ABSTRACT

HOFFMANN, KRISTIN FISHER. The Impact of Graphic Organizer and Metacognitive Monitoring Instruction on Expository Science Text Comprehension in Fifth Grade Students. (Under the direction of Dr. John L. Nietfeld).

This study sought to examine the impact of teaching both graphic organizer and metacognitive monitoring strategies on the comprehension of 5th grade students reading expository science text. In 2000, the National Reading Panel recommended multi-strategy comprehension instruction; graphic organizers and metacognitive monitoring were two of the recommended strategies. Few studies have examined the impact of combining graphic organizer instruction with metacognitive reading strategy instruction. In this study the effectiveness of teaching both graphic organizer and metacognitive monitoring strategies was compared with instruction in either graphic organizer or metacognitive monitoring strategies. Students in the Graphic Organizer + Metacognitive Monitoring Condition and students in the Metacognitive Monitoring Condition showed increased reading comprehension scores over the course of the six-week intervention on seven expository science passages, whereas students in the Graphic Organizer Condition showed no improvement in passage comprehension scores. In addition, over the course of the intervention, students in the Graphic Organizer + Metacognitive Monitoring Condition showed a significant increase in test scores on a standardized test of reading comprehension. With regard to the increase in reading passage and comprehension test scores, findings from this study revealed that score increases occurred only in conditions
where students received metacognitive monitoring strategy instruction. Evidence from this study revealed the importance of metacognitive strategy instruction on reading comprehension gains.
The Impact of Graphic Organizer and Metacognitive Monitoring Instruction on Expository Science Text Comprehension in Fifth Grade Students

by
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BIOGRAPHY

Kristin Hoffmann grew up in Orlando, Florida, and attended the University of Florida where she earned a Bachelor of Science in journalism and a Master of Arts in Mass Communications, specializing in print journalism. It was while pursuing this degree that Kristin experienced teaching for the first time, which proved unforgettable.

Following graduation, Kristin began working for a large advertising agency in the Orlando area. After a year of long, repetitive days and few personal rewards, Kristin decided to seek a teaching position. Trinity Preparatory School, a large Episcopal school, took a chance and hired her as an English, journalism, and photography teacher. Kristin loved teaching and truly learned to teach at Trinity under the tutelage of Kathy Pinson, a veteran English teacher and assistant principal.

Following a move to Clearwater, Florida, Kristin abandoned her college-preparatory teaching career and embarked on a career teaching reading and English to students adjudicated through Florida’s Department of Juvenile Justice. This position sparked her interest in reading comprehension and academic motivation, two areas she noticed were lacking in her students. For the remainder of her teaching career in Florida Kristin worked with at risk students.

Eventually, Kristin and her family had the opportunity to move to Raleigh, North Carolina. After working for a short time at Broughton High School, Kristin enrolled at NC State and earned a Master of Arts in Curriculum and Instruction, specializing in
educational psychology. She remained at the university to pursue a doctorate in the same area. Eventually Kristin hopes to find a position that allows her to continue her research in reading comprehension and self-regulated learning.
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CHAPTER ONE

Introduction

The ability to comprehend expository text in an intentional, metacognitive manner predicts both school and career success (Butler, Cartier, Schnellert, & Gagnon, 2006; Duke, 2004; Durkin, 1993). When students transition from elementary to middle school, expository text plays a critical role in content area instruction as subject area teachers become more likely to employ this type of text as a primary learning source (Gobert & Clement, 1999). Elementary students with comprehension deficits are at a distinct disadvantage as they progress through middle and high school, where expository text prevails, and where teachers are less likely to provide reading comprehension instruction (DiCecco & Gleason, 2002). Elementary students who fall behind in reading comprehension often never catch up with their peers academically and over time show less motivation for reading and content area learning (Blanton, Wood, & Taylor, 2007).

Middle and high school content area teachers often assume that students are able to comprehend and remember information from assigned textbook readings despite the lack of ongoing reading comprehension instruction at these grade levels (Butler et al., 2006; DiCecco & Gleason, 2002). Middle and high school students with measurable comprehension deficits are often placed in “pull-out” classes where reading strategies are
generally taught out of context, a method shown to be ineffective (Blanton et al., 2007).

Compounding the problem, students in content area classes, such as science and social
studies, are often expected to gain much of their content knowledge from their textbooks,
where the content, vocabulary, and text structure is often complex and unfamiliar (Duke,
2000; Stein & Trabasso, 1981). Within expository text, integral text structures, such as
sequence, cause and effect, compare and contrast, and problem and solution, also must
often be inferred (Meyer & Poon, 2001; Williams, Nubla-Kung, Pollini, Stafford, Garcia,
& Snyder, 2007). Because textbooks play such a prominent role in content area learning,
and reading instruction is generally not provided within content area classrooms, it is not
surprising that so many students have difficulty comprehending expository text (Driscoll,
Moallem, Dick, & Kirby, 1994).

In addition to expecting students to be able to comprehend expository text, teachers
also expect students to be able to learn from expository text. In reference to reading,
learning implies a deliberate action on the part of the reader to comprehend surface level
information as well as to extract deeper, relational meaning from text (Caccamise &
Snyder, 2005; Kintsch, 1994; Leutner, Leopold, & Elzen-Rump, 2007). Learning from
expository text requires a significant skill set on the part of the reader, including the ability
to comprehend the meaning of text, remember text content, think critically about text, infer
relationships within text, and use information acquired from text in novel ways (Brown & Campione, 1990; Kintsch, 1994; Pressley, 2000). These skills set the stage for academic success because reading comprehension is an integral part of learning in virtually all content areas, but in 2007, National Assessment of Educational Progress (NAEP) scores showed that only 22% of fourth graders and 27% of eighth graders were able to comprehend, critically analyze, and apply information from expository text at a proficient level, which is a level that represents “solid academic performance and demonstrated competence over challenging subject matter” (National Center for Education Statistics, 2007, p. 6). These percentages illustrate the large number of students who struggle to remember, understand, and construct knowledge using information from text as they progress through school. Based on these recent NAEP findings, the majority of fourth and eighth grade students in the United States should be considered at risk of protracted academic difficulty. The problem is even greater in some areas, such as within urban schools (De Leon, 2002). Nearly half of all urban 17-year-olds are unable to read at a ninth grade level, and in 35 of the largest cities in the United States, almost half of the high schools graduate only 50% of their students (Moss, 2005).

In light of the problems students have understanding expository text and the ongoing academic difficulties that this deficit creates (Butler et al., 2006), there is a
pressing need to address the issue of expository text comprehension more rigorously during the elementary school years. By fourth grade, students are presented with much of their classroom content material in the form of expository text (Moss, 2005). For learning to occur, students must be taught to recognize common expository text structures, as well as to comprehend, critically analyze, and infer conceptual relationships from expository text.

One common classroom tool shown to increase comprehension of expository text is the graphic organizer (Nesbit & Adesope, 2006). Graphic organizers are visual representations of information contained in text that illustrate how concepts are connected and how text is structured (Bromley, Irwin-DeVitis, & Modlo, 1995). Graphic organizers can be utilized throughout the reading process, including pre-reading, during-reading, and post-reading, to help learners identify text structures, isolate important information, and understand conceptual relationships within text. Often, teachers give students a blank graphic organizer to use alongside expository text as a note-taking template, but few teachers explicitly teach students how to construct their own graphic organizers and even fewer provide multi-strategy instruction by teaching students how to construct graphic organizers while employing other metacognitive reading strategies.
CHAPTER TWO

Review of the Literature

Reading Comprehension

Reading comprehension is a concept that has been defined in many ways, and over time these various definitions have informed research, instruction, and assessment (Randi, Grigorenko, & Sternberg, 2005). Winograd and Johnston (1987) argued that although many reading researchers narrowly define comprehension as a strategy-directed activity by which readers arrive at a single meaning, the definition should be broadened to recognize personal and social knowledge construction. Williams et al. (2007) argued that comprehension research not only should examine the processes by which readers remember information from text but must also examine how readers construct knowledge from text.

Because proficient reading comprehension requires multiple levels of processing, Kintsch and van Dijk’s (1978) model of text comprehension, which is a model of adult, fluent reading comprehension, will be used to define reading comprehension for this study. In addition, this model does not compartmentalize comprehension as either memory or learning but defines reading comprehension as an interaction between the reader and the text as readers construct mental representations using both text information as well as their
own prior knowledge (Kintsch & van Dijk, 1978). This definition also allows beginning and fluent readers to be compared (Kintsch & Kintsch, 2005).

Reading comprehension involves the simultaneous interaction of many complex processes, and prior research revealed these processes by examining the skills and strategies that proficient readers possess in order to determine the skills and strategy knowledge that deficient readers lack (Pressley & McCormick, 1995). Despite variability found across proficient readers, there are certain characteristics that most, if not all, good readers possess (Fountas & Pinnell, 2002; Sweet & Snow, 2002). In addition to being able to automatically decode text, proficient readers actively and flexibly attack text using an arsenal of strategies. According to Duke and Pearson (2002), good readers are active; they set goals for reading and evaluate their progress towards the goal; they attend to important information in text; they ask questions about aspects of the text and try to predict what is to come next; they read selectively paying attention to important parts of the text; they use prior knowledge to understand and integrate new information they encounter; they construct summaries of what they have read, and they monitor their understanding of the text and modify the strategies they are employing based on that understanding.

Proficient readers are strategic and self-regulated when reading both narrative and expository text, but some comprehension strategies are particularly applicable to
expository text. When reading expository text, good readers are able to recognize common expository text patterns, such as comparison or causation, and are able to use text structure schemata to help them understand and remember information in the text (Chambliss, 1995; Meyer, Brandt, & Bluth, 1980). Knowledge of text structures allows proficient readers to construct mental models of the most important ideas presented in expository text, enabling them to learn and remember information (Meyer et al., 1980). Because expository text tends to be more complex than narrative, proficient readers of informational text must be metacognitive, meaning that they have knowledge about their own cognitive processes and are able to regulate those processes during reading (Baker & Brown, 1984; Flavell, 1979). Proficient readers regulate their own reading by setting reading goals; they monitor their understanding by thinking about how information they are encountering in the text fits with what they already know about the topic. Readers who adequately monitor their comprehension also are able to employ control, or fix-up strategies, such as rereading or asking themselves questions, when they notice comprehension breakdowns (Samuels, Ediger, Willcutt, & Palumbo, 2005).

Although some poor readers have difficulties decoding text, one of the biggest differences between good and poor readers is that poor readers are not metacognitive (Baker, 2002). Poor readers rarely set goals or think about the purpose of the reading task.
They are often not aware enough of their own cognitive processes to recognize comprehension breaks, and they often lack an arsenal of reading strategies and the knowledge to know when and how to employ these strategies. In addition, poor readers often are unable to monitor their comprehension during reading, and they do not employ fix-up strategies because they are unaware that they do not understand the text. Inefficient readers are unable to pinpoint when and where their understanding failed. Poor readers who lack knowledge of expository text patterns, such as hierarchies, comparison, and causal structures, do not actively encode information according to these predictable, meaningful text patterns. Instead, these readers tend to view text information as a “disconnected list” rather than as an organized pattern (Hyerle, 2009, p. 23), which negatively impacts comprehension. Proficient readers, on the other hand, use their knowledge of expository text structures as a framework on which to organize text information, allowing them to comprehend and retain information more readily (Meyer, 1975; Meyer, Brandt, & Bluth, 1980; Meyer & Poon, 2001).
When readers possess prior knowledge about text content and expository text structures, such as cause and effect or compare and contrast, they are able to construct more elaborate mental models of the text (van Dijk & Kintsch, 1983; McNamara, Kintsch, Songer, & Kintsch, 1996). van Dijk and Kintsch (1983) proposed three separate but interacting levels of mental representations created during reading. The first level, called the surface structure, includes the words contained in the text and requires perceptual and conceptual bottom up processes to transform the words into meaningful idea units, called propositions. A proposition is an idea unit constructed of a relational term, called the predicate, which modifies one or more arguments, indicating the semantic roles of the words. Each proposition contains a verb or preposition and provides information similar to that of a simple sentence. For example, in the sentence, “John went to a rock concert with his friends,” the predicate would be WENT and the arguments would be JOHN, CONCERT, and FRIENDS. The proposition itself would be represented as:

WENT (JOHN, CONCERT, FRIENDS)

(ROCK, CONCERT)

The second representational level is called the textbase, which contains webs of linked propositions. Each proposition acts as a unit of meaning that crosses other levels of meaning, including perceptual, action, linguistic, and symbolic (van Dijk & Kintsch, 1983;
Kintsch, 1994). At this level, propositions that come directly from the text are used to construct the next level of analysis, which describes the semantic and rhetorical structures of the text that are encoded as the text is read. The textbase is comprised of the *microstructure*, a complex web of interrelated propositions, and the *macrostructure*, which is a structure representing the text summary or gist (Kintsch & Kintsch, 2005). Any text recall task requires an individual to process information at the textbase level, using both the microstructure and the macrostructure. The third, and most complex, representational level is called the *situation model*, which represents deeper, more effortful levels of processing whereby readers construct meaning beyond the level of the text itself. The situation model requires that readers integrate their prior knowledge and experience with the *textbase*. The situation model is essentially a mental model consisting of propositions combined with visual imagery, emotions, and experiences (Kintsch & Kintsch, 2005).

