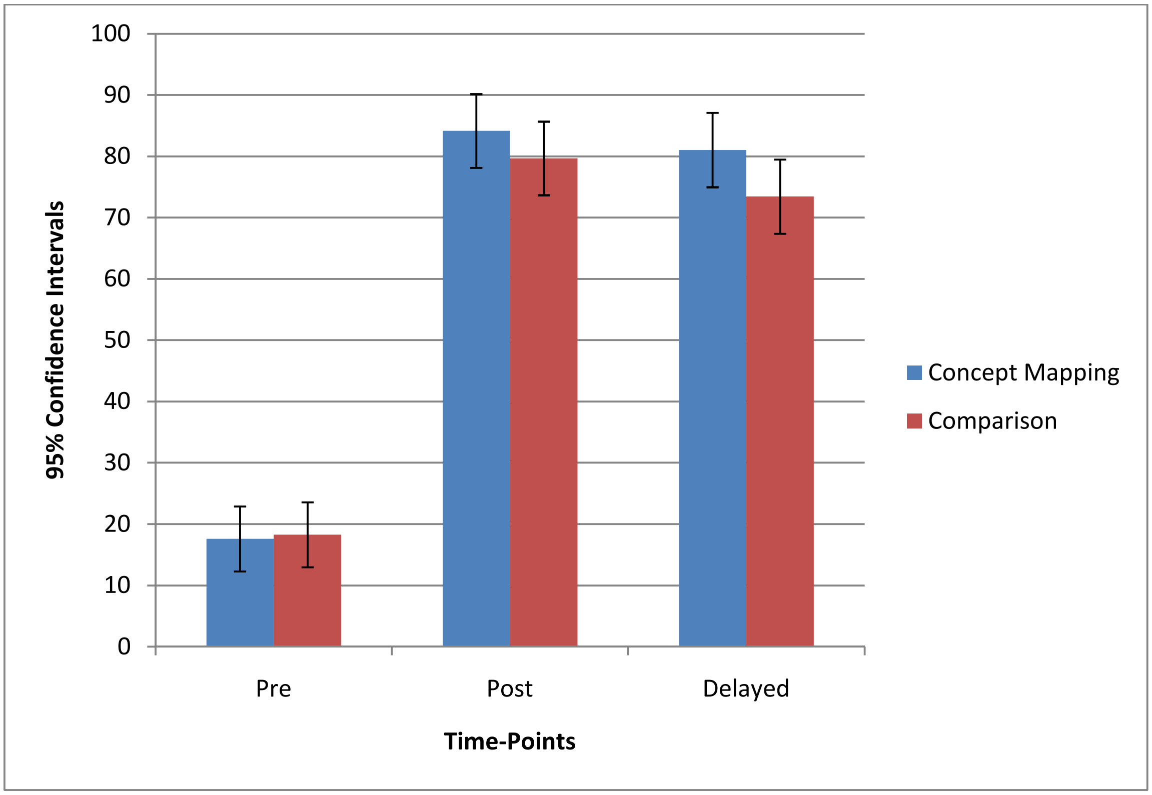

Figure 5. Confidence Intervals for Concept Mapping and Comparison Group at Different Time-Points for the Matching Vocabulary Assessment.

Between-Factors Analysis for Matching Vocabulary

The purpose of the between-factors analysis was to determine if there was a significant difference between the performance of the concept mapping group and the performance of the comparison group. I first performed an overall ANOVA and then follow-up tests using the Sidak procedure to determine which time-points the two groups differed. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(2)=12.28$, $p=.002$); therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon hf=.871$). Field (2005) recommends that when estimates of sphericity are greater than .75 then the Huynh-Feldt correction should be used.

Between-factors effect. There was not an overall significant difference between the concept mapping and comparison group, $F(1, 56) =1.02$, $p=.316$; Partial $\eta^2 =.018$. The between-factors effect for the matching vocabulary assessment is summarized in Table 19.

Table 19
Table of Between-Factors Effect for the Matching Vocabulary Assessment

Source	df	MS	F	ρ	Partial η^2
Intercept	1	606166.09	989.43	.000	.946
Groups	1	625.86	1.02	.316	.018
Error	56	612.64			

Mean differences between-factors. Next, in order to determine if there was a difference between the concept mapping and comparison group at each time-point, I analyzed the between-factors at each time point. The two groups did not differ significantly at the pre-test time-point. At the post-test time-point, the concept mapping group scored higher (p=.295) than the control group by 4.48 points. At the delayed post-test time-point, the concept mapping group again scored higher (ρ=.082) by 7.50 points. But this difference could be due to chance.

Within-Factor Analysis for Matching Vocabulary

Analysis of variance. Next, analysis of variance was analyzed to determine if there was an overall difference within groups of the assessment scores at different time-points. The results are summarized in Table 20. It indicates that there was a significant difference in the scores across time-points, $F(1.74, 97.56) = 1259$, $\rho = < .001$. There was also a significant interaction between the groups and time-points, $F(1.74, 97.56) = 4.33$, $\rho = .020$. There was also a significant between group (concept mapping and teacher questioning) by within group (pre-test, post-test, delayed post-test) interaction. Figure 6 indicates that the effects of concept mapping and teacher questioning had impacted the test performances differently on the post test and delayed post tests. As can be seen in Figure 6, the lines indicating that the slope of the line segment was steeper between the relevant time-points showing a higher learning rate for the concept mapping treatment group, as indicated by the non parallel (slightly divergent) lines representing the changes for the two groups between the pre and post tests. As indicated by the nearly parallel lines between the post test and delayed post test mean scores, both groups experienced a similar decline in mean test performances between the post test and the delayed post test of matching vocabulary.

Table 20
Analysis of Variance for the Matching Vocabulary Assessment

Effect	MS	df	F	ρ
Time	84683.59	1.74	1259.25	<.000
Time x Groups	290.96	1.74	4.33	.020
Error	67.25		97.56	

The interaction between the groups and the time-points are graphically represented in Figure 6 for the Matching Vocabulary Assessment.

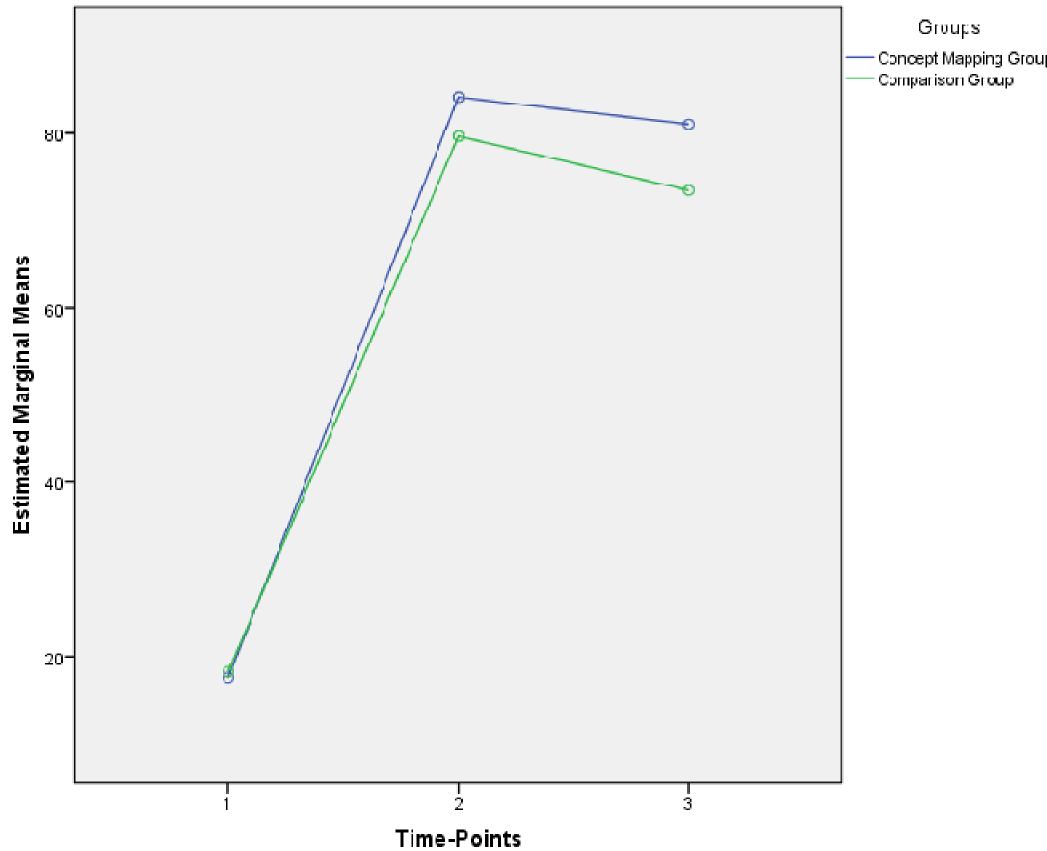

Figure 6. Graph of the Interaction Between the Groups and the Time-Points for Matching Vocabulary Assessment.

Follow up analyses. Next, to determine if there were differences across the time-points for each group individually (comparison and concept mapping) follow-up pairwise comparisons, using the Sidak procedure were run and results are summarized in Table 21. Significance was found between each time-point comparison with the exception of the time-point comparison between the post-test and the delayed post-test for the concept mapping group. It is important to note that for both groups, the difference was in a positive direction between the pre-test and post-test time-point comparison and between the pre-test and delayed post-test time-point comparison, but in the negative direction between post-test and delayed post-test time-point comparison. In addition, there is a significant difference between the post-test time point and delayed post-test time point for the comparison group but not for the concept mapping group. This indicates that the concept mapping group was better able sustain their gain in individual word learning.