According to Kintsch’s (1983) model, proficient text comprehension, particularly at the *situation model* level, is limited by instructional, reader, and text characteristics (Kintsch & Kintsch, 2005). At the instructional level, research has shown that although reading strategy instruction improves comprehension and memory for text (Brown & Palinscar, 1989; Pressley, 2000), comprehension strategies tend to be assessed rather than taught (Durkin, 1978/1979), and although teachers are urged to teach these strategies,
classroom observations often show teachers using reading strategies to inform assessment rather than instruction (Pressley, 2002). Effective reading comprehension instruction includes the explicit teaching of multiple comprehension (Paris, Byrnes, & Paris, 2001) strategies that can be employed in a metacognitive manner before, during, and after reading (Pressley, 2000; 2002).

Reading comprehension also can be constrained by variables at different levels. Comprehension is constrained by multiple factors within the learner, including decoding skill (Stuart & Masterson, 1992), working memory (Linderhom & van den Brock, 2002), motivation (Guthrie & Wigfield, 2000), prior knowledge (Kintsch & Kintsch, 2005), metacognition (Baker & Brown, 1984), and the strategies that readers are able to employ during reading (Zimmerman, 2000). At the text level, comprehension is constrained by the complexity and coherence of the text itself, both at the macro- and microstructure levels (Kintsch & Kintsch, 2005). For example, McKeown, Beck, Sinatra, and Loxterman (1992) found that when text structure and contextual relationships are made explicit texts are easier to read and recall is improved. However, when deeper learning is assessed, more complicated texts can be advantageous for readers with adequate background knowledge because the more effortful and active processing required leads to deeper understanding and learning (Kintsch & Kintsch, 2005).
Expository Text

Text genre can also impact reading comprehension. Expository text, as opposed to narrative prose or written stories, is nonfiction text written to provide information and explanation (Graesser, 1981) making it differ significantly from narrative text (Dole, Duffy, Roehler, & Pearson, 1991; Fang, 2008). Expository text is structurally more complex and information dense than narrative text (Stein & Trabasso, 1981). In addition, expository text sounds less like everyday speech, often broaches topics where students have less prior knowledge, and generally includes more complex text structure combinations (Fang, 2008).

Although the ability to comprehend and learn from expository text is critical for students’ success in school and for life-long learning (Durkin, 1993), narrative text often makes up the bulk of reading for early elementary age students (Duke & Pearson, 2002). Expository text is often introduced when students make the transition from “learning to read” to “reading to learn” (Chall, 1983). This generally occurs after the third grade and can be a difficult transition for many students (Fang, 2008; Williams et al., 2005). This transition also seems to occur about the same time as the “fourth-grade slump,” a period where students who were progressing as readers suddenly seem to fall behind (Chall, 1983; Chall, Jacobs, & Baldwin, 1990). The introduction of expository text, containing more
difficult vocabulary and information and requiring more background knowledge for understanding, may be a contributing factor to this slump (Chall & Jacobs, 2003; Dole et al., 1991). In addition, the problems that upper-elementary students experience comprehending expository text also may be related to a passive reading approach (Williams et al., 2005) and poor metacognition (Baker & Brown, 1984).

Many students have difficulty understanding, remembering, and learning from expository text, not just elementary-age students, or students who have been identified with comprehension problems (Reutzel, Camperell, & Smith, 2002; Wiley, Griffin, & Thiede, 2005; Williams et al., 2005). In addition to the structural complexity of expository text (Armbruster, 1984; Reutzel et al., 2002), Williams, Taylor, and deCani (1984) determined that expository text is more difficult to comprehend because many of the conceptual relationships contained in this type of text are implicit and therefore must be inferred by the reader. Readers may also have more difficulty determining text structure when reading expository text because informational text often contains combinations of two or more text structure types (Meyer & Poon, 2001), including description, sequence, problem-solution, compare-contrast, and cause-effect (Anderson & Armbruster, 1984; Meyer & Freedle, 1984; Meyer, Theodorou, Brezinski, Middlemiss, McDougall, & Bartlett, 2002).
Kucan and Beck (1996) examined the effect of genre, both narrative and expository, on reading comprehension. The researchers had fourth-grade students think aloud about their online comprehension while reading an expository passage and then had the students write a summary of the passage. This same process was repeated for both narrative and expository passages. Kucan and Beck (1996) found significant differences between the narrative and expository think-aloud statements and summaries. Students reading narrative text had higher processing scores and included more important text propositions than students reading expository text.

In a similar experiment, Cote, Goldman, and Saul (1998) examined expository text comprehension in fourth and sixth grade students. The researchers chose passages that had been used in previous comprehension research and modified them to make them equivalent in terms of sentence and word length. The students were told that their purpose for reading was to produce a summary of the information contained in the text. The students read each passage aloud from a computer screen and described their thought processes after reading each sentence. After completing a passage they dictated their summary report to an experimenter who typed it on a computer, allowing the students to make changes to the report but not allowing them to look back at the passage. Results revealed that both fourth and sixth-grade students used strategies such as connecting to prior knowledge, paraphrasing, and metacognitive monitoring but that the students rarely attempted to make connections among propositions within the text itself. The summaries followed the text structure of the reading passages, but the easier passages prompted better summaries for both grade levels than the more difficult passages. In a second experiment, Cote, Goldman,
and Saul (1998) used a similar design with a different group of fourth and sixth-grade students. In this experiment they removed the read-aloud and think-aloud components. The researchers found that rather than explain their summaries in terms of a distinct structure, the students tended to list surface-level facts, especially when attempting to summarize the more difficult expository passage.

Research has shown that students of varying ages have difficulty processing and constructing knowledge from expository text; therefore, it appears that early elementary students may not be receiving enough exposure to expository text nor to the reading strategy instruction necessary for comprehension development (Hall, Markham, & Culatta, 2005). Reading instruction using expository text can be effective as early as kindergarten to increase comprehension and memory for expository text structure (Duke & Kays, 1998). In addition, early elementary-age students have been shown to benefit from increased reading comprehension strategy instruction, particularly training emphasizing knowledge construction and understanding of basic text structures (Hall et al., 2005). Exposure to developmentally appropriate expository text along with reading strategy instruction in elementary school may support later literacy development by developing background knowledge, vocabulary, and comprehension skills.

Developmental Trends

Children begin to develop the skills needed to learn from text early in life. From infancy until the early pre-school years children are exposed to literacy through interpersonal experiences and physical environments (Pressley & McCormick, 1995). This period of early literacy development is called emergent literacy (Pressley & McCormick,
1995), and children who are considered emergent literate, as demonstrated by the reenactment of stories and writing of words by age five, outperform less emergent literate five-year olds in the early grades in reading (Barnhart, 1991). As children enter school they develop phonemic awareness, which is the understanding that words are made of separate and distinct sounds. Phonemic awareness predicts fluency and skill in spelling (Griffith, 1991), and students who lack phonemic awareness often experience reading difficulties throughout the elementary school years (Stuart & Masterson, 1992). Early elementary students also must learn alphabetic decoding, with the goal of automaticity, so that working memory can be used for comprehension rather than the high cognitive load that decoding may impose (Pressley & McCormick, 1995).

Studies of reading comprehension development suggest that the skills, strategies, and prior knowledge needed for comprehension differ from those needed for word reading (Oakhill, Cain, & Bryant, 2003). Proficient readers knowledgeably employ comprehension skills and strategies when they recognize comprehension breakdowns (Pressley & Gaskins, 2006). These readers not only think about their purpose and goals for reading, they also think about what they already know about the topic, and they connect this prior knowledge to text propositions or to the text macrostructure before and during reading. Prior knowledge, which is related to experience and how much a student reads, becomes increasingly important for comprehension as students progress through school, particularly for expository text comprehension (Neufeld, 2005). Students who read the most increase their knowledge of content topics and text structures, resulting in better comprehension than in students who read the least (Stanovich & Cunningham, 1993).
In addition to prior knowledge, high ability readers have strategies at their disposal to use during reading, and they are able to employ and adapt those strategies at will (Pressley, 2000). Effective readers are able to monitor their comprehension, noticing when something does not make sense, and they also are able to notice and remember important information and main ideas (van Dijk & Kintsch, 1983), all of which are skills that many elementary-age children lack (Brown & Day, 1983). Proficient readers understand that there is a great deal of implicit information that must be inferred from text (van Dijk & Kintsch, 1983; Pressley & Gaskins, 2006), and after reading, good readers consider their understanding of the text. The best readers tend to be active readers who employ both skills and strategies, allowing them to construct meaning from text (Pressley, 2000).

Pressley and Gaskins (2006) note that strategies utilized by proficient readers are rarely employed by young readers, but they also note that comprehension strategies can be taught, even to students with poor early reading performance.

Inexperienced and poor readers, especially those who have trouble comprehending expository text, can benefit from strategy instruction. One strategy that has been recommended for less proficient readers and for those who lack prior knowledge is the graphic organizer (Armbruster, Lehr, & Osborne, 2001; Lambiotte & Dansereau, 1992; Mayer, 1979b). Graphic organizers have been found to improve understanding of text by visually depicting key words and concepts and the relationships among them, which allows struggling readers to construct the knowledge necessary for learning (Simmons, Griffin, & Kameʻenui, 1988). Graphic organizers have been shown to improve reading comprehension, content area achievement, retention, and recall of information (Hyerle,
2009). Armbruster et al., (2001), in their widely distributed publication *Put Reading First*, identify graphic organizers as a metacognitive strategy that plays an integral role in comprehension across all text genres, and they stress the importance of teaching students to use flexibly use this strategy in combination with other metacognitive strategies.

**Graphic Organizers and Learning from Text**

Reading comprehension is considered by many to be one of the most important academic skills (Mastropieri & Scruggs, 1997), yet comprehension instruction is just one of five critical areas identified by the National Reading Panel (National Institute of Child Health and Human Development [NICHD], 2000), which include phonemic awareness, phonics, fluency, vocabulary, and finally, comprehension strategy instruction. The Panel reviewed comprehension strategies and endorsed seven research-based strategies, one of which is the use of graphic organizers, where “. . . readers make graphic representations of the material to assist comprehension.” Like Armbruster et al. (2001), the Panel also advocated teaching students to use graphic organizers alongside other reading strategies, such as comprehension monitoring.

Like the word comprehension, the term graphic organizer has been defined in many ways, but the definitions typically have certain overlapping characteristics, much like a Venn diagram. For the purpose of this discussion, graphic organizers will be defined as two-dimensional, visuospatial adjunct displays that are commonly used alongside text to facilitate comprehension without adding semantic content (Robinson, Robinson, & Katayama, 1999).
Graphic organizers are used to illustrate conceptual text structures and relationships between text elements and concepts (Stull & Mayer, 2007). According to Horton, Lovitt, and Bergerud (1990), a graphic organizer is a text adjunct that is a “visuospatial arrangement of information containing words or statements that are connected graphically to form a meaningful diagram” (p. 12). Concept maps, knowledge maps, Venn diagrams, causal diagrams, and matrices are just a few of the common graphic organizers seen in textbooks (Stull & Mayer, 2007) and utilized in the classroom. Outlines and lists are also considered text adjuncts by some, but these organizers are missing what is known as visual argument (Waller, 1981), which uses “. . . the relative location of objects in two-dimensional space to communicate relations among those objects” (Robinson & Schraw,
1994, p. 401). With visual argument the organization of text concepts is shown rather than explained, which makes textual relationships more explicit.

Outlines and lists must be viewed in a linear fashion to be understood, much like text, so for the purposes of this discussion, the term graphic organizer will be reserved for spatial adjunct displays, which communicate relationships between concepts by the visual placement of the concepts relative to each other (Robinson & Molina, 2001; Robinson & Schraw, 1994). Both linear and spatial organizers are commonly found in textbooks to help students comprehend and remember text (Bera & Robinson, 2004), but studies have shown that students viewing spatial graphic organizers learn more than if they view equivalent linear graphic organizers (Alvermann, 1981; Lambiotte & Dansereau, 1992; Robinson & Kiewra, 1995) because of the perceptual enhancement provided by the visuospatial arrangement of the information, which promotes computational efficiency (Larkin & Simon, 1987).

Comprehension of expository text often depends on the ability of a learner to understand multiple levels of text component relationships and to build a “coherent mental representation of the information being comprehended” (Gernsbacher, 1990, p. 1). Graphic organizers can be used to make the text’s structure and the inferential relationships between and among text elements more explicit (Graesser, Singer, & Trabasso, 1994). During reading a competent learner seeks to build “a coherent cognitive structure that makes sense, by being internally consistent (i.e., coherent internal connections) and consistent with existing knowledge (i.e. coherent external connections)” (Mayer, 2008, p. 354). One cognitive structure that readers construct as they read expository text is the
macrostructure (Kintsch, 1998), or rhetorical structure of the text. This is the structure commonly used by writers to organize their ideas and information and the structure used by efficient readers to comprehend text (Chambliss & Calfee, 1998). Mayer (2008) describes the most common rhetorical structures found in expository text as generalization, which presents a main idea and describes the supporting evidence; enumeration, which presents a list of facts; sequence, which describes a series of events or steps in a process; classification, which divides information into categories, and compare and contrast, which shows the similarities and differences of two or more items along different dimensions. Some of the graphic organizers that are commonly paired with each of these text structures will be described later in this chapter.

Graphic Organizers as Text Adjuncts

The use of graphic organizers to aid in text recall arose from studies by Ausubel (1960) who wanted to provide students with information prior to a learning task that would help them organize and interpret new information. These early organizers were linear verbal displays called structured overviews, and because they were presented prior to the learning task, they were eventually called advance organizers. Ausubel (1968) used structured overviews to provide students with knowledge of the upcoming text information so that they would have “ideational scaffolding for the stable incorporation of the more detailed and differentiated material that follows” (p. 148). Advance organizers, which are still used today, provide prior knowledge for those in need of it and activate prior knowledge in those who already possess it (Mayer, 2003).
While Ausubel (1960) used a short piece of text as the advance organizer in his early studies, Barron and Cooper (1973) used a visuospatial representation as an advance organizer in their research and found that their advance organizer benefited more proficient readers rather than those who were less proficient. In a series of nine later studies, Mayer (1979b) found that advance graphic organizers presented alongside text can compensate for text structures that are confusing and inefficient for readers and that they aid recall when readers use them to reorganize text information, which encourages deeper processing. Interestingly, he also found that graphic organizers did not help recall and understanding when used with easy-to-read text that had a well defined and explicit text structure. In a study of tenth-grade students, Alvermann (1981) also discovered that advance graphic organizers facilitate recall with expository text when reorganization of text is necessary due to an intricate text structure, and she also found that graphic organizers do not benefit recall when reorganization is unnecessary.

In addition to presentation before a piece of text, graphic organizers can also be presented within text or immediately after text to emphasize text structures and contextual relationships. Attempting to make the use of graphic organizers a more active, student-driven process, Barron and Stone (1974) developed the graphic post-organizer. The researchers had students construct their own graphic organizers after reading expository text and found this to be more effective for learning than viewing teacher-made advance organizers or reading the text twice (Griffin & Tulbert, 1995). Horton et al. (1990) described this type of graphic organizer as a post-reading visuospatial structure that:
Consolidates information into a meaningful whole so students do not have the impression that they are being taught a series of unrelated terms, fact, or concepts. In effect, the diagram itself acts as a nonverbal, visuospatial referent that alerts the student to the interrelationships between ideas and their logical connections to superordinate, equal, or subordinate pieces of information (p. 13).

Since these early studies, graphic organizers have been integrated into K-12 classrooms, and multiple meta-analyses investigating the efficacy of graphic organizer as adjunct reading comprehension and learning tools have been conducted. A meta-analysis by Boyle and Weishaar (1997) showed that although empirical support for graphic organizers as a reading comprehension/learning tool in the classroom has been mixed, it has become more positive over time. An earlier meta-analysis by Rice (1994) revealed similar findings. Rice argues that divergent findings seen in graphic organizer studies result from flawed and inconsistent research, which do not allow for easy comparison or replication and therefore show no consistent trends. Rice notes that graphic organizer studies have used various types of organizers, some more complex than others, and some presented at different time points in text reading, and that there has also been an inconsistency in experimental design. All of which makes graphic organizer research difficult to replicate. Rice also argues that some studies contain methodological flaws, including no control group, inconsistent intervention methods, and inconsistent dependent measures. Some of the inconsistent findings in graphic organizer research also may be
related to theoretical issues since multiple theories have been driving graphic organizer research since its inception (DiCecco & Gleason, 2002).

Theories Driving Graphic Organizer Research

Schema Theory / Cognitive Load Theory

Schema theory describes the propensity for individuals to organize new information around schemata, which are “networks of connected ideas” (Slavin, 1988, p. 155). British psychologist Frederick Bartlett (1932) had his students recall information after reading a Native American folktale and found that when students were asked to retell the story they could not retell it verbatim but that they often added elements that were familiar to them but not found in the story. Bartlett called the familiar information schemata, and he described schemata as existing knowledge that helps people make sense of and remember new information. He found that over time precise information found in the stories is forgotten but that the underlying schemata are recalled, distorting the original story.

Schema theory is one of the earliest theories driving graphic organizer research in education. Key words and concepts graphically displayed by an organizer serve to activate prior knowledge, providing a framework on which new information can be attached. Schema theory was applied to education in the mid 1970s, about the same time graphic organizer research in reading was gaining momentum. Although Piaget (1926) had used the term schema many years before, schema theory, as it pertains to learning, was developed by Anderson (1977) who described organized knowledge as an elaborate
network of abstract mental structures called schemata, which represent an individual’s knowledge base. Anderson described schemata as embedded mental structures that are:

1. Organized in a meaningful manner that can be added to and developed into more specific structures.
2. Flexible enough to change as information is received and reorganize when necessary.
3. Able to combine, forming a whole greater than the sum of its parts.

Cognitive load theory, another theory seen often as the basis for graphic organizer studies, is based on the goal of schema acquisition and on the idea that working memory has a limited capacity for the amount of information that can be processed at one time (Miller, 1956). Long-term memory, on the other hand, contains vast amounts of cognitive structures, called schemata, which are acquired over a lifetime, but for learning to occur, information must first be processed by working memory (Sweller, 1988). Anderson (1977) argued that short-term memory load must be reduced or managed in order for learning to occur, but Sweller’s (1988) cognitive load theory was the first to consider the effect of cognitive overload on learning and the ways in which instructional design could affect cognitive load. Cognitive overload can impair the process of schema acquisition, which in turn can affect learning and academic performance (Sweller, 1988).

Sweller (1993) later described three sources of cognitive load that can affect learning: intrinsic, extraneous, and germane. Intrinsic cognitive load refers to the difficulty of the content to be learned and was characterized by Sweller as “imposed by the basic characteristics of the information rather than by the instructional design” (p. 6) and later as
“the mental work imposed by the complexity of the content” (Clark, Nguyen, & Sweller, 2006, p. 9). Expository science text, due to its more complex and more difficult nature, falls into this category. Extraneous cognitive load refers to cognitive load created by the design of the instructional materials and the manner in which they are presented (Chandler & Sweller, 1991). Extraneous cognitive load limits the working memory’s capacity to process information to be learned. Germane cognitive load, also called relevant load, refers to load that contributes to learning and results when “free working memory capacity is used for deeper construction and automation of schemata” (Bannert, 2002, p. 139).

Graphic organizers can be used in instruction to help manage intrinsic cognitive load, reduce extraneous cognitive load, and increase germane cognitive load. For example, an author- or teacher-provided graphic organizer can scaffold comprehension and encourage generative learning by alleviating extraneous processing and offsetting intrinsic cognitive load produced by an information-laden text (Mayer & Moreno, 2003). A graphic organizer provides an external representation of complex text information and text structure that can be used to offload information. This reduces extraneous cognitive load caused by poorly written or very complex text by making the organization and structure of text or relationships that are implicit within text more clear to the reader. Graphic organizers can also be used during instruction to create germane cognitive load, which is cognitive load that contributes to learning. For example, a teacher could provide a guided lesson on creating graphic organizers based on a particular text structure and then have students practice creating graphic organizers on their own from other pieces of text with that same structure.
Text structure training, based on reducing cognitive load by making the knowledge of text structure explicit, was another early driver of graphic organizer research (Meyer et al., 1980). The assumption that texts have a structure beyond the sentence level and the idea that there are some common organizational patterns in text structure are supported by research (Kintsch, & van Dijk, 1978; Meyer, 1975; Meyer & Poon, 2001). Organizational patterns such as description, sequence, causation, problem-solution, classification, and comparison play an important role in both reading and writing (Jiang & Grabe, 2007; Meyer & Poon, 2001). Text structure influences what readers understand and remember (Alvermann, 1981; Meyer, Brandt, & Bluth; 1980) because readers who are able to recognize text structure and use that structure knowledge to process information have a comprehension advantage (Pearson & Johnson, 1978).

Meyer et al. (1980), in their study of expository text learning, noticed that ninth-grade readers were falling back on the strategy of listing text facts in order to remember them because they were unable to discern any type of text structure. The researchers suggested training students in expository text structures to help them discern major concepts and implicit relationships contained within the text. Graphic organizers can reduce intrinsic and extrinsic cognitive load by making text structures more explicit, providing a framework on which to organize text information and concepts.

*Depth of Processing / Assimilation Encoding Theory*

Studies examining the extent to which student constructed graphic organizers increase retention and learning are often based on depth of processing theory (Craik & Lockhart, 1972), an extension of schema theory, which says that recall is affected by the
way in which a person processes information. Deep processing of information requires more active thinking and elaboration, resulting in better recall for that information. For example, when a descriptive text structure, which often has to be processed serially, is actively reorganized by a reader into a more explicit structure, such as compare and contrast, what often results is better memory for text information because of the active process of reorganization by the reader (Meyer et al., 1980).

An extension of depth of processing theory (Craik & Lockhart, 1972) and schema theory is assimilation-encoding theory (Mayer, 1979a). Assimilation-encoding theory states that learners actively integrate new information with existing knowledge depending on whether information is received in working memory and whether prior knowledge is available in long-term memory. Mayer (1979a) applied assimilation-encoding theory to graphic organizer research and found graphic organizers to be most beneficial for learning when learners had little prior knowledge of content and when learners were less experienced readers because the graphic organizer provided a framework on which to assimilate new information. Testing another premise of the theory, Mayer (1979b) also found that graphic organizers aided recall when readers had to actively reorganize text information but that they did not help when there was no need for text reorganization.

Another theory based on the idea of active processing is activity theory (Mayer, 2003), which says that generative learning occurs when the learners are required to generate a product. Student construction of a graphic organizer showing relationships among text concepts is considered generative (Wittrock, 1989). In this case, the student must actively read the text searching for information to place into an organized structure, a
process Mayer (2008) calls building internal and external connections. Student-constructed graphic organizers have been shown to promote generative learning (Katayama & Robinson, 2000; Moore & Readence, 1980, 1984; Nesbit & Adesope, 2006), but some studies suggest that extraneous cognitive load is produced when students are required to construct their own graphic organizers from text (Stull & Mayer, 2007). This extraneous cognitive load inhibits generative processing and results in decreased learning and recall for some students.

*Dual Coding / Conjoint Retention Hypothesis*

Other theories that drive graphic organizer research are based on information processing theories such as dual coding (Paivio, 1986). Kulhavy’s conjoint retention model (Kulhavy & Stock, 1996), which is based on Paivio’s theory of dual coding, is also consistent with Baddeley’s (Gathercole & Baddeley, 1993) working memory model in which the central executive component regulates processing, storage, and retrieval in working memory while two “slave system” components, the visuospatial sketchpad for visual information and the phonological loop for verbal information, process and temporarily maintain information. Conjoint retention assumes that visual information is encoded as a single piece of information in working memory and acts as a framework on which to encode, store, and retrieve verbal information. The combined visual and verbal information is then stored in long-term memory as a single unit (Verdi, Kulhavy, Stock, Rittschof, & Johnson, 1996).

Verdi et al. (1996) described three distinct parts of the conjoint retention hypothesis. First, visual codes, representing a diagram or image, and verbal codes,
representing written propositions are referentially connected, so that each code can be used as a cue for the other. These connections are associative, and because they connect verbal and visual representations, retrieval is aided because additional cues are available for the learner. Second, the model states that graphic organizers contain both feature and structure information that is encoded during learning, and third, images stored and processed as units are seen as privileged over verbal information, which must be processed serially during encoding. The serial encoding required by verbal information is more effortful and can overload cognitive processes. Unlike text, images can be stored as intact units and can therefore be attended to quickly without taxing working memory (Larkin & Simon, 1987). Because working memory is not overloaded by the encoding of the visual image, readers can use the image of the graphic organizer to provide additional retrieval cues that aid in recalling related verbal information.

Using the conjoint retention (1996) model of text learning, Verdi et al. (1996) illustrated the advantages of presenting a graphic organizer prior to the text. They found that additional retrieval cues and easier recall result when a reader views a graphic organizer prior to reading text because the graphic organizer image is stored first and is easily processed as a complete unit in working memory. That image is then available in working memory as the reader reads the text. Robinson, Robinson, and Katayama (1999) used the conjoint retention hypothesis to compare spatial graphic organizers, which can be understood when viewed in any order or any direction, with linear organizers such as outlines. They found that graphic organizers that arrange information spatially rather than
in a linear manner enabled students to encode conceptual relationships more easily, resulting in greater learning and higher levels of transfer.

As one can see, a number of researchers have attempted to explain how graphic organizers affect text comprehension. These explanations tend to fall into two theoretical areas: cognitive processing of information (Kulhavy & Stock, 1996; Verdi et al., 1996) and cognitive load reduction (Mayer & Moreno, 2003; Stull & Mayer, 2007). More research is needed to determine which of these best explains graphic organizer effects or if both are valid models.