Table 21
Sidak Comparison of Mean Differences for the Concept Mapping Group and the Comparison Group for the Matching Vocabulary Assessment

Group	Time Point	Compare	Mean Difference	ρ
Concept mapping	Pre-Test	Post-Test	66.55	<.001
	Pre-Test	Delayed Post	63.45	<.001
	Post-Test	Delayed Post	-3.01	.158
Comparison	Pre-Test	Post-Test	61.38	<.001
	Pre-Test	Delayed Post	55.17	<.001
	Post-Test	Delayed Post	-6.21	.001

Writing Assessment

Mean scores. The mean scores and standard deviations for both the concept mapping (i.e., experimental) and comparison group were computed for the pre-test, post-test and delayed post-test and are summarized in Table 22.

Table 22
Means Scores for the Concept Mapping Group and the Comparison Group for the Writing Assessment

		Pre-Test		Post-Test		Delayed Post-Test	
Group	N	M	SD	M	SD	M	SD
Concept mapping	29	24.14	8.14	76.72	17.59	74.14	17.01
Comparison	29	25.86	4.64	62.93	25.55	54.31	24.15

Table 23 summarizes the confidence intervals for the Concept Mapping Group and the Comparison Group for the Writing Assessment at the different time-points (pre-test, post-test, delayed post-test). The confidence intervals are larger as compared to other assessments due to the scoring of the writing assessments. The scoring of the writing assessments were modeled after the state writing assessment scoring system in which students' writing are scored from a one (lowest) to a four (highest). If a student received a "one", then he or she was given 25 points. If a student received a "two", then he or she was given 50 points. If a student was given a "three", then he or she was given 75 points. Lastly, if a student received a "four", then he or she was given 100 points.

Table 23

Confidence Intervals for the Concept Mapping Group and the Comparison Group for the Writing Assessment

	Pre-Test	Post-Test	Delayed Post-Test
Group	95% CI	95% CI	95% CI
Concept mapping	[21.67, 26.60]	[68.57, 84.88]	[66.37, 81.91]
Comparison	[23.40, 28.33]	[54.77, 71.09]	[46.54, 62.08]

Figure 7 graphically displays the mean scores and confidence intervals for the individual groups for the Writing Assessment.

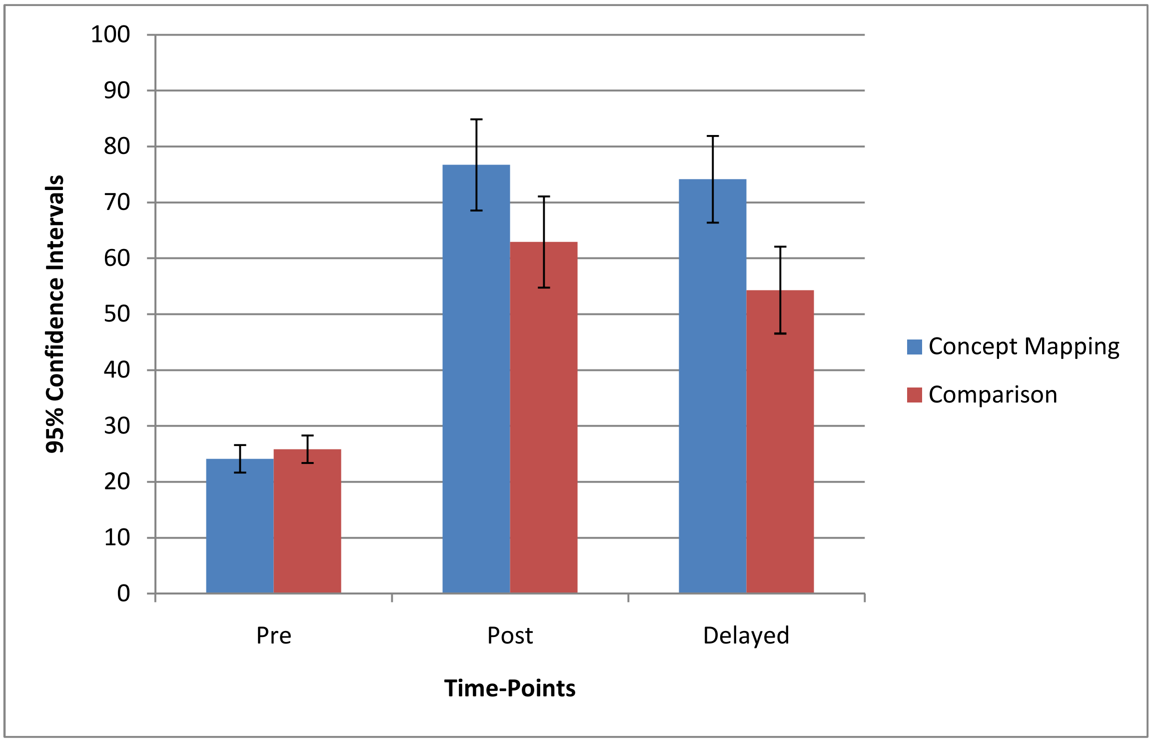

Figure 7. Confidence Intervals for Concept Mapping and Comparison Group at Different Time-points for the Writing Assessment.

Between-Factors Analysis for Writing Assessment

The purpose of the between-factors analysis was to determine if there was a significant difference between the performance of the concept mapping group and the performance of the comparison group. I first performed an overall ANOVA and then follow-up tests using the Sidak procedure to determine at which time-points the two groups differed. Regarding sphericity, the Mauchly's Test for this analysis was not significant, W=.915, $\chi^2(2)$=4.860, p=.080, therefore I assumed sphericity.

Between-factors effect. There was an overall significant difference between the concept mapping and comparison group, *F*(1, 56) =8.71, p=.005; Partial η^2 =.135. The between-factors effect for the writing assessment is summarized in Table 24.

Table 24
Table of Between-Factors Effect for the Writing Assessment

Source	df	MS	F	ρ	Partial η^2
Intercept	1	489084.05	866.09	<.001	.939
Groups	1	4917.39	8.71	.005	.135
Error	56	564.71			

Mean differences between-factors. Next, in order to determine if there was a difference between the concept mapping and comparison group at each time-point, I analyzed the between-factors at each time point. The two groups did not differ significantly at the pre-test time-point. At the post-test time-point, the concept mapping group scored higher (ρ=.020) than the comparison group by 13.79 points. At the delayed post-test time-point, the concept mapping group again scored higher (ρ=.001) than the comparison group by 19.83 points.

Within-Factor Analysis for Writing Assessment

Analysis of variance. Next, analysis of variance was analyzed to determine if there was an overall difference within groups of the assessment scores at different time-points. The results are summarized in Table 25. It indicates that there was a significant difference in the scores across time-points, $F(2, 112) = 174.47$, $\rho = < .001$. There was also a significant interaction between the groups and time-points, $F(2, 112) = 9.04$, $\rho = < .001$. There was also a significant between group (concept mapping and teacher questioning) by within group (pre-test, post-test, delayed post-test) interaction. Figure 8 indicates that the effects of concept mapping and teacher questioning had impacted the test performances differently on the post test and delayed post tests. As can be seen in Figure 8, the lines indicating the initial rates of learning between the pre-test and the post test were not parallel, indicating that the slope of the line segment was steeper between the relevant time-points showing a higher learning rate for the concept mapping treatment group, as indicated by the non parallel (slightly divergent) lines representing the changes for the two groups between the pre and post tests. Furthermore, the crossing of the lines between the pre-test and post-test indicate a fairly large interaction (Fields, 2005). As indicated by the nearly parallel lines between the post test and delayed post test mean scores, both groups experienced a similar decline in mean test performances between the post test and the delayed post test of the writing assessment. But the comparison group had a greater decline from post-test to delayed post-test.

Table 25

Analysis of Variance for the Writing Assessment

Effect	MS	df	F	ρ
Time	34601.29	2	174.47	<.001
Time x Groups	1792.39	2	9.04	<.001
Error	198.33	112		

The interaction between groups and time-points is graphically represented in Figure 8 for the Writing Assessment.

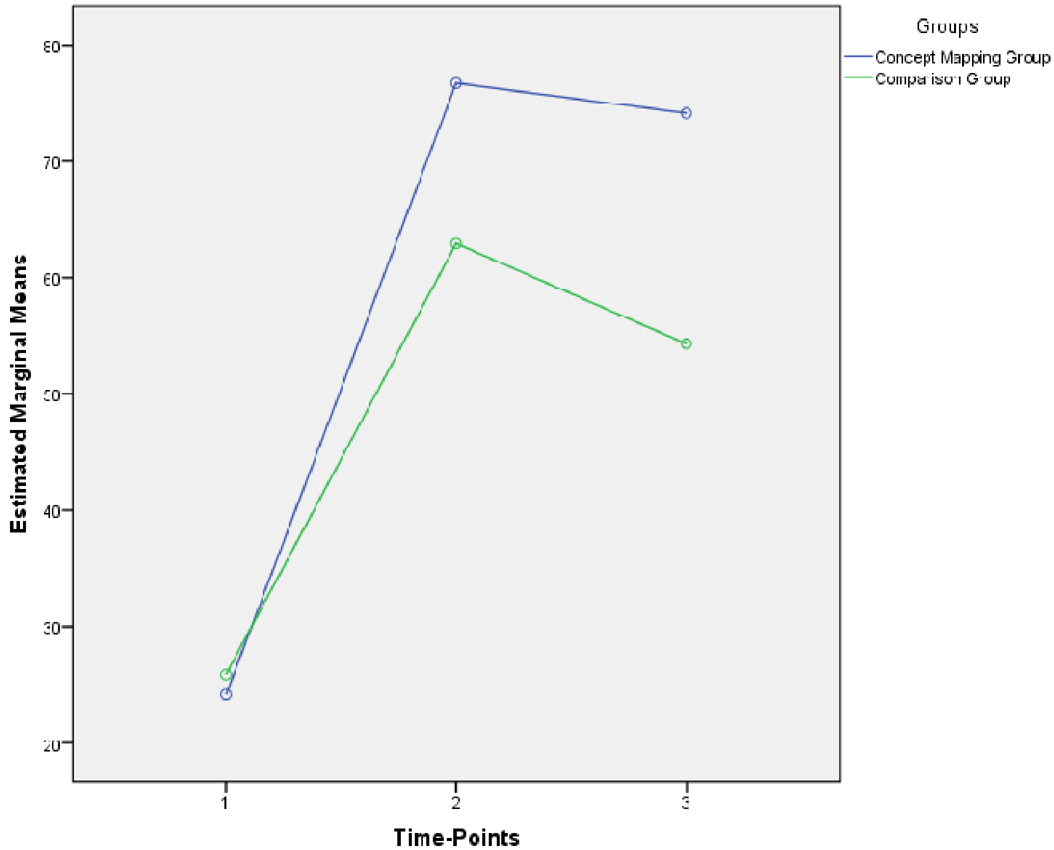

Figure 8. Graph of the Interaction Between the Groups and the Time-Points for Writing Assessment.

Follow up analyses. Next, to determine if there were differences across the time-points for each group individually (comparison and concept mapping) follow-up pairwise comparisons, using the Sidak procedure were run and results are summarized in Table 26. Significance was found between the pre-test and the post test as well as the pre-test and the delayed post-test. There was no difference between the post-test and delayed post-test indicating retention of knowledge.

Table 26
Sidak Comparison of Mean Differences for the Concept Mapping Group and the Comparison Group for the Writing Assessment

Group	Time Point	Compare	Mean Difference	ρ
Concept mapping	Pre-Test	Post-Test	52.59	<.001
	Pre-Test	Delayed Post	50.00	<.001
	Post-Test	Delayed Post	-2.59	.795
Comparison	Pre-Test	Post-Test	37.07	<.001
	Pre-Test	Delayed Post	28.45	<.001
	Post-Test	Delayed Post	-8.62	.023

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this intervention study was to examine and compare the impact of concept mapping and questioning on students' organization and retention of science knowledge when used in conjunction with interactive informational read-alouds for third-grade students. The use of the following has been shown to benefit science and reading instruction: frameworks for integrating science and literacy development (Pearson, et al., 2010); using informational texts (Smolkin, McTigue, Donovan & Coleman, 2008); using interactive informational read-alouds (Smolkin & Donovan, 2001); and the use of graphic organizers specifically concept maps (Oliver, 2009). However, limited research has combined these methods to examine its effect on student learning. Specifically, the present study examined how the use of interactive read-alouds using informational texts with concept mapping or questioning affect elementary students' organization and retention of *different types of science knowledge*.

The participants in this study consisted of 58 third-grade students assigned to either a concept mapping group or a comparison group using questioning. The intervention was over an eight-day instructional time-period. The students were administered the following pre- and post- assessments: a relational vocabulary assessment; a multiple-choice assessment; a matching vocabulary assessment; and a writing assessment at three different time-points (pre-test, post-test, delayed post-test).

The results of the study were analyzed using a mixed-ANOVA model to determine if there were differences between the performances of the concept mapping group and the comparison group, as well as to see if there was a significant change of the students' performance over time within groups as assessed in the pre-test, post-test and delayed post-test.

This chapter is organized in several sections. First, the summarized results from the study will be presented. Then, significant findings will be examined and discussed followed by concluding thoughts. Then, limitations of the study will be revealed followed by implications for further research.

Research Questions

The following are the research questions used in this study:

a). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' performance on a test of relational vocabulary?

b). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' ability to identify key ideas on a multiple-choice test?

c). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' individual word knowledge as measured by a vocabulary matching test?

d). In association with interactive read-alouds with informational trade books, to what extent do the instructional procedures of teacher questioning or concept mapping facilitate students' clarity of written expression as measured by a holistically scored writing test?

Conclusion

The concept mapping group and the comparison group (questioning group) both produced gains in all assessment measures from the pre-test to the post-tests indicating that both interventions were successful in facilitating learning of the target science concepts. However, the concept mapping group produced significantly higher gains in the following assessments: (a) relational vocabulary assessment (measuring relational knowledge); (b) multiple-choice assessment (measuring students' ability to identify key ideas); and (c) writing assessment (measuring students' relational thinking, students' ability to retain and recall key information and students' ability to use domain knowledge). However, there was no significance found between the concept mapping group and the comparison group's performance on the matching vocabulary assessment (measuring individual word learning). Significant findings from this study are highlighted in the following sections. In addition, there have been several cognitive theories associated with the use of graphic organizers in aiding students' relational knowledge including (a) cognitive load theory, (b) visual argument and (c) conjoint retention theory, which I present below to better understand the possible reasons for the findings (Cooper, 1998; Robinson & Kiewra, 1995; Vekiri, 2002). It is important to note that these theories are not mutually exclusive. I first present the key findings and then discuss each one in reference to relevant theories and previous research.

Relational Knowledge

Relational knowledge is being able to identify relationships between concepts as well as how they are related (DiCecco & Gleason, 2002). Concept mapping helped students increase their relational knowledge as measured by the relational vocabulary assessment. These findings are logical based on the goals of concept mapping. Based on Ausubelian principles and constructivist ideas, Novak designed the concept map as a tool to show students' understanding and meaning of concepts and prepositions in their own cognitive structure (Novak, 1998; Novak & Gowin, 1984; Novak, 2005;). Moreover, concept maps have been shown to be beneficial due to its visuospatial elements. This graphical instructional tool features *cross-links* that highlight relationships or links between concepts in different domains of the concept map, signaling hierarchical relationships (or other types of relationships) that can be immediately perceived by the student (Novak & Canas, 2006). Finally, I present previous research that is relevant to this finding starting with cognitive-load theory.

Cognitive load theory. In comparison to text formats, concept mapping allows learners to perform more semantic processing in visuospatial working memory and avoid overload in their verbal working memory (Chang & Yang, 2010). In association with the cognitive load theory, it suggests that the working memory capacity is limited and stresses that optimum learning occurs when working memory is kept to a minimum

(Chang & Yang, 2010; Amadieu, van Gog, Paas, Tricot & Marine, 2009). Concept mapping helps lessen cognitive load by organizing and grouping concepts, as illustrated by Novak and Canas (2006) in the following example. If a person is given a list of ten to twelve letters or numbers to memorize in seconds, the most that will be recalled is five to nine letters or numbers, but if the letters or numbers can be grouped to form a word-like unit or number-unit, it can be related to something such a phone number, then ten or more letters can be recalled. Accordingly, if students are given ten to twelve familiar but unrelated words to memorize in seconds, most individuals will only be able recall five to nine words and only two to three if they are unfamiliar words. But if the words are familiar and can be related to existing or prior knowledge (i.e., cognitive structure), twelve or more may be recalled. According to Cooper (1998) graphic organizers have been shown to reduce cognitive load by organizing concepts in a cohesive design which then providing space for the working memory to learn new information. In summary, the cognitive load theory explains students' gains in relational vocabulary by the visuospatial elements of the concept map by organizing, grouping and displaying relationships of the science concepts.

Visual argument. A supporting theory similar to cognitive load is the *visual argument theory* (Waller, 1981) which suggests that the "visuospatial" properties of graphical displays such as concept maps are more "computationally efficient" on students' learning because patterns and relationships of concepts are easily perceived without complex cognitive energy (Vekiri, 2002). Robinson and Kiewra (1995) contributed this theory to their study in which graphic organizers helped students learn hierarchical and coordinate relationships increasing their relational knowledge versus studying alone. Rather than limited by the constraints of linear texts and verbal descriptions, concept maps can capitalize on the flexibility of graphical presentations, which can make it faster to find information. In conclusion, the visual argument would predict that concept maps facilitated students learning of relational vocabulary because the visuospatial arrangement of the concept map enables the learner to identify important relationships by the way the concepts are arranged and connected to one another.

Conjoint retention hypothesis. Originally the conjoint retention hypothesis theory (Kulhavy, Lee & Caterino, 1985) was used to interpret learning from geographical maps, but has been recently attributed to the explanation of the *facilitative effects* of graphic organizers (Katayama & Robinson, 2000). This theory states that information contained in a map, or in this case, a semantic map, is encoded in memory in both a spatial and verbal format. In contrast, text is only encoded in a verbal format (Kulhavy, et al., 1985). This theory has much overlap with Dual coding Theory (Paivio, 1990; Paivio & Csapo, 1973) which is discussed in the next section. According to Katayama & Robinson (2000) the maps or graphical representations are encoded in two formats and are linked in which activating one format leads to the activation of the other format. As a result, conjointly retained text information is more opt to be retrieved than text that is encoded only in a verbal format.