Text Structures and Common Graphic Organizers

Networks and Hierarchies (Concept Maps and Knowledge Maps)

There are many types of graphic organizers used in education, but one of the most popular is the concept map. Concept maps (Novak & Gowin, 1984) and knowledge maps (Lambiotte & Dansereau, 1992) are graphic organizers in which the interrelationships among ideas are indicated by linked nodes. Each node represents an idea or concept and is linked with other nodes. The links can be labeled to show the directions and explain the relationships between the nodes, or the links can be unlabeled and nondirectional (Nesbit & Adesope, 2006). Knowledge maps differ from concept maps in that their nodes must be connected with directional links labeled with a fixed set of symbols (Lambiotte & Dansereau, 1992). Concept and knowledge maps can be author constructed or student constructed. They can be complete or partial, and they can be used before, during, or after reading text.
Research has shown that knowledge maps increase recall for main ideas more than does studying text alone (Hall, Dansereau, & Skaggs, 1992), result in greater motivation and positive affect during studying and testing (Hall & O’Donnell, 1996), and lead to transfer of text processing skills (Chmielewski & Dansereau, 1998). Hall and O’Donnell (1996) compared college students studying identical content but in different formats; half of the students studied a knowledge map while the others studied text alone. After a two-day delay students completed a free recall task and rated their motivation, anxiety, and concentration. Students in the knowledge map group recalled more main ideas, showed increased motivation, increased concentration, and more positive affect than did the text only group.

Chmielewski and Dansereau (1998) also noted the positive effects of knowledge maps on text processing skills. The researchers trained college students to use knowledge maps and then had them study two pieces of text. Another group of students studied the same two pieces of text but received no knowledge map training. No knowledge maps were available to either group as they studied. Five days later both groups were tested, and the students trained with knowledge maps recalled more macro-level ideas than the group with no training even though no maps were given to either group during the delayed task. Nesbit and Adesope (2006), in their meta-analysis of 122 concept and knowledge map studies, found that when compared with reading, direct instruction, and class discussion, concept and knowledge mapping activities were more effective for learning, for both recall and transfer. At all grade levels, elementary through post-secondary, concept maps increased memory for text information more than did studying equivalent text passages,
lists, or outlines. An interesting finding of this meta-analysis was that the use of concept and knowledge maps produced no significant negative effects in any of the 122 included studies.

Sequence Organizers (Causal Diagrams)

Sequence organizers denote a sequence of events or concepts; flowcharts depict steps in a process while timelines depict an order of events. Sequence organizers are used extensively in science and social studies. A graphic organizer particularly appropriate for making explicit the many complex cause and effect relationships found throughout science texts is the causal diagram, a type of flowchart. Causal diagrams are similar to knowledge and concept maps, but this type of display only depicts causal relationships (McCrudden, Schraw, Lehman, & Poliquin, 2007). In a causal diagram, the cause and effect relationship is shown as a flowchart describing the steps in a process with arrows representing direction of causality. Causal diagrams facilitate comprehension of three types of cause and effect inferences: direct effects, indirect effects, and multiple causal sequences (McCrudden et al., 2007). There has been little research on causal diagrams’ effect on expository science text comprehension, but McCrudden et al. (2007) found that author-provided causal diagrams presented alongside text helped students infer cause and effect relationships found within the text by making textual relationships explicit, thus reducing cognitive load. Stull and Mayer (2007) found that author-provided causal diagrams presented with expository science text resulted in deeper learning gains than learner-created causal diagrams, which created too much cognitive load for increased comprehension and learning.
**Compare and Contrast Organizers (Matrices)**

Venn diagrams and matrices are graphic organizers commonly used to identify similarities and differences between text concepts and to make explicit the compare and contrast text structure. Venn diagrams have been used for years to help students understand and organize information across content areas, especially in math, but matrices, which are constructed of rows and columns, allow students to compare multiple concepts in more complex ways. Calfee and Chambliss (1988) described the matrix as the graphic organizer that best mimics the compare and contrast rhetorical text structure. A matrix arranges concepts and attributes in a manner that communicates facts, hierarchical relationships, and the sequence of attribute values within and among the concepts (Kiewra, DuBois, Christian, & McShane, 1988; Robinson & Schraw, 1994). Robinson and Schraw (1994) demonstrated the efficiency of a matrix over an outline when equivalent information was to be learned, but when testing was delayed the matrix advantage was lost and an outline advantage was seen. The researchers found that the matrix was more efficient than the linear outline, but because matrix processing was so effortless, deeper processing did not occur, resulting in degraded memory for information over time. The matrix proved to be too efficient for learning in this study.

**Individual Differences and Graphic Organizer Research**

Few studies have examined the influence of individual differences on learning from text using graphic organizers, but learner differences are important because learning depends on the relation between the graphic organizer, the task demands, the learner’s prior knowledge, and the learner’s cognitive abilities (Schnotz, 2002, p. 113). Prior
knowledge and cognitive abilities are age-dependent differences that influence the ways in which an individual comprehends and learns from text (Pressley & McCormick, 1995). Graphic organizers have been shown to aid comprehension and learning, especially for students with low prior knowledge and low verbal ability (Schnotz, 2002). Learner differences that have been explored most frequently in graphic organizer research are verbal ability, prior knowledge, and learning disability.

*Verbal Ability*

Despite calls for learner-centered instruction and assessment, instruction, particularly in grades six through twelve, often is highly teacher-centered with an emphasis on verbal skills (Lambiotte & Dansereau, 1992). Text- and lecture-based instruction and assessment are prevalent, and when authentic opportunities are offered, they are often reserved for students who have mastered basic skills. Students with low verbal ability but high spatial ability can be at a disadvantage in a traditional school setting, but ability strengths and weaknesses can be accommodated by providing both visual and verbal materials during learning (Mayer, 2003). When visual and verbal materials are presented together students have the opportunity to utilize their strengths while working on their deficits at the same time. There is some evidence that students with low verbal ability obtain greater recall and learning benefits from instructional diagrams than do high-ability learners (Lambiotte & Dansereau, 1992; Nesbit & Adesope, 2006), but more research is needed examining the impact of graphic organizers on comprehension in students of varying verbal abilities.
Prior Knowledge

The majority of graphic organizer studies examining the effects of individual differences without taking diagnosed learning disabilities into account are those that have examined the role of prior knowledge on comprehension and learning. Mayer (1979b) examined the effects of advance organizers on subjects with different levels of prior knowledge and predicted that a graphic organizer “should have its strongest effects for subjects who would not otherwise use a meaningful assimilative set” (p. 378). He found that students with less prior knowledge were more likely to benefit from graphic organizers than those with more prior knowledge. Lambiotte and Dansereau (1992) also found that students with low prior knowledge benefited more from the use of concept maps and knowledge maps (O’Donnell, Dansereau, & Hall, 2002) than did high prior knowledge students. Graphic organizers, such as concept maps, which help make the text macrostructure explicit to the low knowledge student, may interfere with the macrostructure knowledge that the high knowledge student already possesses, impeding comprehension and learning (Mayer, 1979b). This interference can induce the expertise reversal effect (Kalyuga, Ayres, Chandler, & Sweller, 2003), which states that when high knowledge, experienced learners attempt to reconcile and integrate redundant information (provided by the graphic organizer) with their own mental representations, cognitive overload can result, which can impair learning.

Learning Disability

Students diagnosed with learning disabilities, although a heterogeneous group, often experience difficulty comprehending expository text because they are unable to
understand and isolate expository text structures, which affects their encoding and retrieval of information (Englert & Thomas, 1987). DiCecco and Gleason (2002) examined the effect of graphic organizers on middle school students diagnosed with a learning disability. One group of students was trained to examine teacher-constructed graphic organizers after reading social studies text while another group of students received text only. Students were asked to write an essay after reading each text and were assessed on the number and quality of relational knowledge statements. Students in the graphic organizer condition provided significantly more relational knowledge statements but did not recall more factual text information than students in the text-only group. In a later study examining the effects of strategy training on the expository text comprehension of students diagnosed with learning disabilities, Kim, Vaughn, Wanzek, and Wei (2004) found that although graphic organizers increased comprehension initially, these gains did not hold up on transfer or maintenance tasks. More research is needed to examine the ways in which graphic organizers affect learning in students diagnosed with a learning disability, particularly with regard to maintenance and transfer.

Convergent and Divergent Findings

Findings about the extent to which graphic organizers increase meaningful learning and recall from text was initially mixed, but studies have shown that graphic organizers often have a positive effect on comprehension, text recall, and learning (Chang, Sung, & Chen, 2002; Kim et al., 2004; Mayer, 2003; Robinson, 1998), particularly in students who lack prior knowledge (O’Donnell et al., 2002; Schnitz, 2002). Individuals who receive graphic organizers alongside text encode conceptual relationships more easily, recall more
text-based information, and perform better on transfer tasks (Chularut & DeBacker, 2004; Robinson, 1998; Robinson, Robinson, & Katayama, 1999; Winn, 1991).

Although research illustrates the benefits of using graphic organizers, the question of what causes these outcomes and what type of learner benefits the most from graphic organizers is still debated and is difficult to discern because of the lack of uniformity in graphic organizer research (Griffin & Tulbert, 1995). Some say that the increase in performance is related to selective cuing (Verdi et al., 1996) where students see the same information twice, once in the text and once in the display, and therefore attend more to that information. Others attribute learning gains seen with graphic organizers to a decrease in extraneous cognitive load (Mayer & Moreno, 2003; McCrudden et al., 2007; Sweller, 1988). Learning gains could also result from the benefit of encoding information through both visual and verbal means (Paivio, 1986), which has been found to promote higher levels of learning and transfer by making conceptual relationships easier to encode (Lambiotte & Dansereau, 1992; Robinson & Schraw, 1994; Robinson, Robinson, & Katayama, 1999).

Although many studies have found graphic organizers beneficial for learning, there have been discrepancies in determining how students learn from organizers and if there are interactions between organizer type, organizer placement, learner differences, text type, and task type (Schnott, 2002). For example, Hawk (1986) found significant learning gains after training middle school students to create their own graphic organizers after reading science text, while other researchers utilizing different levels of graphic organizer training, have found that graphic organizer generation by the learner hinders comprehension due to
increased extraneous cognitive load (Stull & Mayer, 2007). It is difficult to interpret these findings because of the training differences involved. Hawk (1986) taught sixth and seventh-graders to construct graphic organizers over a period of weeks and found increased achievement in science while the Stull and Mayer (2007) study, which found no significant benefit of graphic organizer construction, utilized five minutes of training.

Discrepant findings can also be seen in graphic organizer research where students are presented with different types of graphic organizers. Chang, Sung, and Chen (2002) examined the effects of concept mapping on comprehension and summarization of science text using fifth grade learners and found that when students were required to correct inaccurate organizers, summarization and text comprehension were enhanced, but when the researchers taught students to create concept maps, only summarization was enhanced. No gains were found in the concept map generation group, possibly due to increased extraneous cognitive load. Most recent graphic organizer studies have shown that graphic organizers have positive effects on learning, but there have been discrepancies when graphic organizer type, placement and learner differences are examined. Future research that controls for individual differences, such as prior knowledge, and utilizes a consistent training period, graphic organizer type and placement is needed in these areas to resolve these discrepant findings.

The Future of Graphic Organizer Research

It is evident from a review of graphic organizer research that there are gaps future research can fill. There are at least four pertinent areas for researchers to direct their attention. First, most graphic organizer research has taken place with post-secondary
students on university campuses or with younger students diagnosed with learning disabilities; therefore, more ecologically valid K-12 research is needed within K-12 classrooms. In the Nesbit and Adesope (2006) meta-analysis of concept and knowledge map studies, only 13 of the 55 studies examined K-12 students (only three of those were with elementary-age students). Second, research is needed that examines the relationships between learner differences, such as verbal ability, prior knowledge, and metacognition, different types of graphic organizers (spatial, linear, teacher-constructed versus learner-constructed), and various training types. Third, future research needs to address methodological and theoretical deficiencies in graphic organizer research, and finally, more research is needed on the ways in which long-term graphic organizer training affects learning from text, particularly the ways in which graphic organizers can be incorporated into multi-strategy approaches to instruction that encourage better expository text comprehension. Graphic organizers were just one of the seven comprehension strategies mentioned by the National Reading Panel (National Institute of Child Health and Human Development [NICHD], 2000). The Panel endorsed the use of graphic organizers, where “. . . readers make graphic representations of the material to assist comprehension.” But the Panel also advocated combining graphic organizer instruction with other recommended comprehension strategies. Research is needed to examine the impact of combining graphic organizer instruction with these other recommended strategies.

Self-Regulated Learning as a Framework for Reading Comprehension Research

The term self-regulated can be used to describe learning that is guided by metacognition, strategic action, affect, and motivation to learn (Butler & Winne, 1995;
Winne & Perry, 2000; Zimmerman, 1990). In particular, self-regulated learners are cognizant of their academic strengths and weaknesses and have a repertoire of strategies that can be applied to academic tasks. Zimmerman (2000) stated, “Perhaps our most important quality as humans is our ability to self-regulate” (p. 13), but in school students generally receive little instruction in how to be successful learners, and students rarely have the opportunity to self-direct their learning processes. Boekaerts and Niemvırta (2000) point out that teachers are expected to convey information and procedures, monitor student performance, provide feedback, and motivate students to be engaged learners – all processes that hinder the development of self-regulation by making learning the responsibility of the teacher rather than the learner.