As summarized, these cognitive theories support the findings that graphic organizers can help students in increasing their relational knowledge (Katayama & Robinson, 2000; Vekiri, 2002). I now present empirical research, which is based on these theories, with similar and contrasting findings to this study. Schmid and Telaro (1984), examined the use of concept mapping on high school biology students. They found that students who used student-constructed concept maps outperformed students in relational knowledge, than students who received traditional instruction without the use of concept mapping. It is interesting to note, analogous to this current study, students actively constructed the concept maps. Additionally, the researchers suggested that the construction of the map was the most important factor for the positive findings because the use of teacher-constructed graphic organizers mimics rote memorization of concepts (Schmid & Telaro, 1984). According to Nesbit and Adesope (2006) the translation of information from text format to a graphical design, such as a concept map, requires the learner to process meaning or information more deeply than they would by reading text alone. Additionally, Stice and Alvarez (1987) found similar results with elementary students. Specifically they found that the instructional use of concept maps improved students' performance in conceptual relations (relational knowledge) and patterns of science. In contrast, the finding of this study is inconsistent with a study conducted by Griffin, Simmons and Kameenui (1991) in students' use of graphic organizers did not yield significant gains in relational knowledge. One possible explanation for these inconsistent findings is the fact that the experimental and comparison group had very similar instruction but in a different format (Kim, Vaughn, Wanzek & Wei, 2004). The experimental group received informational from a graphic organizer, while the comparison group received the same information in a list format. This leads to inconclusive results and warrants the need for further research since both types of interventions were visual in nature.

As previously mentioned, relational knowledge is the ability to identify relationships as well as explain how they are related. The use of concept mapping has proven by to be a promising instructional tool for increasing relational knowledge, which is key to understanding scientific concepts as evidenced by this current study as well as previous studies (Stice & Alvarez, 1987; Schmid & Telaro, 1984).

Recalling Key Ideas

Another second key finding in this study is that the concept mapping group performed significantly higher than the comparison group in recalling key ideas as measured by the multiple-choice assessment. These findings are logical due to its graphical design elements and are consistent with dual coding theory, which suggests that the use of graphic organizers such as concept maps facilitate in the learning and recall of concepts (Vekiri, 2002; Robinson, 1998). The research behind this theory has been proven to be consistent with the findings of this study. This theory is briefly discussed in the following sections. Next, I will present empirical research which examined similar questions.

Dual coding theory. There are two different types of representations in long-term memory-verbal and nonverbal. This theory suggests that storing information in two codes, verbal and nonverbal (e.g., visual), may aide in increasing memory or recall of that information because it provides two pathways to retrieve it from long-term memory (Paivio, 1983; Paivio & Csapo, 1973; Vekiri, 2002; Sadoski, 2005). Next, this theory also suggests that the visual representation (concept map) can be accessed as a whole rather than as separate pieces, as is the case with verbal representations (Vekiri, 2002).

This theory derived from work by Paivio and Csapo (1973) in which they conducted a series of studies to examine people's memory of visual and verbal information. In these studies, participants were asked to memorize lists of words or sentences as well as pictures depicting concrete concepts and to recall them at a later time. They found that the participants had a better memory for picture than for words (Paivio & Csapo, 1973). In addition, Paivio and colleagues found that the exposure to both words and pictures had *additive effects* on memory (Paivio & Csapo, 1973). For example, participants who were shown both words and pictures remembered more words than participants who only saw words or pictures. This reinforces the notion that pictures or in the case of this study that graphical representations as used in the concept maps can improve memory for verbal information (Vekiri, 2002), thus aiding in students' recall of key information, which is consistent with the findings in this study. As stated, dual coding theory can be applied to concept mapping because the graphical organizers uses visual graphics (shapes) as well as text proving advantageous for memory.

Several studies have previously investigated the effect of graphic organizers on students' recall of key ideas (Anderson & Huang, 1989; Alvermann, 1981; DiCecco & Gleason, 2002). Anderson & Huang (1989) examined the use of concept mapping on eighth-grade students learning science concepts. Students were taught how to use the concept mapping technique and utilized this tool in their learning of science. Researchers determined that concept mapping had a positive impact on learning science concepts.

Alvermann (1981) found similar results when examining the use of graphic organizers on learning from science informational text on tenth grade students. She discovered that students who used graphic organizers with informational text had better recall of key concepts than those who did not use graphic organizers. In addition, Alvermann and Boothby (1983) reported fourth-grade students who used graphic organizers were able to recall significantly more relevant information over social studies content after reading an informational text passage as measured by a written assessment.

In contrast, the findings of this study were inconsistent with a study conducted by DiCecco and Gleason (2002) with a group of middle school students in which they found that graphic organizers failed to increase students' recall of social studies information as measured by content knowledge multiple-choice tests. However, it is important to note that in DiCecco and Gleason's study (2002), the participants who used graphic organizers had scored higher on essays than students who did not use graphic organizers. Essay scores were indirectly based on the recall of information. As a result, students' performance may have been influenced by the type of assessment.

In summary, the use of concept mapping has proven to be an effective tool for helping students' recall of key ideas as proven by this current study as well as previous studies (Alvermann, 1981; Anderson & Huang, 1989). Interestingly, the study conducted by DiCecco and Gleason (2002) had mixed results. Students who used graphic organizers failed to perform significantly higher on the multiple-choice assessments which measured recall of key ideas but did perform significantly higher on a written assessment that also measured key ideas showing inconsistent findings.

Written Expression

Sturm and Rankin-Erickson (2002) stress that writing constitutes a variety of cognitive skills and processes. In this study, the written assessment tested several skills indirectly including the previously discussed measures of relational knowledge and recall of key ideas. However, writing also measured students' ability to apply their newly acquired domain knowledge about soil into a coherent essay. Specifically holistic rubric was scored on these dimensions: a) relational knowledge; and b) identification of key ideas; and c) organization. The concept mapping group performed significantly higher on the written assessment than the comparison group. This finding is consistent with Flower and Hayes (1980) theoretical writing model which states that the materials available in the task environment influence the writer's long-term memory, which as Robinson and Kiewra (1995) point out influences how a writer organizes information. In this study, students who used and studied the concept map from the task environment encoded and stored a more efficient representation in memory, which helped in producing more organized, coherent essays.

One of the most critical processes in writing is the organization of ideas. According to Novak and Gowin (1984), graphic organizers such as concept maps are powerful pedagogical tools because they allow learners to visualize concepts as well as the hierarchical relationships between them. In previous research, DiCecco and Gleason (2002) also found that students who used graphic organizers for learning science also scored higher on written essays. In summary, the use of graphic organizers, such as concepts maps, can be beneficial for students in the area of writing combining their ability to apply newly acquired knowledge as well as express their relational knowledge in a coherent essay. The writing process can be difficult for many students and the use of a concept map, organizing concepts and ideas can be beneficial. This effectiveness of concept maps is evidenced by this current study as well as past studies (DiCecco & Gleason, 2002).

Individual Word Learning

In addition to discussing the significant differences between the groups, it is equally critical to discuss areas in which they did not differ in performance. Specifically, there was not a significant difference between the concept mapping group and the comparison group on individual word learning, as measured by the matching vocabulary assessment.

Of interest, in the analysis of graphic organizer research, few studies have used the matching format as an assessment. This may be due to the fact that the type of learning theoretically promoted by concept maps (relationships) (Novak & Canas, 2006), is not easily captured by such a format. Therefore, there may be other literacy instructional methods that might be more beneficial for individual word learning.

Beck & McKeown (2007) recommends using a “direct and rich instruction” model in teaching individual word learning. Through this model, teachers explain word meanings in student-friendly language and provide multiple examples in multiple contents. They also require students to process the words to be learned deeply by identifying and explaining both appropriate uses and inappropriate uses in multiple contexts (Beck & McKeown, 2007). Consistent with this type of instructional practice is a study conducted by Beck, Perfetti, and McKeown (1982) in which they examined the impact of intense of intense vocabulary intervention on individual word learning with fourth-grade students. Students were assigned to a either a control group or an experimental group. Participants in the control group used traditional language arts instruction following a textbook curriculum. Students in the experimental group received daily vocabulary instruction during their language arts block. The treatment was over a five month period. Participants in the experimental condition had the following treatment: introduction of 8-10 words a week, practice of words in a variety of instructional practices, and assessment to determine mastery. These instructional practices included the following: defining tasks (writing definitions), sentence-generating tasks, classification tasks (categorizing the words), oral and written production tasks and timed game-like activities. In summary, students in the experimental group received 2.5 hours of instruction weekly on the 8-10 targeted words which included 10 encounters with each word. A total of 104 target words were chosen over the intervention period and were chosen from the *Ginn Reading 720* series. They found that students who participated in the vocabulary intervention program had higher gains from the pre-test to post-test time-points in vocabulary knowledge as measured by the Iowa Test of Basic Skills-Vocabulary subtest.

Individual word knowledge is essential to learning science concepts (Rupley & Slough, 2011). Many students have difficulty with this domain due to limited background knowledge (DeLuca, 2010) as well as the complex nature of the content-specific words (Rupley & Slough, 2011). According to Graves (2000) there are four essential components to teaching individual word learning: a) wide independent reading; b) instruction in specific words to increase comprehension of texts containing these words; c) instruction in independent word-learning strategies; and d) word-play activities to motivate and enhance learning. In accordance with these teaching components, there have been several word learning strategies that have been shown to help students including: Frayer Model (Stahl & Nagy, 2009); using concept word walls with pictures (Harvey & Goudvis, 2007); and collaborative strategic reading (Shook, Hazelkorn, & Lozano, 2011; Vaughn, Klingner, & Bryant, 2001). These will be examined in the following sections starting with the Frayer model.