A growing body of research in self-regulated learning indicates that explicit instruction in self-regulated learning strategies, such as goal setting, planning, and metacognitive monitoring promotes academic achievement (Schunk & Zimmerman, 1998) by encouraging active learning, persistence, efficient strategy use, and higher levels of self-efficacy (Zimmerman & Martinez-Pons, 1990). Research has shown that even though most teachers agree that one of the primary goals of education is to develop intrinsically motivated self-regulated learners (Paris, Lipson, & Wixson, 1994), few students receive instruction in self-regulated learning in school and few students have opportunities to regulate their own learning (Randi & Corno, 2000). Teachers need training and support to effectively teach students to be strategic, self-regulated readers (Pressley & Gaskins, 2006), one of the keys to becoming a self-regulated learner.
Research suggests that individuals who are able to self-regulate learning in intentional and reflective ways are more likely to achieve academic success (Butler et al., 2006). Self-regulated learning refers to the extent to which learners become motivationally, metacognitively, and behaviorally active participants in their own learning (Zimmerman, 1986) through the linkage of cognition, behavior, motivation, and affect. In social cognitive theory, self-regulated learners are viewed as engaging in four processes: goal setting, self-observation, self-judgment, and self-reaction (Schunk & Zimmerman, 1989). Self-regulated learning is “metacognitively guided,” strategic, and intrinsically motivated (Winne & Perry, 2000, p. 533) and includes processes such as goal setting, effective strategy use, and performance monitoring (Pintrich & De Groot, 1990).

Pintrich (2000) defines self-regulated learning as an “active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment” (p. 453).

Pintrich notes that although there are many models of self-regulated learning most share four main assumptions:

1. Learners actively construct knowledge during the learning process.

2. Learners actively control, monitor, and regulate aspects of their learning environment, as well as facets of their own cognition, behavior, and motivation.

3. Learning is goal-driven, and goals are compared to set standards or criteria in order to monitor progress and adapt facets of cognition, behavior, and motivation if necessary.
4. Learners’ regulation of their own cognition, behavior, and motivation acts as a mediator between the person, their context, and their achievement.

Models of self-regulation also contain metacognitive components including self-monitoring (Kanfer & Ackerman, 1989) and control (Nelson & Dunlosky, 1994; Nelson, Dunlosky, Graf, & Narens, 1994). Self-monitoring allows learners to observe their own thoughts and behaviors. This metacognitive component allows the learner to observe their progress toward desired goals and to compare their current progress to a goal end-state so that attention and effort can be allocated. Control allows the learner to reallocate effort or strategically utilize or change strategies based on monitoring judgments, even when making judgments about something unfamiliar or unknown. Nelson et al. (1994) found that when studying for a test, self-regulated learners were able to adjust their study tactics based on their judgments of the difficulty of the material. In Winne and Hadwin’s (1998) model self-regulated learning is a recursive, four-phase event that places monitoring and control at the center of self-regulated learning. In Phase One, the learner assesses and defines the task at hand; in Phase Two, the learner sets goals and creates a plan to attain the goals; in Phase Three, the learner applies strategies and tactics, and in Phase Four, the learner controls learning by making adaptations to their learning based on metacognitive monitoring judgments.

In the 1970s, when researchers began emphasizing cognitive processes and the learner came to be seen as an active participant in learning rather than a passive receptacle, cognitive learning strategies were developed (Weinstein, 1978). According to Weinstein and Meyer (1991), cognitive learning strategies must be goal directed, intentionally
invoked, and effortful. The ability to know and utilize cognitive learning strategies was found to discriminate between successful students and those who are less successful (Pintrich & DeGroot, 1990). It was also determined that both cognitive learning strategies and self-regulation strategies could be taught by exposing students to effective models and giving students opportunities for practice (Weinstein, Husman, & Dierking, 2000).

Reading and learning strategies, which are both cognitive and metacognitive, play important roles in the self-regulation of reading comprehension because they help learners plan their learning, process information effectively during learning, evaluate their learning, and adapt their processing based on monitoring and task demands. Schunk and Zimmerman’s (1997) domain specific, four-level, social cognitive model of self-regulated competence provides a framework for effective cognitive and metacognitive reading strategy instruction. Observation is the first level of this model, and it is at this level where a student learns by observing an expert, usually the teacher, model a strategy. By “thinking aloud” the model can display the required thought processes and behaviors, and learning is enhanced when the model “provides guidance, feedback, and social reinforcement during practice” (p.199). During the second phase, called emulation, the learner tries to emulate the model’s thinking and behavior. In the self-control phase, the third phase of the process, the learner has internalized the strategy and can use it independently but must think about the steps required in order to use the strategy correctly. By the fourth phase, called self-regulation, the learner controls the use of the strategy, can employ the strategy intentionally, and can adapt the strategy to fit a variety of situations. Self-reinforcement through increased self-efficacy and self-motivation occurs during this final phase.
Metacognition

Metacognition, which is often described as “thinking about thinking,” was originally defined by Flavell (1976) who described metacognition as “…one's knowledge concerning one's own cognitive processes or anything related to them, e.g., the learning-relevant properties of information or data. For example, I am engaging in metacognition if I notice that I am having more trouble learning A than B; if it strikes me that I should double check C before accepting it as fact.” (p. 232). Later, Flavell (1979) expanded the definition of metacognition beyond its original scope, which entailed knowledge of cognition related to task, person, and strategy variables, to include metacognitive experiences, which he described as feelings of understanding. Flavell also included knowledge, motivation, and affect in this definition of metacognition (Jacobs & Paris, 1987) making it strikingly similar to some current definitions of self-regulated learning.

Baker and Brown (1984) constrained Flavell’s (1979) definition of metacognition to two “clusters of activities” (p. 353): knowledge of cognition and regulation of cognition (Baker, 1984; Jacobs & Paris, 1987). Knowledge of cognition refers to a learner’s knowledge about his or her own thinking and the compatibility between a learner and the learning situation. Knowledge of cognition also includes three subcategories: declarative knowledge, which entails understanding one’s self as a learner and one’s knowledge of strategies; procedural knowledge, which entails knowing how to use strategies; and conditional knowledge, which is knowing why and when to employ certain strategies (Brown, 1987; Jacobs & Paris, 1987). Regulation of cognition includes three subcomponents: planning, where learners engineer a way to reach a desired goal through
the selection of strategies; *monitoring*, where learners make accurate metacognitive judgments regarding progress and make modifications based on those judgments; and *evaluation*, where learners assess their own learning, goals, and tasks (Jacobs & Paris, 1987).

Knowledge of cognition and regulation of cognition are related (Baker & Brown, 1984), but there are still questions about the nature of that relationship (Sperling, Howard, Staley, & DuBois, 2002). Schraw and Denison (1994) argued that although the two aspects of metacognition are related, each makes unique contributions to overall levels of metacognition. In classroom settings, several studies have found positive correlations between knowledge and regulation of cognition as well as between metacognition in general and strategy use (Sperling et al., 2002). Sperling and her colleagues (2002) also found significant correlations between metacognition and academic monitoring and positive correlations between metacognition, metacognitive strategy use, and motivation. Research has also indicated that individuals vary in their levels of metacognitive knowledge (Schraw, 1997; Schraw & Nietfeld, 1998).

Early metacognitive reading research using children of various ages as participants revealed that knowledge of metacognition and regulation of metacognition in children varies depending on age and comprehension ability (Markman, 1977; Pressley & Afflerbach, 1995). Markman (1977), investigating whether first- and third-grade students were able to detect a major omission in a set of verbal instructions, discovered that third-graders were able to internally enact the instructions and therefore were able to realize that the instructions were missing an important direction, while first graders were unable to
detect the omission. Myers and Paris (1978) conducted one of the first studies of metacognition and reading using 8- and 12-year-old participants. The researchers, using a scripted interview technique, found that the older children were more knowledgeable about variables and strategies that affect reading performance than the 8-year olds. In a later study, Paris and Myers (1981) compared skilled and unskilled fourth grade readers and found that the better readers knew more about reading strategies, were able to detect more errors, and remembered more text information than the poor readers. These studies illustrate that knowledge about reading and comprehension increases with age and ability (Jacobs & Paris, 1987), a finding that has distinct implications for metacognitive reading strategy instruction.

*Metacognitive Monitoring in Reading Strategy Instruction*

In the past 30 years the shift in thinking from viewing the learner as a receptacle for information to viewing the learner as an active, motivated participant able to process information in complex ways has led to the development of self-directed, cognitive learning strategies (Weinstein, 1978). This idea has been an important development in cognitive psychology and educational psychology because studies have shown that knowing learning strategies and being able to use them are characteristics of high achieving students (Pintrich & De Groot, 1990). Although learners can spontaneously develop learning strategies, the development of effective strategies is often based on exposure to effective instruction and opportunity for practice (Pressley & McCormick, 1995). This is particularly true in reading instruction where knowledge of cognitive
reading strategies coupled with the ability to regulate the use of those strategies is crucial for success.

Metacognitive reading strategy instruction, when taught within a framework of self-regulation (Schunk & Zimmerman, 1998), has been implicated in higher levels of reading comprehension, learning, and performance (Paris & Jacobs, 1984; Winne & Hadwin, 1998). Metacognitive comprehension strategy instruction assists students in planning, monitoring, and evaluating their own comprehension, which leads to higher levels of knowledge construction and deeper learning from expository text (Artelt, Schiefele, & Schneider, 2001; Borkowski, Schneider, & Pressley, 1989). Strategies seen as critical for constructing meaning from text include: activating prior knowledge, setting a purpose for reading, summarizing, inferring, monitoring, visualizing, and self-regulating strategy use before, during, and after reading (Pintrich, 2003). Explicit instruction in acquiring procedural knowledge, which consists of how to use strategies, and conditional knowledge, which consists of why and when to use strategies, is also seen as critical by reading researchers (Jacobs & Paris, 1987; Schraw & Dennison, 1994).

To comprehend text, readers must not only know strategies and procedures that are integral to the reading process, such as inferring relationships contained within the text, but readers also must have the conditional knowledge to know when and why certain strategies should be used (Paris et al., 1983). In addition to conditional knowledge, readers must have the ability to monitor their comprehension online as they read so that they are able to stop and employ the correct strategy when comprehension goes awry. Reading comprehension truly is a form of self-regulated learning in that so much of what makes a person a
proficient reader must be self-directed. Metacognitive monitoring and the flexible control of one’s own thought processes are characteristics of proficient, mature readers, but these processes and skills are teachable, even to younger and inexperienced readers.

**Graphic Organizers as a Metacognitive Reading Strategy**

When attempting to comprehend and learn from expository text, readers must be able to employ both surface-level and deep strategies. Surface-level strategies consist of strategies that help readers understand and remember fact-level textbase and macrolevel (Kintsch & Kintsch, 2005) information. Deep processing strategies are those that help readers select important information, link new information with prior knowledge, and ultimately construct a situation (Kintsch & Kintsch, 2005) or mental model (Schnotz, 2005). Graphic organizers encourage deep learning because they help readers construct knowledge from text by making the interrelationships between text concepts explicit (Horton, Lovitt, & Bergerud, 1990).

The National Reading Panel (National Institute of Child Health and Human Development [NICHD], 2000) and multiple researchers (Armbruster et al, 2001; Bean, Singer, Sorter, & Frazee, 1983; Hyerle, 2009) have identified the graphic organizer as an important metacognitive reading comprehension strategy that should be used in conjunction with other metacognitive reading strategies. Graphic organizers are particularly applicable to metacognitive reading strategy instruction and self-regulated learning because they can be utilized before, during, and after reading. Graphic organizers can be used to activate prior knowledge in those who lack it, guide metacognitive monitoring, and assess learning. Weinstein and Mayer (1986) found that graphic organizer
strategies, such as concept mapping, help students attend to the task, focus on important task features, organize concepts and information, and maintain positive affect and motivation for learning.

Reading strategies and learning strategies go hand in hand, and graphic organizers are versatile reading strategy tools that can be employed during all stages of reading to help learners construct knowledge from text (Chang, Sung, & Chen, 2002; Weinstein & Mayer, 1986). Despite discrepancies in the research, graphic organizers have been shown to benefit reading comprehension (Chimielewski & Dansereau, 1998; DiCecco & Gleason, 2002) by making text concepts and structure explicit (Meyer & Poon, 2001). Graphic organizers have the potential to benefit many types of learners, but many of these benefits may not yet have been realized. The majority of graphic organizer studies examined earlier in this paper did not examine the impact of extended instruction, nor did these studies combine graphic organizer strategies with other metacognitive strategies, such as metacognitive monitoring. More research is needed to refine and build upon what we already know about the different types of graphic organizers and how, why, and when they work. In addition, more research is needed to examine the best ways in which to combine graphic organizer and metacognitive monitoring instruction.

Overview of Current Study

Although graphic organizers have been identified as a worthwhile, research-based comprehension and note-taking strategy (Chimielewski & Dansereau, 1998; National Reading Panel, 2000; Novak, 1990; Weinstein & Mayer, 1986), there has been little research examining the impact of combining graphic organizers with other metacognitive
reading strategies. Content area reading textbooks often suggest using graphic organizers as an organizational and note-taking strategy based on text structure (Bromley et al., 1995; Vacca & Vacca, 2001), but this approach neglects the ways in which graphic organizers can be used to not only encourage graphical note-taking based on recognition of text structure, but to also encourage students to monitor and regulate their cognition before, during, and after reading. This study will examine the impact of teaching 5th grade students both graphic organizer and metacognitive monitoring strategies on the comprehension of science text.