Frayer model. Very similar to the individual word learning map is the Frayer model also referred to a four-square vocabulary learning map (Stahl & Nagy, 2009; Greenwood, 2002). In this strategy, a box is divided into four sections. In the first section, the student lists the word to be learned. In the next, section, the student lists examples of the word. Then, in the section below the word, the student provides a definition of the word. In the last section, the student provides non-examples of the word. Figure 9 is an example of a completed Frayer model.

Definition:	**Characteristics:**
Mammals can live on land, in the sea, or under the ground. They have important traits that are different than other animals.	They have hair They can regulate temperature They are warm-blooded Most walk with 2 -4 legs
Mammals	
Examples: humans whales cheetahs bears	**Non-Examples:** frogs birds snakes

Figure 9. Frayer Model.

Concept word wall with pictures. In this instructional practice, the student writes the word to be learned on a card, its definition in his or her own words and draws an illustration of the word. Then the word is placed on a "word wall" along with other words that the students have learned throughout the year. According to Harvey & Goudvis (2007) when students illustrate and write in their own words, they are more likely to remember the information. In addition, the use of word walls can be adapted to even secondary students (Vallejo, 2006; Yates, Cuthrell & Rose, 2011). In a study conducted by Yates et al. (2011), they found that the use of science word walls displaying science concepts in which they were studying helped increase eighth grade students' performance on science achievement tests.

Collaborative learning strategy. In this method, there are four strategies in learning word knowledge with text (Shook, et al., 2011; Vaughn, Klinger & Bryant, 2001). First, the students preview, by discussing and brainstorming what they know about a certain concept as well as predict what they think will learn. Next, the students use the strategy of “click and clunk”. By using the “click” strategy, students refer to portions of text that make sense to them. In the “clunk” strategy, students refer to portions that do make sense. Next, they use the “get the gist” strategy by summarizing the important concepts. The last step is called “wrap and review” in which students review what they have learned. In a study conducted by Shook et al. (2011), they investigated the impact of the learning collaborative strategy on high school biology students in learning science concepts. The intervention lasted a period over eight weeks for two-thirty minute sessions a week. The found that the students’ vocabulary knowledge increased as measured by multiple-choice quizzes taken at the end of the week. They also found that the students enjoyed using this strategy in learning science concepts.

In conclusion, the use of concept mapping is not conducive to teaching individual word learning. As discussed concept mapping helps students in other areas of learning science concepts such as relational knowledge and identifying key ideas, but they may benefit from instructional activities that are direct and rich (Beck & McKeown, 2007) as mentioned to help them in individual word learning.

Another possible reason for the performance of the concept mapping group on the matching assessment is that the format of the assessment may have been unfamiliar to students and was not a valid measure. Due to the format of the state tests of this school district, students frequently practice using multiple-choice and writing assessment formats. They are rarely given matching assessments. However, both groups (concept mapping and comparison) would have been at an equal disadvantage.

In conclusion, based on this study and previous research, concept maps do not appear to promote individual word learning. But as stated earlier, teachers can incorporate other activities including intensive vocabulary instructional practices that are rich and direct, such as using the Frayer model, and utilizing word walls to help students increase their individual word knowledge. In addition, students may benefit from being assessed in a variety of formats including matching versus instead of being solely assessed using multiple-choice and writing formats.

Delayed-Recall of Information

Finally, an important feature in this experimental design was through the use of immediate and delayed post-testing. The results indicate that the concept mapping group's gains in relational vocabulary, identifying key ideas and written expression were maintained in the delayed testing, indicating that concept mapping facilitates learning as well as retaining the information. According to Robinson (1988), one of the limitations in past research on graphic organizers is the limited use of assessing students in a delayed measurement. However, to measure long term learning, delayed measures are more important than immediate recall.

As expected, all groups performed lower in the delayed post-test than the immediate post-tests. However, the amount of loss differed between the concept mapping group and comparison group. In all of the four assessments, the comparison group (questioning group) had a greater point decrease in the mean average between the time-points of the post-test and the delayed post-test.

In the relational vocabulary assessment, the mean of the comparison group decreased by 5.52 points, while the concept mapping group only decreased by 4.83 points. The differences were significant for both groups between the post-test time-point and the delayed post-test time-points, but the concept mapping group had a lower decrease of the mean than the comparison group. This indicates that participants in the concept mapping group were better able to sustain their gains in relational knowledge.

In the multiple-choice assessment, the mean of the comparison group decreased by 7.93 points, while the concept mapping group only decreased by 3.79 points. The differences were significant between the post-test and delayed test time-point for both groups but the concept mapping had a lower decrease of the mean. This indicates that the concept mapping group had better recall of identifying key ideas than the comparison group.

For the matching assessment, the mean of the comparison group decreased by 6.21 points, while the concept mapping group only decreased by 3.01 points. The difference between the post-test and delayed post-test time points was significant for the comparison group but there was not significant for the concept mapping group. This indicates that the concept mapping group had better recall of individual word learning than the comparison group. This finding is interesting because as shared earlier there was not a significant difference between the concept mapping group and comparison group in the post-test and delayed post-test.

For the writing assessment, the comparison group decreased by 8.62 points, while the concept mapping group only decreased by 2.59 points. There was a significant difference between the post-test and delayed test time-points for the comparison group but not for the concept mapping group. Again, this indicates that the participants in the concept mapping group were able to sustain their ability to apply relational thinking, identify key information and use domain knowledge through writing than the comparison group.

The significant difference between groups in a delayed-measure is similar to the results of Simmons, Griffin and Kameenui (1988) in which their participants using a post-reading graphic organizer for social studies outperformed students receiving traditional instruction in a delayed post-test assessment. However, in contrast, the study's results is in contradiction to a study conducted by Griffin, Malone and Kameenui (1995) in which participants in the comparison groups who received traditional basal instruction scored significantly higher than participants using graphic organizers. However, according to Griffin, Malone and Kameenui, the delayed results findings are "suspect" due to the fact that participants in the comparison groups scored higher on the delayed post-test than they did in the immediate post-test.

In summary, in all of the four assessments, the participants in the concept mapping group had a greater recall of relational knowledge, identifying key ideas, individual word knowledge as well as in written expression which was a combination of key ideas and relational knowledge. This indicates that the use of concept mapping can help students in retention of learning science concepts.

Concluding Thoughts

In conclusion, concept mapping can be beneficial in helping students increase relational knowledge as evidenced by the significant difference between the concept mapping group and comparison group. Relational knowledge is essential to science learning because it is imperative for students to be able to identify relationships and understand their connection (Pearson, Moje & Greenleaf, 2010). In addition, concept mapping can be beneficial in helping students identify key ideas in science as evidenced by the significant difference between the concept mapping and the comparison group. This is an important skill for students to truly grasp scientific concepts and understand science phenomena (Shanahan & Shanahan, 2008; Pearson, et al., 2010). Lastly, concept mapping can be advantageous in writing combining the skills of relational knowledge and the identification of key ideas (DiCecco & Gleason, 2002). Writing can be a difficult process for many students and the visuospatioal elements of graphic organizers especially its organizational structure can aide students in the identification and understanding of relationships of science concepts. In addition, concept mapping can help students sustain their relational knowledge, ability to identify key ideas and their ability in written expression, as well as individual word knowledge. The findings from this study can be promising for educators because advanced science skills are imperative for our students to be productive members of society (Shanahan & Shanahan, 2008; Pearson, et al., 2010). Next, we will examine the limitations for this study.

Limitations

The study had several limitations that might have affected the study or the statistical outcome of the data.

1. Length of the study. A longer treatment period would provide students with more opportunities to further develop their skills associated with the use of concept mapping with additional topics and concepts in science. The length of the study (8 days) was based on the instructional time period allotted for the concept of "soil formation" according to the district's scope and sequence. These longer and more diverse conditions would increase the generalizability of the results of the current study. It would also be interesting to see if the levels of differences between the concept mapping group and the comparison group would increase, decrease or sustain.
2. Time period between post-test and delayed post-test. Due to constraints of the school calendar, there was only five days between the post-test and delayed post-test. It would have been ideal if there was a longer period between the post-test and delayed post-test.
3. Number of students. Due to the size of the school, only 58 students were available to participate. In addition, due to the class sizes, the groups of students were small. The average classroom size is larger than the classroom sizes used in this study.

Implications for Teaching & Research

While moderate in scale, the results of this study indicated that concept mapping may be an effective strategy to implement when students are studying from multiple sources. The use of concept mapping did not take more time than answering comprehension questions, but was more effective on three of four assessments, in both immediate and delayed post-testing. Using concepts maps with a set of related texts, facilitated students to make connections across texts and focusing on the underlying science concepts. Additionally, the discourse and interaction between students when creating the concept maps may have been a rich source of learning. It is also interesting to note that the concept mapping group had an advantage on the relational vocabulary, but not on the matching vocabulary assessment. This finding indicates that concept mapping may be suited to promote certain types of knowledge. Finally, while technology was not used this study, multiple software programs (e.g., *Inspiration*) would allow students to authentically incorporate technology into similar lessons with concept mapping.

Future Directions

This study lends itself to being replicated in different conditions including: students with learning disabilities; students who are second-language learners; and integrating the use of technology. Little or no research has used interactive informational read-alouds with concept mapping in these conditions.