The goal of this study is to examine the impact of combining matrix-building instruction, in which students are taught to construct a matrix to represent compare and contrast relationships within text components, with metacognitive monitoring strategy instruction, where students are taught to assess and to repair comprehension difficulties. This study differs from previous studies in two ways. First, this intervention will utilize fifth grade students in intact classrooms and students will not be differentiated by exceptionality. The ability to comprehend expository text is critical for students at this grade level because most will be advancing to a middle school the following year. Numerous studies have examined the effects of graphic organizers on comprehension in post-secondary students or in students with diagnosed learning disabilities (Kim et al., 2004; Nesbit & Adesope, 2006); however, few have utilized a general population of upper elementary students.

Second, this study will extend graphic organizer research by examining the effect of teaching students to construct a matrix, a common organizer illustrating the compare
and contrast text structure, within metacognitive monitoring strategy instruction. Although graphic organizers are sometimes deemed metacognitive in and of themselves (Hyerle, 2009; Armbruster, 2001; Novak, 1990), few studies have examined the effects of explicitly teaching a graphic organizer strategy that can be used alongside metacognitive monitoring strategies at all stages of the reading process. Although graphic organizers can be found in textbooks and classroom materials throughout content areas and at most grade levels, teachers are rarely trained to teach students both graphic organizer and metacognitive monitoring strategies. The majority of graphic organizer studies examined for this discussion had participants constructing graphic organizers as an after-reading cognitive strategy rather than as a part of metacognitive strategy instruction, where students monitor and control their comprehension across all phases of reading. Armbruster et al., (2001), in their widely distributed publication *Put Reading First*, identify graphic organizers as a metacognitive strategy and stressed the importance of teaching students to flexibly use this strategy in a metacognitive manner *in combination* with other metacognitive strategies.

This study will add to graphic organizer and reading comprehension research by examining whether upper-elementary students who are taught to build a matrix along with other metacognitive monitoring strategies before, during, and after reading comprehend expository science text better than students receiving only matrix-building instruction or metacognitive monitoring instruction. In addition, this study will examine the effects of individual differences, such as verbal ability, prior knowledge, and metacognition on comprehension when students are taught both graphic organizer and metacognitive monitoring strategies in tandem and separately.
Research Questions and Hypotheses

In this study, the following research questions will be addressed:

1. What is the impact of instructional condition on a standardized test of reading comprehension?

2. What is the impact of instructional condition on comprehension scores across seven expository reading passages? Do students in different instructional conditions show different rates of comprehension change?

Based on previous graphic organizer and metacognitive monitoring research, it is hypothesized that students in the combined graphic organizer and monitoring condition will show greater gains in comprehension than students in instructional conditions where the graphic organizer or monitoring strategies are taught in isolation. Research in which K-12 students have been explicitly taught over a period of time to construct their own graphic organizers after reading has shown increased comprehension and learning (Boyle & Weishaar, 1997; Bulgren, Schumaker, & Deschler, 1988; Gardill & Jitendra, 1999).

Mayer (2003) suggests that generative learning occurs when students are required to generate a product. A student-created graphic organizer depicting relationships among text concepts is just such a product, and student-constructed graphic organizers have been shown to promote this type of generative learning (Katayama & Robinson, 2000).

Although some studies have shown larger comprehension gains when students utilize teacher- or author-constructed graphic organizers rather than constructing their own due to increased cognitive load (Mayer & Moreno, 2003; McCrudden et al, 2007; Sweller, 1988), participants in these studies were not given extended training and therefore did not have an
opportunity to learn or practice the strategy over time.

In addition, successful readers are those who are aware of comprehension difficulties in their own reading and then are able to correct those difficulties in a strategic manner (Afflerbach, 2002; Johnson & Afflerbach, 1985; Pressley, 2002; Pressley & Afflerbach, 1995). Students explicitly taught to use metacognitive monitoring strategies have shown increases in metacognitive knowledge (Paris, Cross, & Lipson, 1984), strategy use (Bereiter & Bird, 1985) and reading comprehension (Klingner & Vaughn, 1999; Mason, 2004); therefore it is expected that students receiving metacognitive monitoring instruction will show gains in reading comprehension over time. In this study, because students will be given a minimum of 300 minutes of both graphic organizer and monitoring instruction and practice time over a period of four weeks, it is expected that the combination of the two strategies will produce the greatest comprehension gains.

3. *Does verbal ability, metacognition, or prior knowledge moderate the relationship between instructional condition and reading passage comprehension?*

Students with higher levels of verbal ability, metacognitive knowledge and regulation, and prior knowledge should be more able to attend to relevant information in text, to elaborate on what they are reading by inferring relationships among and between text elements (McNamara et al., 1996), and to build mental models that help them understand and remember what was read (Anderson & Pearson, 1984; Trabasso & Bouchard, 2002). Students with better monitoring proficiency have been shown to comprehend text better than students with who are unable to monitor their understanding effectively (Oakhill et al., 2005). The ability to monitor comprehension is also related to
the level of prior knowledge a reader holds. Prior knowledge of a topic frees up working memory, allowing the reader to monitor comprehension more effectively (Kinnunen & Vauras, 1995). Because proficient readers are those with high levels of verbal ability, metacognition, and prior knowledge, all of which assist the reader in creating accurate situation models by combining the propositions contained in the textbase with their prior knowledge (Kintsch, 1983, 1992, 1998, 2005, van Dijk & Kintsch, 1983), it is hypothesized that verbal ability, metacognition, and prior knowledge will moderate the relationship between instruction and comprehension in all instructional conditions.

4. What is the impact of instruction on metacognition, as measured by the Jr. Metacognitive Awareness Inventory (Jr. MAI) and the Metacomprehension Strategy Index (MSI)?

Proficient readers regulate their own reading by monitoring their understanding as they read. Readers who adequately monitor their comprehension also are able to employ control, or fix-up strategies, such as rereading or asking themselves questions, when they notice comprehension breakdowns (Samuels, Ediger, Willcutt, & Palumbo, 2005). One of the biggest differences between good and poor readers is that poor readers are not metacognitive (Baker, 2002). Poor readers rarely set goals or think about the purpose of the reading task. They are often not aware enough of their own cognitive processes to recognize when their comprehension breaks down, and they often lack an arsenal of reading strategies and the knowledge to know when and how to employ these strategies. Because students in the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition will receive extended instruction in metacognitive
monitoring processes, it is hypothesized that students in these two conditions will show increases in both metacognitive knowledge and regulation, as measured by the Jr. MAI and the MSI.
CHAPTER THREE

Methods

Participants

The 162 fifth-grade students who participated in this study were recruited from a large, public elementary school in central North Carolina. Seven fifth-grade teachers at the school volunteered to participate in the study, and all of their students within seven mixed-ability 5th grade classes, each containing 20 to 30 students, were asked to participate as well. Eighty-nine male students and 73 female students participated in this study, and the mean age of the students was 125.07 months. 78% of the participants attended this same school the previous year. The participating teachers were all female and had years of teaching experience ranging from three to 19 years. In 2009, the school housed a total of 975 students in grades K-5 representing the following demographic percentages: 66.3% White, 16.8% Black, 6.4% Hispanic, 6.0% Asian, 4.2% mixed race, and 0.3% American Indian. The free and reduced lunch population for this school in 2009 was 18%.

Because this school operated on a multi-track year-round schedule, students were assigned to one of four tracks, in which they rotated through nine weeks of instruction followed by three weeks of break throughout the year. Across the four tracks, there were two fifth-grade classes on Track 1, one class on Track 2, two classes on Track 3, and two classes on Track 4. Each of the seven classes was randomly assigned to one of four
conditions: Graphic organizer + Metacognitive Monitoring, Graphic Organizer, Metacognitive Monitoring, or to a Comparison Group. Two classes were randomly assigned to each of the instructional conditions while the class left over became the comparison group.

**Time Frame and Conditions**

This study took place during the first nine weeks of school during the 2009-2010 school year. Due to the year-round schedule, the study began with students in Track 1 and Track 2 in early July and concluded with students in Track 3 and Track 4 in late September. Classes were randomly assigned to each of the four conditions, and instruction for all students took place two times a week for 50 minutes a session. The four conditions were:

1. *Graphic Organizer + Metacognitive Monitoring* (GO+MM): Students in this condition were taught two comprehension strategies to utilize in tandem when reading expository science text. Students were taught how to create a matrix while reading to illustrate compare and contrast relationships within expository text and were also taught to use metacognitive monitoring strategies before, during, and after reading the text.
2. Graphic Organizer (GO): Students in this condition were taught how to create a matrix while reading to illustrate compare and contrast relationships within the science text.

3. Metacognitive Monitoring (MM): Students in this group were taught to use metacognitive monitoring strategies before, during, and after reading science text.

4. Comparison Group (CG): Students in this group did not receive the study-directed graphic organizer or metacognitive monitoring instruction but did read each of the science texts and were given the same assessments as students in each of the other conditions.

Measures and Materials

Demographic Questionnaire: Participants were given a four-item measure to identify age, gender, ethnicity, and the school attended the previous school year.

Gates-MacGinitie Reading Test 5th Grade Version Forms K & L: The Gates-McGinitie Reading Tests Forms K (pretest) and L (posttest) (MacGinitie, MacGinitie, Maria, & Dreyer, 2002) were given to all study participants. The Gates-MacGinitie is a standardized diagnostic measure used to determine reading comprehension level and vocabulary knowledge and is accepted as a reliable and valid instrument by literacy researchers (Collins & Cheek, 2000). During the comprehension section of the test
students read passages and answered 48 multiple-choice questions about each. During the vocabulary section, students read definitions and then selected the correct vocabulary word from a multiple-choice list. There were 45 questions on the vocabulary portion of the test. Students were given 55 minutes to complete the test.

*Jr. MAI (Jr. Metacognitive Awareness Inventory):* The Jr. MAI is a 12-item scale used to measure general metacognitive awareness in the form of two factors: knowledge of cognition and regulation of cognition. Factor analysis and high intercorrelations between items within factors across multiple studies revealed the Jr. MAI to be a reliable measure of self-report metacognitive awareness (Sperling, Howard, Miller, and Murphy, 2002).

*Metacomprehension Strategy Index (MSI):* The MSI is a 25-item, multiple-choice questionnaire that measures children’s awareness of strategic reading practices before, during, and after reading (Schmitt, 1990). Lonberger (1988) and Schmitt (1990) have separately reported the MSI to have high internal reliability with evidence for concurrent validity.

*Reading Passages:* The study utilized eight expository passages, all of which aligned with the North Carolina Standard Course of Study for fifth-grade science. Each passage was written by the researcher and utilized a compare and contrast text structure. The passages were standardized according to number of words as well as readability. Each passage contained between 390 and 420 words and was rated at a Flesch-Kincaid Grade Level of between 5.0 and 6.0. Seven fifth-grade teachers and the county senior administrator in elementary science examined each of the passages for suitability of
content and difficulty level. In addition, all of the passages were field tested prior to the study with a separate sample of fifth-grade students.

Table 3.1

<table>
<thead>
<tr>
<th>Passage Title</th>
<th>Flesch-Kincaid Grade Level</th>
<th>Word Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glaciers</td>
<td>5.5</td>
<td>394</td>
</tr>
<tr>
<td>Forest Biomes</td>
<td>5.7</td>
<td>397</td>
</tr>
<tr>
<td>The Atmosphere</td>
<td>6.0</td>
<td>405</td>
</tr>
<tr>
<td>Volcanoes</td>
<td>5.9</td>
<td>399</td>
</tr>
<tr>
<td>Hurricanes</td>
<td>6.0</td>
<td>412</td>
</tr>
<tr>
<td>The Food Chain</td>
<td>5.9</td>
<td>412</td>
</tr>
<tr>
<td>Simple Machines</td>
<td>5.7</td>
<td>420</td>
</tr>
<tr>
<td>Clouds</td>
<td>5.9</td>
<td>401</td>
</tr>
</tbody>
</table>

*Prior Knowledge:* Prior knowledge for each topic was assessed immediately before the students read each passage. Students were given a blank sheet of paper and were given three minutes to write down as much as they could about the topic. Two independent raters coded the prior-knowledge sheets, and the number of accurate and original propositions was recorded. One point was given for each unique, accurate proposition included. Interrater reliability was established to be 90%, and any disagreements were resolved.
through discussion.

*Passage Comprehension Assessment:* Students were given a researcher-created comprehension assessment following each reading passage. The assessments given for the first and last reading passages, *Glaciers* and *Clouds* respectively, consisted of 10 multiple-choice questions, including three inference questions, three fact-level questions, two vocabulary questions, and two main idea questions. The other six assessments included eight multiple-choice questions: three inference questions, three fact-level questions, one vocabulary question, and one main idea question. The assessments were scored and a percentage correct score was utilized in all analyses.

*Procedures*

This study took place over the course of six weeks within each class, with instruction taking place two times per week during each class’s designated 50-minute reading block. Participants in the three instructional conditions: Graphic Organizer + Metacognitive Monitoring, Graphic Organizer, and Metacognitive Monitoring, received 50 minutes of instruction two times per week during weeks two through five of the study. The first and last weeks were reserved for pre- and posttests. The primary researcher provided instruction for students in the three instructional conditions. Students in the Comparison Group were given the same reading passages and assessments in the same order as students in the instructional conditions but were given no graphic organizer or metacognitive monitoring instruction. They read the passages and took the assessments twice per week during their regular reading block with their classroom teacher.
Before the start of the study all students were given a letter explaining the study and a parental consent form, which gave parents the option of having their children participate in alternate reading assignments provided by the classroom teachers if they did not want their child to participate in the study. Two students did not participate in the study.

During the first week all participating students completed a series of assessments, which were administered by the researcher in the same order in all of the classes. During Week 1: Session 1, which took 1.5 hours, the researcher introduced herself to the students and told the students that they would be participating in a reading comprehension study. The students then completed the demographic survey and were given the Gates-MacGinitie Reading Test to establish a baseline score for each student for verbal ability. During the second session, students were given one hour to complete a packet of surveys, which included the Jr.MAI and the MSI. During the third session, which took place during the first session of the second week, students were tested on their prior knowledge of glaciers and then were given the passage *Glaciers* as a reading passage comprehension pretest. To test for prior knowledge of glaciers, each student was given a blank sheet of paper. The students had three minutes to write down as much as they could about glaciers. Following this assessment, the glacier passage was distributed, and the students were given 30 minutes to read the passage and complete the 10-item assessment.

Instruction in each of the conditions began the following session. From the second session of week two until the final session of week five, the researcher provided instruction to students in the three instructional conditions. During the first two instructional sessions,
the researcher modeled metacognitive monitoring and matrix building by “thinking aloud” for the students so that the researcher’s own thought processes were able to be heard. With each successive session, instructional scaffolding was reduced so that students were reading, creating graphic organizers, and taking the comprehension assessments entirely on their own by the end of week four. By week five, students were reading and taking the assessments independently. For a description of the six-week schedule see Table 2. In the comparison classroom, the students, supervised by their classroom teacher, received passages twice per week in the same order as students in the instructional conditions and completed the same assessments as students in the instructional conditions.

Table 3.2

**Six-Week Assessment Schedule for all Students**

<table>
<thead>
<tr>
<th>Week</th>
<th>Session 1</th>
<th>Session 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>● Demographic Survey</td>
<td>● Jr. MAI</td>
</tr>
<tr>
<td></td>
<td>● Gates-MacGinitie Reading Test (K)</td>
<td>● MSI</td>
</tr>
<tr>
<td>Week 2</td>
<td>● Passage: <em>Glaciers</em></td>
<td>● Passage: <em>Biomes</em></td>
</tr>
<tr>
<td>Week 3</td>
<td>● Passage: <em>Atmosphere</em></td>
<td>● Passage: <em>Volcanoes</em></td>
</tr>
<tr>
<td>Week 4</td>
<td>● Passage: <em>Hurricanes</em></td>
<td>● Passage: <em>Food Chain</em></td>
</tr>
<tr>
<td>Week 5</td>
<td>● Passage: <em>Simple Machines</em></td>
<td>● Passage: <em>Clouds</em></td>
</tr>
<tr>
<td>Week 6</td>
<td>● Jr. MAI</td>
<td>● Gates-MacGinitie Reading Test (L)</td>
</tr>
<tr>
<td></td>
<td>● MSI</td>
<td></td>
</tr>
</tbody>
</table>
Conditions

Graphic Organizer + Metacognitive Monitoring (GO + MM)

Students in this condition received explicit instruction in matrix construction as well as instruction in metacognitive monitoring strategies. During the first six instructional sessions, students were given a blank matrix and monitoring checklist along with their reading passages to help them remember the steps of each process. The metacognitive monitoring and matrix checklist provided a list of questions for the students to ask themselves at each stage of reading and matrix construction. The checklist contained the following prompts:

Before reading:
- _____ I scanned the material.
- _____ I thought about what I already know about the topic.
- _____ I thought about my purpose for reading the text.
  
  I am reading this text:
  - _____ to learn.
  - _____ to complete a task.
  - _____ for fun.

During Reading:
- _____ I underlined information that should go in my matrix
- _____ I marked the text with a * (star) when I did not understand or lost my concentration.
- _____ I circled any vocabulary words that I was not able to figure out.
- _____ I re-read as a “fix-up” strategy.
- _____ I used context-clues as a “fix-up” strategy.
- _____ I continued on as a “fix-up” strategy
- _____ I began constructing my matrix.

After reading, I checked my understanding by:
- _____ Asking myself if the text made sense to me. Did I understand it?
- _____ Reviewing my matrix to make sure I put all the important information in it.
- _____ Thinking about whether I could explain this text well to one of my friends.
Students were given the checklist along with their reading passage and a blank matrix during the first three weeks of instruction. The first instructional session began with the researcher explaining why it was important to learn to monitor comprehension and build matrices. At the beginning of each session, the researcher would ask the students to explain how these two strategies would be helpful to them in the future. Then the researcher would provide instruction according to the condition and to the progress the students were making. Next, the researcher would test the students on their prior knowledge of the passage topic for the day. After the prior knowledge assessment was collected, the reading passage and its accompanying assessment, the Metacognitive Reading Checklist, and a blank matrix were distributed. The researcher followed this procedure until week five when the students were reading, matrix building, and taking the assessments independently. During week five the students took the prior knowledge assessment but received only the reading passage, its assessment, and a blank matrix sheet.

The researcher began instruction using modeling and think-alouds to show the students how proficient readers might monitor their comprehension and build matrices comparing and contrasting important text components. After modeling, the researcher asked the class to perform the monitoring and matrix-building steps while reading the expository passage for that session. The researcher would walk the classroom examining the students’ progress and providing scaffolding when needed. With each successive instructional period scaffolding was reduced; by week five, students were reading the text, creating a matrix, and taking the corresponding assessment independently. During both sessions of week five, students received the passages without a checklist or matrix frame.
Sample Graphic Organizer + Metacognitive Monitoring Script: Session One

First, have any of you ever heard of the word metacognition? Great! Where have you heard this word? Right, the word metacognition is used quite a bit in classrooms today when teachers talk about reading strategies. A simple definition of metacognition that many people use is “thinking about thinking.” What do you think that means? Well, when you talk about reading, thinking about your thinking means paying attention to what your brain is doing while you read. How many of you have ever read a page and then realized you had no idea what you just read? I see that most of you have experienced this. When you stop because you realize that you don’t know what you just read, you are doing something metacognitive. Paying attention to your understanding as you read is a metacognitive process. I will be working with you for the next five weeks to help you learn to be a more metacognitive reader. We are going to work on metacognitive monitoring, which means that we are going to learn to pay attention to our understanding as we read, and we are going to learn some strategies we can use when we realize we have lost our understanding. Why do you think this is especially important for you all to be able to do well next year? Right, you will be in middle school, and you will have more than one teacher. Your middle school teachers will expect you to be able to learn from reading, and paying attention to your understanding is a huge part of being a better reader.

I am also going to teach you how to make a graphic organizer called a matrix. How many of you have heard of a matrix? Not many! Well, how many of you have heard of a Venn diagram? All of you! Great! Why do you use a Venn diagram? Right, you use a Venn diagram when you want to compare how things are alike and how they are different.
Let’s draw a Venn diagram on the white board. Somebody give me the names of three animals. Good, we’ve got a giraffe, a dolphin, and a mouse. I would like somebody to come to the board and draw a Venn diagram that we can use to compare and contrast these animals. What would the Venn diagram look like? Right, it would need to have three interconnected rings. Let’s put some information in the rings. How are the animals different and where would we put this information? Right, we put information about how things are different in the non-overlapping areas of the three circles. That’s good because it gives us a lot of space to write the differences, but where do we put the similar characteristics? Right, we put them in the small overlapping spaces, which does not give us much room to write. What would we need to do if we wanted to compare and contrast five animals? Draw lots of connected circles? Well that would be confusing, so I am going to teach you how to make an organizer called a matrix. It is a simple way to compare and contrast multiple things and still have lots of room for your notes. A matrix is a simple way to take notes on the most important parts of a passage that has a compare and contrast structure.

Let’s begin. I would like you all to scan the reading passage I have just given you. Think about what you already know about this topic and what you would like to learn about this topic. Can you tell from the title or from the illustration what type of text structure or text structures this passage has? I can see from the title and from the illustration that we will be reading about different types of trees, and I notice that there are words italicized throughout the text followed by descriptions. This tells me that the passage may have a compare and contrast text structure, which means that we will
probably be reading about types of trees and how they are the same and different from each other. I am going to read the passage aloud, and I will show you how I think about my comprehension as I read and how I make sure I understand what I am reading. I will also show you what I do when I am certain that I know the text structure.

Before I begin reading I like to think about why I am reading and what I already know about the topic. Because I am in class and because this is a passage that is supposed to give me information about trees, I know that I am reading this passage to learn something. Also, I am going to think about what I already know about trees. After I think about what I know I am going to read the first paragraph. Hmmm . . . already I’ve run into a word I don’t recognize. I’m not sure I know the meaning of this word “deciduous” so I am going to circle it. I circle any words I don’t know to remind myself that I may need to look at this word again. I am not sure what the word “deciduous” means, but I know it must be important because it is in italics. I think I’m going to search around that word to see if I can find any clues to its meaning. I see that the sentence does mention that deciduous trees lose their leaves in the winter so maybe that is what deciduous means.

Since I’m pretty sure that this is a compare and contrast piece of text I am also going to begin underlining important ideas that should probably go in my matrix. I know that this passage is about types of trees so I am going to underline information that identifies the main types of trees and I will also underline the important similarities and differences of those trees.

In addition to modeling metacognitive monitoring and control, I also model how I mark structure clue words as I read. In the first paragraph I see a sentence that says there
are “different types” of trees. I am going to underline the words “different types” because this lets me know that the passage may be about to tell me about these different types.

Remember the word deciduous, which was also in the first paragraph. It is probably a type of tree that loses its leaves. I usually underline all of the italicized words because they most likely identify objects that are to be compared or contrasted. Every time I see a word that is italicized, one provides a text structure clue, or one that provides important information about the items I am to compare and contrast I underline it.

I keep reading until I reach the end of the first paragraph. Using the Metacognitive Monitoring Checklist, I stop and ask myself the “during reading” questions. Does this paragraph make sense to me? Do I understand it well? Yes, so far I understand what I am reading – other than the word deciduous, but I think I know what it means now. Can I identify the text structure or structures found in the passage? Yes, now I am pretty sure it is a compare and contrast structure. Did I mark information I need to include in my graphic organizer? Yes, I underlined the italicized words. Did I mark any words I did not understand? Yes, so far I understand the passage, and I’m pretty sure I know the meaning of the word deciduous. Sometimes though, there aren’t any clues near the word to help me understand its meaning. If this happens I will make sure I have circled the word and I will keep reading. Maybe the meaning will become clear to me after I have finished reading the entire passage.

What happens when you get really confused or you realize that you are not paying attention to what you are reading? Right, you don’t understand or remember anything. It is very important to notice when your understanding has been lost. Some people don’t realize
that they do not understand and they just keep reading, but it is important to pay attention to your understanding, which is also called comprehension. That is one of the reasons we are going to use the checklist. It slows us down a bit so that we can get used to checking our comprehension. Once we get the hang of monitoring our comprehension we won’t need the checklist, but for now we are going to use it to keep us on track. When you realize that you don’t understand what you are reading, either because it was difficult text or because you just weren’t paying attention, I want you to mark that spot in the text with a star. This will make you stop and think about what you should do next. One strategy that you can use is to go back and read that part of the text again. Often, a second reading will help focus your attention and will help you understand the text better. Let’s read the rest of the text together. We are going to circle the words we don’t know, underline information for our matrix, and draw a star if we realize we don’t understand or haven’t been paying attention.

Now that I’ve reached the end of the passage I need to think about how well I understand it. I can always re-read parts of the passage if I don’t understand parts of it. I also need to think about whether I’ve marked the important compare and contrast information for my matrix. I’m going to look back at the passage to make sure I’ve marked the different types of trees and any important words that describe those types of trees. Once I am satisfied that I have marked the important information I begin filling in my blank matrix. Next, I model how I refer back to the text to look at the information I underlined so that I can write that information in my matrix. Once my matrix is filled in I need to ask myself a few questions. Did I include all the important information from the passage in my
matrix? Is all of the information I included in my matrix correct? (I show the students how I go back and forth between the matrix and the text making sure to check off all the information in the text that I placed in the matrix and making sure it is accurate.) I make sure I understand all the words in my matrix, and I even ask myself if I think a friend would be able to use my matrix to study for a test on trees.

During the first instructional session, a short sample passage about trees was modeled in this manner. Once I was done modeling the tree passage I gave each student a blank sheet of paper for a prior knowledge assessment. After they wrote down as much as they could in three minutes about biomes, the second passage, I collected the prior knowledge sheets and handed out the Metacognitive Monitoring Checklist, a blank matrix, the Forest Biome passage and its assessment. I told the students to look at the monitoring checklist to get started. We answered the first few before-reading questions as a class and then I had them read on their own. I asked them to stop and look at me when they finished the first paragraph. Once all of the students had finished reading the first paragraph, we discussed the during-reading questions together. I had them complete reading independently. We also filled in one matrix column together and then I released them to complete the matrix on their own. In each successive class I scaffold instruction less and less until they were completing the passage, assessment, and matrix on their own by the beginning of week 5.