Students with learning disabilities. Informational text can be difficult for students with learning disabilities to make inferences, to make connections, to identify key ideas as well as to determine relationships between concepts (DiCecco & Gleason, 2002). There has been an increase in research examining the use of graphic organizers with informational text on students with learning disabilities (DiCecco & Gleason; Horton, Lovitt & Bergerund, 1990). But the research has provided inconsistent results. DiCecco and Gleason (2002) reported in their study examining the use of graphic organizers on informational text with middle-school students and found mixed results. There was not a significant difference between the graphic organizer group and the comparison group who were taught using traditional instruction on factual knowledge as measured by a multiple-choice tests and quizzes. In contrast, the graphic organizer scored significantly higher on relational knowledge as measured by written essays. Horton, Lovitt and Bergerund (1990) reported in their study with secondary students in content area classes (science and social studies) that students who used graphic organizers in reading informational text passages had higher recall on key ideas than the students in the comparison group who did not use a graphic organizer. In addition, little or no research has examined the effect of graphic organizers on elementary students.

Second-language students. Another possible replication of this study could be with second-language learners. The findings in this study helped students in relational knowledge and recalling key ideas could be beneficial to second-language learners in learning concepts. Ritchie and Gimendez (1996) conducted a study with fourth-grade students who were second-language learners whose prominent language was Spanish. One group created a computer-generated graphic organizer and one group created embedded list of topics. The group using graphic organizers performed significantly higher than the comparison group in short-term recall (post-test) and the long-term recall (delayed post-test) and found that the use of graphic organizers helped students in learning and recalling concepts.

Integrating technology. Finally, another possible replication for this study would to integrate computer-generated graphic organizers using *Inspiration*. In this possible study, students would create their own graphic organizers using computer software (*Inspiration*). We live in a society in which technology is becoming increasingly important and students could benefit with the incorporation of multimedia learning. In addition, with the increase of technology, there has been a heightened interest on the effect of computer-based/multimedia learning including on cognitive load (Mayer & Moreno, 2002; Chang & Yang, 2010). According to the cognitive theory of multimedia learning (Mayer & Moreno, 2002) the instructional design can impact cognitive load. Under this theory, it is more advantageous to present multimedia messages through words and pictures (graphics) than solely with words. But this theory has been tested with mixed results with younger learners (McTigue, 2009; Chang & Yang, 2010) warranting the need for further research and careful design.

Another incorporating of technology could be the integration of interactive white-boards also referred to as *Interactive Smart Boards*. Little or no research has combined the use of concept mapping, interactive informational read-alouds, and using *Interactive Smart Boards*. As evidenced from this study, concept mapping coupled with interactive informational read-alouds has a positive impact on learning science concepts. It has also been shown that the use of *Interactive Smart Boards* can help students in learning science in past studies (Hogan & Gomm, 2001; Preston & Mowbray, 2008). The combining of these instructional practices can have promising results for the education world in science instruction.

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APPENDIX A

PARENT INFORMATION AND CONSENT LETTERS

November 19, 2010

Dear Parents and/or Guardians

As you know, reading is vital to learning as well as a vital component to your child's future. As a researcher, at Texas A & M University, it is my goal to investigate instructional procedures that can increase student achievement. As a former teacher at Fields Elementary, I want to discover ways to help our students. They are indeed our future scientists, teachers, engineers, nurses, entrepreneurs and the list continues. As an educator and researcher, it is my role to ensure they are prepared. From November 30^{th} to December 9^{th}, I will be conducting an intervention study that involves information read-alouds. Your child has been chosen to participate in this study. The intervention study will have eight days of instructional lessons consisting of 45 minutes that will include an interactive read-aloud and participating in a question and writing activity. There will also be several assessments measuring your child's learning. The material that will be taught aligns with the districts scope and sequence. In the next week, you will receive a letter of permission for your child to participate. This study has potential benefits including increasing reading achievement. Please do not hesitate to contact me if you have any questions or concerns.

Please bring back the permission slip by Tuesday, November 23rd.

Working to improve education,

Jaime Berry Email: jlberry@tamu.edu Phone number: 281 701-7336

November 19, 2010

Dear Parents and/or Guardians

As you know, reading is vital to learning as well as a vital component to your child's future. As a researcher, at Texas A & M University, it is my goal to investigate instructional procedures that can increase student achievement. As a former teacher at Fields Elementary, I want to discover ways to help our students. They are indeed our future scientists, teachers, engineers, nurses, entrepreneurs and the list continues. As an educator and researcher, it is my role to ensure they are prepared. From November 30th to December 9th, I will be conducting an intervention study that involves using graphic organizers (concept mapping) with information read-alouds. Your child has been chosen to participate in this study. The intervention study will have eight days of instructional lessons consisting of 45 minutes that will include an interactive read-aloud and participating in a graphic organizer activity. There will also be several assessments measuring your child's learning. A survey will also be administered to assess your child's attitude/likeness toward using graphic organizers in their learning. The material that will be taught aligns with the districts scope and sequence. In the next week, you will receive a letter of permission for your child to participate. This study has potential benefits including increasing reading achievement. Please do not hesitate to contact me if you have any questions or concerns.

Please bring back the permission slip by Tuesday, November 23rd.

Working to improve education,

Jaime Berry, Email: jlberry@tamu.edu Phone number: 281 701-7336

PARENT PERMISSION FORM FOR STUDENTS IN QUESTIONING GROUP
How does the use of questioning and concept mapping affect students' learning of science concepts?

Introduction
The purpose of this form is to provide you (as the parent of a prospective research study participant) information that may affect your decision as to whether or not to let your child participate in this research study. Also, if you decide to let your child be involved in this study, this form will be used to record your consent.

If you agree, your child will be asked to participate in a research study using graphic organizers. The purpose of this study is to determine how students with different reading abilities respond to graphic organizers. He/she was selected to be a possible participant because he/she is a third grade student at Fields Elementary.

What will my child be asked to do?

If you allow your child to participate in this study, they will be asked to do the following:

- On November 30th, he/she will participate in a brief pretest over the material that will be taught. This will be to test what he/she knows about the topic.

- On November 30th-December 9th, your child will participate in an informational interactive read-aloud using research based questioning techniques. (Teacher will ask students' questions to strengthen comprehension and understanding)

- Then on December 10th, your child will be assessed using a brief test that will be very similar to the pretest.

- On December 15th, your child will be assessed to determine if they retained the information taught.

Participation may be video recorded.

What are the risks involved in this study?
The risks associated in this study are minimal, and are not greater than risks your child ordinarily encountered in daily life.
What are the possible benefits of this study?
The purpose of this study is to determine what tools can improve reading comprehension. The possible benefits can improve your child's reading.
Does my child have to participate?
No, your child doesn't have to be in this research study. You can agree to allow your child to be in the study now and change your mind later without any penalty.

This research study will take place during regular classroom activities; however, if you do not want your child to participate, an alternate activity will be available. Your child will participate in a research activity on the same topic.

What if my child does not want to participate?
In addition to your permission, your child must agree to participate in the study. If you child does not want to participate they will not be included in the study and there will be no penalty. If your child initially agrees to be in the study he/she can change their mind later without any penalty.

Who will know about my child's participation in this research study?
This study is confidential.
The records of this study will be kept private. No identifiers linking you or your child to this study will be included in any sort of report that might be published. Research records will be stored securely and only I, Jaime Berry will have access to the records.

If you choose to allow your child to participate in this study, they will be video recorded. Any recordings will be stored securely and only I, Jaime Berry will have access to the recordings. Any recordings will be kept for one week and then erased.

Whom do I contact with questions about the research?
If you have questions regarding this study, you may contact:
Jaime Berry, jlberry@tamu.edu; 281 701 7336

Whom do I contact about my child's rights as a research participant?
This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979)458-4067 or irb@tamu.edu.

Signature
Please be sure you have read the above information, asked questions and received answers to your satisfaction. You will be given a copy of the consent form for your records. By signing this document, you consent to allow your child to participate in this study.

______ My child MAY be video recorded.
______ My child MAY NOT be video recorded.

Signature of Parent/Guardian: ___________________________ Date: _______________

Printed Name
____

Printed Name of Child:
____

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If you choose to allow your child to participate in this study, they will be video recorded. Any recordings will be stored securely and only I, Jaime Berry will have access to the recordings. Any recordings will be kept for one week and then erased.
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Signature
Please be sure you have read the above information, asked questions and received answers to your satisfaction. You will be given a copy of the consent form for your records. By signing this document, you consent to allow your child to participate in this study.

______ My child MAY be video recorded.
______ My child MAY NOT be video recorded.

Signature of Parent/Guardian: ______________________________**Date:** ____________
Printed Name:
____

Printed Name of Child:
____

APPENDIX B

ASSESSMENTS

Relational Vocabulary/Categorization

<u>**Directions:**</u>
The teacher will read aloud the following test to the students one on one.

"Hi. I am going to state three words. I need you to tell me how they relate. For example, in the words "ocean, lake, river". How are they the same?"

If students answer "they are all types of water", go on to question number one.

If student is incorrect, use another example.
In the first example, ocean, lake and river are all types of water, or bodies of water. Let's try another example. "hat, baseball cap, helmet". (Student typical response should be "you wear on your head").

Questions:
1. subsoil, parent material, topsoil (types of soil)
2. slugs, worms, snails (types of decomposers)
3. clay, silt, sand (types of soil)
4. wind, water, ice (types of erosion or types of weather that change the Earth surface)
5. Grand Canyon, Mammoth Cave, Arches National Park (Examples of erosion)
6. fungi, bacteria, protozoa (organisms in the soil that help decompose)
7. twigs, dead leaves, plant remains (types of organic matter)
8. planting trees, decreasing cutting down trees and plants, recycling paper to reduce need for wood.(ways to help environment; ways to help soil formation)
9. sunlight, water, air (things plants need to grow)
10. tropical, desert, artic (Types of soils/climates)

Matching Vocabulary

Teacher Directions: ***On the first column, there is a list of words. Use the second column to find its definition. Let's do some sample problems together. What is the definition of "Prediction/Hypothesis?". Use the second column and write the letter that corresponds by number one. The correct answer is "B". A Prediction/Hypothesis is "Use what you know to tell what you think will happen". Let's try number two. What is the definition of "Matter"? The correct answer is "A". Matter is anything that has mass and takes up space. The last sample question is "Magnets". Write the letter of the definition for magnets. The correct answer is "C". Magnets are any piece of iron or steel that can attract iron or steel.***

Sample Problems

1._______Prediction/Hypothesis	A. Anything that has mass and takes up space
2._______Matter	B. Use what you know to tell what you think will happen
3._______Magnets	C. Any piece of iron or steel that can attract iron or steel.

In the box below you will see ten terms. Match the definition to the words. Write the letter of the definition that matches the terms on the left. You will have 15 minutes to complete this. It is okay if you do not know all your answers. Please try your best.

1. ____Soil	A. Mass of small particles carried along by flowing water. (sediments)
	B. Changes in Earth's surface; Soil carried away by water, ice, or wind (erosion)
2.____Organic Matter	C. Rocks or stones broken down by wind, rain and ice. (weathering)
	D. Collected sediment being dropped or dumped (decomposition).
3.____ Erosion	E. Remains of organisms (organic matter).
4.____Nutrients	F. Useful chemicals in rocks (minerals)
	G. Group Together
5.____ Decompose	H. Material that plants and animals need to grow (nutrients)
6.____Weathering	I. Thin layer of material on Earth's surface in which plants have their roots; made of many things including weathered rock and dead plants. (soil)
7.____Sediments	J. Creatures that break down organic material and eat them (decomposers)
8.____Minerals	K. To mix organic materials together (compost)
9.____Decomposers	L. Central layer of Earth (extra)
	M. name for magma when it reaches the Earth (extra)
10.____Compost	

Multiple Choice Test

<u>Multiple Choice Directions:</u> Read each statement. Circle the best answer choice.

1. The continuous breaking down of rocks would lead to the formation of what natural resource?
A. water
B. minerals
C. coal
D. soil

2. The breaking down of rock, a process that helps form soil, is called-
A. growth
B. sedimentation
C. flow
D. weathering

3. In addition to rock, what are the main components of soil?
A. bacteria and microbes
B. plant and animal remains
C. mushrooms and other fungi
D. worms and Insects

4. How would the soil be different in an area that gets very little rainfall? The soil would contain-
A. a greater variety of plants
B. fewer bits of broken rock
C. many insects and worms
D. less water and organic matter

5. What could be done to the rock above to turn it into the beginning states of soil?

A. flip it upside down
B. put it in a dark closet
C. hit it with a hammer
D. place it on a table

6. Weathering is important because it-
A. wears away rock to form soil
B. gives water to the plants we eat
C. blows seeds across for distances
D. cools and heats the land

7. Which of these is NOT weathering?
A. light
B. wind
C. water
D. earthquakes

8. Rocks are important because they-
A. break down soil
B. contain minerals
C. are made of plants
D. are Earth's most important resources

9. Humus can best be described as-
A. weathered rocks
B. loam & minerals
C. decayed plants and animals
D. clay and particles of sand

10. Why is weathering important to plants and animals
A. It contains food that plants and animals need to live.
B. It creates water that plants and animals need to grow.
C. It breaks down rocks into soil that contain minerals they need.
D. It protects smaller plants and animals from floods and earthquakes.

Writing Prompt

<u>Direction</u>: Respond in writing to the following questions:

a). If you were able to play in a large pile of dirt, or soil, what kind would you like best?

b). Write about why you can do certain things with sandy soil

Formation of Soil Formation
Writing Rubric

Key Concepts:

- **Soils are made up of small pieces of weathered rock.**
- **Soil contains many substances including decomposed plant and animal remains.**
- **The material in soil (soil type) are different in different areas.**
- **Soils have different characteristics.**
- **Soils have different purposes.**

Mastered Level	Progression Level	Developing Level	Introductory Level
Covered ALL key concepts in the writing essay (4)	Covered 75% of the key concepts in the writing essay (3)	Covered 50% of the key concepts in the writing essay (2)	Covered less than 50% of the writing essay (1)

*Adapted from Fourth Grade Science TAKS Scoring Guide

APPENDIX C

CHECKLIST FOR OBSERVATIONS AND VIDEOTAPE

Checklist for Fidelity to be used with Videotaping

Date:_________ Class________

1. Did the teacher introduce the new concept for the day's lesson?	Y	N
2. Were vocabulary terms introduced?	Y	N
3. Did the teacher introduce the book?	Y	N
4. Did the teacher point to the title of book?	Y	N
5. Did the teacher point to the table of contents?	Y	N
6. Did the teacher ask the students to predict what the text would be about?	Y	N
7. Did the teacher call on at least 2 students to share their prediction?	Y	N
8. Did the teacher stop at a specific page and ask 2 questions?	Y	N
9. Did the teacher call on at least one student for each question?	Y	N
10. Did the read the book in its entirety?	Y	N
11. Did the teacher ask at least 2 questions after reading the book?	Y	N
12. Did the teacher call on at least one person for each question?	Y	N
13. Did the teacher tell the students about the next day's lesson?	Y	N

Additional Notes

____

APPENDIX D

TABLE OF PROCEDURES FOR DAY 2-8

Day 2	**Experimental Group**	**Comparison Group**
Pre-Reading	Lesson /Concept Introduction: **Soil Formation** **Concept Mapping** Students will write terms on index cards associated with “soil formation” . The cards will be placed on the front board next to the word “soil formation”. Lines will connect terms using “connecting words” to show the relationships between the words and the concept of “soil formation”.	Lesson/Concept Introduction: **Soil Formation** **Comprehension Questioning with Writing** Students will write on an individual piece of paper for 3 minutes over the topic of soil formation. The written responses will be collected by the teacher for data collection purposes.
Vocabulary Introduction	Teacher introduces vocabulary selected from text that will be used in interactive informational read-aloud **Terms:** Earthworms, vitamins, shelter, predator, protect, root, isopod	
Interactive Informational Read Aloud: ***Without Soil***	**Prediction:** Teacher will show the cover, title, table of contents using the Elmo document camera. Students will have an opportunity to share what they think the book will be about. **Reading of Text:** Teacher will read pg 4 to 11. **During Reading Questions:** The teacher will ask the following questions: 1. What/Who depends on soil? 2. How is soil a habitat? Students will raise their hand to respond and teacher will call on students. **After-Reading Questions** 1. How do we protect soil? 2. How do animals help make soil? Students will raise their hand to respond and teacher will call on students.	

Post-Reading Activities	**<u>Concept Mapping</u>** Student will have an opportunity to add to the class concept map. The teacher will take a picture of the class constructed concept map for data collection purposes. Students will be given a pre-generated concept map that is 90% completed. Students will use the word bank located under the graphic section of the concept map.	**<u>Quick Write</u>** The teacher will ask the following question taken from the text used in the informational interactive read aloud: ***" How would life be like without soil?"*** The students will spend 5 minutes writing on answering this question independently on their piece of paper. Writing will be collected for data collection purposes.
Day 3	**<u>Experimental Group</u>**	**<u>Comparison</u>**
Pre-Reading	Lesson /Lesson Introduction: **Dirt** **<u>Concept Mapping</u>** Students will write terms on index cards associated with "dirt" . The cards will be placed on the front board next to the word "dirt". Lines will connect terms using "connecting words" to show the relationships between the words and the	Lesson/Concept Introduction: **Dirt** **<u>Comprehension Questioning with Writing</u>** Students will write on an individual piece of paper for 3 minutes over the topic of dirt. The written responses will be collected by the teacher for data collection purposes.

	concept of "dirt".	
Vocabulary Introduction	Teacher introduces vocabulary selected from text that will be used in interactive informational read-aloud **<u>Terms:</u>** dirt, humus, silt, clay, decomposers	
Interactive Informational Read Aloud: Dirt	**<u>Prediction:</u>** Teacher will show the cover, title, table of contents using the Elmo document camera. Students will have an opportunity to share what they think the book will be about. **<u>Reading of Text:</u>** Teacher will read pg 4 to 11. **<u>During Reading Questions:</u>** The teacher will ask the following questions: 1. How is dirt and soil the same? 2. How are the layers of sand different? Students will raise their hand to respond and teacher will call on students. **<u>After-Reading Questions</u>** 1. What is humus and why is it important? 2. How can animals make soil better for plants? Students will raise their hand to respond and teacher will call on students.	
Post-Reading Activities	**<u>Concept Mapping</u>** Student will have an opportunity to add to the class concept map. The teacher will take a picture of the class constructed concept map for data collection purposes. Students will be given a pre-generated concept map that is 75% completed. Students will use the word blank that is located on the concept mapping sheet to complete the concept map.	**<u>Comprehension Questioning with Writing</u>** The teacher will ask the following question taken from the text used in the informational interactive read aloud: ***"Why is sand best for making sand castles?"*** The students will spend 5 minutes writing on answering this question independently on their piece of paper. The writing will be collected for data collection purposes.

Day 4	**Experimental Group**	**Comparison Group**
Pre-Reading	Lesson/Concept Introduction: **Erosion** **Concept Mapping** Students will write terms on index cards associated with "erosion". The cards will be placed on the front board next to the word "erosion". Lines will connect terms using "connecting words" to show the relationships between the words and the concept of "erosion".	Lesson/Concept Introduction: **Erosion** **Comprehension Questioning with Writing** Students will write on an individual piece of paper for 3 minutes over the topic of erosion. The written responses will be collected by the teacher for data collection purposes.
Vocabulary Introduction	Teacher introduces vocabulary selected from text that will be used in interactive informational read-aloud **Terms:** Erosion, weathering, sediments, global warming	
Interactive Informational Read Aloud: ***Without Soil***	**Prediction:** Teacher will show the cover, title, table of contents using the Elmo document camera. Students will have an opportunity to share what they think the book will be about. **Reading of Text:** Teacher will read pg 4 to 15. **During Reading Questions:** The teacher will ask the following questions: 1. What is erosion? 2. How does erosion affect the Earth? Students will raise their hand to respond and teacher will call on students. **After-Reading Questions** 1. How can we prevent erosion? 2. What are the types of erosion? Students will raise their hand to respond and teacher will call on students.	
Post-Reading Activities	**Concept Mapping**	**Comprehension**

	Student will have an opportunity to add to the class concept map. The teacher will take a picture of the class constructed concept map for data collection purposes. Students will be given a pre-generated concept map that is 75% completed. Students will complete the concept using the words from the word bank that is located on the concept mapping sheet.	**<u>Questioning with Writing</u>** The teacher will ask the following question taken from the text used in the informational interactive read aloud: ***"How has erosion affected the Earth?"*** The students will spend 5 minutes writing on answering this question independently on their piece of paper. The paper will be collected for data collection purposes.
Day 5	**<u>Experimental Group</u>**	**<u>Comparison Group</u>**
Pre-Reading	Lesson/Concept Introduction: **Types of Erosion** **<u>Concept Mapping</u>** Students will write terms on index cards associated with "types of erosion". The cards will be placed on the front board next to the words "types of erosion". Lines will connect terms using "connecting words" to show the relationships between the words and the concept of "types of erosion".	Lesson /Concept Introduction: **Types of Erosion** **<u>Comprehension Questioning with Writing</u>** Students will write on an individual piece of paper for 3 minutes over the topic of types of erosion. Students' responses will be collected by the teacher for data collection purposes.
Vocabulary Introduction	Teacher introduces vocabulary selected from text that will be used in interactive informational read-aloud **<u>Terms:</u>** Wind erosion, ice erosion, soil erosion, conservation,	

	hurricanes	
Interactive Informational Read Aloud: Erosion	**<u>Prediction:</u>** Teacher will show the cover, title, table of contents using the Elmo document camera. Students will have an opportunity to share what they think the book will be about. **<u>Reading of Text:</u>** Teacher will read pg 4 to 13. **<u>During Reading Questions:</u>** The teacher will ask the following questions: 1. How do waves cause erosion? 2. How was the Grand Canyon formed? Students will raise their hand to respond and teacher will call on students. **<u>After-Reading Questions</u>** 1. How do hurricanes cause erosion? 2. What is conservation? Students will raise their hand to respond and teacher will call on students.	
Post-Reading Activities	**<u>Concept Mapping</u>** Students will be given an opportunity to compare this map to the class map. Student will have an opportunity to add to the class concept map. The teacher will take a picture of the class constructed concept map for data collection purposes.	**<u>Comprehension Questions with Writing</u>** The teacher will ask the following question taken from the text used in the informational interactive read aloud: "***How does conservation help Earth?"*** ***"What ways can you conserve?"*** The students will spend 5 minutes writing on answering these two questions independently on their piece of paper. The paper will collected for data collection purposes.
Day 6	**<u>Experimental Group</u>**	**<u>Comparison Group</u>**
Pre-Reading	Lesson /Concept Introduction: **Minerals** **<u>Concept Mapping</u>**	Lesson/Concept Introduction: **Minerals** **<u>Comprehension</u>**

	Students will write terms on index cards associated with "minerals". The cards will be placed on the front board next to the word "minerals". Lines will connect terms using "connecting words" to show the relationships between the words and the concept of "minerals".	**Questioning with Writing** Students will write on an individual piece of paper for 3 minutes over the topic of minerals. Students' responses will be collected by the teacher for data collection purposes.
Vocabulary Introduction	Teacher introduces vocabulary selected from text that will be used in interactive informational read-aloud **Terms:** Minerals, element, atom, crystal, properties	
Interactive Informational Read Aloud: Minerals	**Prediction:** Teacher will show the cover, title, table of contents using the Elmo document camera. Students will have an opportunity to share what they think the book will be about. **Reading of Text:** Teacher will read pg 4 to 15. **During Reading Questions**: The teacher will ask the following questions: 1. How are minerals formed? 2. How are they grouped? Students will raise their hand to respond and teacher will call on students. **After-Reading Questions** 1. Why are minerals important? 2. How are minerals different from each other? Students will raise their hand to respond and teacher will call on students.	
Post-Reading Activities	**Concept Mapping** Student will have an opportunity to add to the class concept map. The teacher will take a picture of the class constructed concept map for data collection	**Quick Writes** The teacher will ask the following question taken from the text used in the informational interactive read aloud: ***-"Why are minerals different?"***

	purposes. Students will be given a pre-generated concept map that is 50% completed. Students will complete the concept map using the words from the word bank that is located on the concept mapping sheet.	***-"Explain how minerals are formed?"*** The students will spend 5 minutes writing on answering this question independently on their piece of paper. The paper will be collected for data collection purposes.
Day 7	**Experimental Group**	**Comparison Group**
Pre-Reading	Lesson/Concept Introduction: **Earthworms** **Concept Mapping** Students will write terms on index cards associated with "earthworms". The cards will be placed on the front board next to the word "earthworms". Lines will connect terms using "connecting words" to show the relationships between the words and the concept of "earthworms".	Lesson/Concept Introduction: **Earthworms** **Comprehension Questioning with Writing** Students will write on an individual piece of paper for 3 minutes over the topic of earthworms. Students' responses will be collected by the teacher for data collection purposes.
Vocabulary Introduction	Teacher introduces vocabulary selected from text that will be used in interactive informational read-aloud **Terms:** Cocoon, burrows, castings	
Interactive Informational Read Aloud: Wiggling Worms	**Prediction:** Teacher will show the cover, and title, using an Elmo document camera. Students will have an opportunity to share what they think the book will be about. **Reading of Text:** Teacher will read pg 4 to 13. **During Reading Questions**: The teacher will ask the following questions: 1. Why do farmers plow their field? 2. How do earthworms tunnel through sand?	

	Students will raise their hand to respond and teacher will call on students. **<u>After-Reading Questions</u>** 1. How do we worms help new plants grow? 2. Why do worms cover dead plants? Students will raise their hand to respond and teacher will call on students.	
Post-Reading Activities	**<u>Concept Mapping</u>** Student will have an opportunity to add to the class concept map. The teacher will take a picture of the class constructed concept map for data collection purposes. Students will be given a pre-generated concept map that is 25 % completed. Students will complete the concept map using words from the word bank that is located on the concept mapping sheet.	**<u>Comprehension Questions with Writing</u>** The teacher will ask the following question taken from the text used in the informational interactive read aloud: ***-"Why are worms beneficial to helping things grow?"*** ***-"What is its role?"*** The students will spend 5 minutes writing on answering this question independently on their piece of paper. The paper will collected for data collection purposes.
Day 8	**<u>Experimental Group</u>**	**<u>Comparison Group</u>**
Pre-Reading	Lesson/Concept Introduction: **Composting** **<u>Concept Mapping</u>** Students will write terms on index cards associated with "composting" . The cards will be placed on the front board next to the word "composting". Lines will connect terms using "connecting words" to show the relationships between the words and the	Lesson/Concept Introduction: **Composting** **<u>Comprehension Questioning with Writing</u>** Students will write on an individual piece of paper for 3 minutes over the topic of composting. The written responses will be collected by the teacher for data collection purposes.

	concept of "composting".	
Vocabulary Introduction	Teacher introduces vocabulary selected from text that will be used in interactive informational read-aloud **<u>Terms:</u>** Composting, Compost, Decompose, Decomposers Bacteria, Fungi	
Interactive Informational Read Aloud: Composting: Nature's Recyclers	**<u>Prediction:</u>** Teacher will show the cover, title, table of contents using the Elmo document camera. Students will have an opportunity to share what they think the book will be about. **<u>Reading of Text:</u>** Teacher will read pg 4 to 13. **<u>During Reading Questions</u>**: The teacher will ask the following questions: 1. What is composting? 2. What is a compost heap? Students will raise their hand to respond and teacher will call on students. **<u>After-Reading Questions</u>** 1. What are decomposers? 2. What is their role in the compost heap? Students will raise their hand to respond and teacher will call on students.	
Post-Reading Activities	**<u>Concept Mapping</u>** Student will have an opportunity to add to the class concept map. The teacher will take a picture of the class constructed concept map for data collection purposes. Students will be given a pre-generated concept map that is 25% completed. Students will complete concept map using words from the word bank that is	**<u>Comprehension Questions with Writing</u>** The teacher will ask the following question taken from the text used in the informational interactive read aloud: ***"How does composting affect or help the environment?"*** The students will spend 5 minutes writing on answering this question independently on their piece of paper. The writing will be collected by the teacher for data collection purposes.

	located on the concept mapping sheet.	

VITA

Jaime Leigh Berry received her Bachelor of Science degree in education from Sam Houston State University in 2000. She received her Masters of Educational Leadership in 2003 from Stephen F. Austin State University. Then, she received her Doctor of Philosophy in August of 2011 from Texas A&M University. Her research interests include content area literacy, dyslexia and ESL. She will be an Assistant Professor of Early Childhood Education at Armstrong Atlantic State University in Savannah, Georgia in the fall of 2011.

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