Metacognitive Monitoring Condition: Session One

Students in this condition were given the same Metacognitive Monitoring Checklist that the students in the Graphic Organizer + Metacognitive Monitoring Condition received
along with the example reading passage about trees. Instruction began with the researcher explaining why it was important to learn to monitor comprehension and how it would help the students in middle school. Next, the researcher used the tree passage to model metacognitive monitoring. The process was the same as in the Graphic Organizer + Metacognitive Monitoring Condition and used the same monitoring checklist but with all references to matrices removed. There was also no instruction about building matrices. The researcher modeled how she would go about reading the passage on trees using the monitoring checklist as a guide. The students observed as the researcher modeled thinking about the purpose for reading, what she already knew about trees, and all of the other monitoring processes included on the monitoring checklist.

Next, the researcher tested students on their prior knowledge of the passage topic for the day, *Forest Biomes*. After the prior knowledge assessment was collected, the reading passage, its accompanying assessment, and the Metacognitive Reading Checklist were distributed. The researcher and the students read the first paragraph together following the steps of the monitoring checklist. The students read the rest of the passage independently but the research walked around the room assisting students when necessary. With each successive instructional period scaffolding was reduced so that by the beginning of week five, students were reading text and taking the corresponding assessments independently. During both session of week five, students received the passages without the monitoring checklist. A sample script is not included for this condition because the researcher used the same script used in the Graphic Organizer + Metacognitive Monitoring Condition but with any references to matrices removed.
Graphic Organizer Condition (GO)

Students in the Graphic Organizer Condition were taught to read compare and contrast text with the intention of making a matrix to illustrate similarities and differences between items in the text. First, the benefits of building matrices as compared to Venn diagrams were discussed. Then students in this condition were taught to look for words that would identify the text as having a compare and contrast structure. Using the example tree text, the first instructional session began with the researcher thinking aloud and modeling the process of looking for and underlining text structure clue words. Then the researcher modeled how to underline important information in the text and how to transfer that information from the passage to the matrix. The researcher built a matrix that compared types of trees. Following the modeled instruction with the tree text, the researcher distributed a blank sheet of paper for the prior knowledge assessment on Forest Biomes. After three minutes, the researcher collected the prior knowledge sheets and distributed the Forest Biomes passage and the blank matrix. The researcher and the class read the first paragraph together looking for compare and contrast clue words and underlining important information. The class was released to read the rest of the passage independently but the researcher walked the room scaffolding students when necessary. After all of the students were finished reading, the researcher led the class in filling in the first column of the matrix together. The class was told to complete the rest of the matrix independently, but the researcher circulated among the students examining the matrices and providing feedback when necessary. With each successive lesson scaffolding was decreased so that students were reading and creating matrices independently by the
beginning of week five.

Sample Graphic Organizer Instruction Script

Today we will begin by reading a short passage about trees. I need to try to figure out if this passage has a compare and contrast text structure. I am going to read the passage aloud, and I will show you how I look for text structure clue words as I read. I begin reading and stop when I get to the sentence that says there are many different kinds of trees. I am going to underline the words “different kinds” because this lets me know that the passage may be about to compare types of trees. I read until I get to the word “deciduous.” Hmm . . . I’ve come across a word I’m not sure about and I notice that it is in italics. This must mean the word is important, so I need to make sure I notice any italicized words. I am going to underline the word deciduous because even though I do not know exactly what it means, it is most likely an important difference between tree types. The words in italics may be identifying objects that are going to be compared or they could be identifying descriptive words about the items that are being compared. I am going to keep reading and I am going to underline important information that I want to put in my matrix as I go. I am getting to the end of the text, so I am going to look at all the important information I underlined so that I make sure I put all of it in my matrix.

After modeling the example passage, I pass out blank sheets of paper for the prior knowledge assessment on Forest Biomes. After the students complete that assessment, I distribute the Forest Biomes passage, its assessment, and a blank matrix. The students and I fill in the first column of this matrix together and then they are released to complete the reading, matrix, and assessment on their own. As they complete the first matrix I walk
around the room examining matrices and providing assistance when needed. Scaffolding was reduced with each instructional period until the students were reading, constructing matrices, and taking assessments on their own by the beginning of week five.

*Comparison Group (CG)*

Students in the comparison classes took the prior knowledge assessments, read the same passages, and took the same reading assessments in the same order as students in the instructional conditions. The students in this condition were also given a blank sheet of paper with each passage and told to take notes on the passage in any manner that they desired. Their classroom teacher directed these tasks. The only instructions given to the classroom teacher other than the instructions about the passages and the assessments was that she was not to teach metacognitive monitoring or matrix-building strategies during the six weeks of the study.

*Study Schedule*

**Week One**: (Pretesting for all students)

- Day One: Demographic Questionnaire & Gates MacGinitie (1.5 hours)
- Day Two: Jr. MAI and MSI (50 minutes)

**Week Two**:

- Day One: Reading Passage 1 (pre-test): *Glaciers* (no instruction in any condition)
- Day Two: Instruction and Passage 2: *Forest Biomes*
  - Graphic Organizer + Metacognitive Monitoring: Researcher models how to utilize metacognitive monitoring and graphic organizer strategies before, during, and after reading the example *Trees* passage and shows students how to construct a matrix. After instruction, the researcher assesses prior knowledge, provides verbal and written (metacognitive monitoring and matrix checklist) scaffolding as students read and create a matrix using the *Forest Biome* passage. Students then take the passage comprehension assessment.
  - Graphic Organizer: Researcher models how to look for text structure clues
and important compare and contrast information to create a matrix after reading the example *Trees* passage. After instruction, the researcher assesses prior knowledge and then provides verbal scaffolding as the students read the *Forest Biome* text, construct a matrix, and take the comprehension assessment.

- Metacognitive Monitoring: Researcher models how to utilize metacognitive monitoring strategies before, during, and after reading the example *Trees* passage. After modeling, the researcher assesses prior knowledge, provides verbal and written (metacognitive monitoring checklist) scaffolding as students read and take the passage comprehension assessment.
- Comparison Group: Classroom teacher assesses prior knowledge, has students read the *Biome* text, take notes from the text, and take the comprehension assessment.

**Week Three:**

- **Day One: Instruction and *Atmosphere* passage**
  - Graphic Organizer + Metacognitive Monitoring: Researcher reviews the students’ *Forest Biome* organizers and test from the previous class and answers any questions. After the review, the researcher collects the *Forest Biome* materials and assesses prior knowledge about the atmosphere. The researcher then provides verbal and written scaffolding (metacognitive monitoring and matrix checklist) as students read and create a matrix using the *Atmosphere* text. Students then take the passage comprehension assessment.
  - Graphic Organizer: Researcher reviews the matrix from the *Forest Biome* text. After the review the researcher assesses prior knowledge for the atmosphere. The researcher then provides verbal scaffolding when needed as students read the *Atmosphere* text, construct a matrix, and take the comprehension assessment.
  - Metacognitive Monitoring: Researcher reviews the students’ *Forest Biome* assessment from the previous class. After the review, the researcher assesses prior knowledge for the atmosphere. The researcher then provides verbal and written scaffolding (metacognitive monitoring checklist) as students read the *Atmosphere* text and take the passage comprehension assessment.
  - Comparison Group: Classroom teacher assesses prior knowledge, has students read the *Atmosphere* text, take notes from the text, and take the comprehension assessment.

- **Day Two: Instruction and *Volcano* passage**
  - Graphic Organizer + Metacognitive Monitoring: Researcher reviews the students’ *Atmosphere* organizers and test from the previous class and answers any questions. After the review, the researcher collects *Atmosphere* materials and assesses prior knowledge about volcanoes. Verbal and written
scaffolding (metacognitive monitoring and matrix checklist) are provided as students read and create a matrix using the Volcanoes text. Students then take the passage comprehension assessment.
  - Graphic Organizer: Researcher reviews creating a matrix from the Atmosphere text. After the review the instructor collects the Atmosphere materials and assesses prior knowledge for volcanoes. The researcher provides verbal scaffolding when needed as students read the Volcanoes text, construct a matrix, and take the comprehension assessment.
  - Metacognitive Monitoring: Researcher reviews the students’ Atmosphere assessment from the previous class and answers any questions. After the review, the instructor collects the Atmosphere materials and assesses prior knowledge for volcanoes. Then the researcher provided verbal and written scaffolding (metacognitive monitoring checklist) as students read the Volcanoes text and take the passage comprehension assessment.
  - Comparison Group: Classroom teacher assesses prior knowledge, has students read the Volcanoes text, take notes from the text, and take the comprehension assessment.

**Week Four:**
- **Day One: Instruction and Hurricane passage**
  - Graphic Organizer + Metacognitive Monitoring: Researcher assesses prior knowledge about hurricanes, provides verbal and written scaffolding (metacognitive monitoring checklist) as students read and create a matrix using the Hurricane text. Students then take the passage comprehension assessment.
  - Graphic Organizer: Researcher assesses prior knowledge for hurricanes. Then she provides verbal scaffolding when needed as students read the Hurricane text, construct a matrix, and take the comprehension assessment.
  - Metacognitive Monitoring: Researcher assesses prior knowledge for hurricanes. Then she provides written scaffolding (metacognitive monitoring checklist) as students read the Hurricane text and take the passage comprehension assessment.
  - Comparison Group: Classroom teacher assesses prior knowledge, has students read the Hurricane text, take notes from the text, and take the comprehension assessment.
- **Day Two: Instruction and Food Chain passage**
  - Graphic Organizer + Metacognitive Monitoring: Researcher assesses prior knowledge about food chains. Then she provides only written scaffolding (metacognitive monitoring checklist) as students read and create a matrix using the Food Chain text. Students then take the passage comprehension assessment.
  - Graphic Organizer: Researcher assesses prior knowledge for food chains. The researcher provides verbal scaffolding when needed as students read
the *Food Chain* text, construct a matrix, and take the comprehension assessment.

- Metacognitive Monitoring: Researcher assesses prior knowledge for food chains. The researcher provides written scaffolding only (metacognitive monitoring checklist) as students read the *Hurricane* text and take the passage comprehension assessment.
- Comparison Group: Classroom teacher assesses prior knowledge, has students read the *Hurricane* text, take notes from the text, and take the comprehension assessment.

**Week Five:**

- **Day One: Simple Machines Passage**
  - Graphic Organizer + Metacognitive Monitoring: Researcher assesses prior knowledge about simple machines. Students then read and create a matrix using the *Simple Machines* text. Students then take the passage comprehension assessment.
  - Graphic Organizer: Researcher assesses prior knowledge for simple machines. Students then read the *Simple Machines* text, construct a matrix, and take the comprehension assessment.
  - Metacognitive Monitoring: Researcher assesses prior knowledge for the atmosphere. Then students read the *Simple Machines* text and take the passage comprehension assessment.
  - Comparison Group: Classroom teacher assesses prior knowledge, has students read the *Simple Machines* text, take notes from the text, and take the comprehension assessment.
- **Day Two: Clouds Passage (posttest)**
  - Graphic Organizer + Metacognitive Monitoring: Researcher assesses prior knowledge about clouds. Students then read and create a matrix using the *Clouds* text. Students then take the passage comprehension assessment.
  - Graphic Organizer: Researcher assesses prior knowledge for clouds. Students then read the *Clouds* text, construct a matrix, and take the comprehension assessment.
  - Metacognitive Monitoring: Researcher assesses prior knowledge for clouds. Then students read the *Clouds* text and take the passage comprehension assessment.
  - Comparison Group: Classroom teacher assesses prior knowledge, has students read the *Clouds* text, take notes from the text, and take the comprehension assessment.

**Week Six:**

- **Day One: Jr. MAI and MSI Posttests**
- **Day Two: Gates-MacGinitie Reading Test (Form L)**
CHAPTER FOUR

Results

In this study the impact of the four conditions on standardized comprehension test scores, reading passage comprehension scores, and metacognitive variables was analyzed using both Repeated-Measures Analysis of Variance (RM-ANOVA) as well as multilevel modeling. This section contains descriptive statistics followed by analyses related to the primary research questions for the study.

Prior to addressing the primary research questions, preliminary analyses were conducted to provide descriptive statistics of primary measures and to determine whether there were any significant differences in student pretest scores across the conditions. Descriptive statistics for the Gates-MacGinitie, Jr. MAI, and MSI can be found in Table 4.1. One-way ANOVA tests revealed that students did not differ significantly across conditions in their Gates-MacGinitie Reading Comprehension pretest scores $F(3,147) = 2.00, p = .15$, their Jr. MAI pretest scores $F(3,144) = 2.10, p = .1$, or their MSI pretest scores $F(3,125) = 1.60, p = .19$. 
Table 4.1

*Descriptive Statistics for the Gates-MacGinitie Test, Jr.MAI, and MSI Pretests*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Gates-MacGinitie Comprehension Pretest Mean (SD)</th>
<th>Gates-MacGinitie Comprehension Posttest Mean (SD)</th>
<th>Jr. MAI Pretest Mean (SD)</th>
<th>Jr. MAI Posttest Mean (SD)</th>
<th>MSI Pretest Mean (SD)</th>
<th>MSI Posttest Mean (SD)</th>
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<tbody>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
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<tr>
<td>GO +</td>
<td>29.43 (10.40)</td>
<td>31.95 (11.29)</td>
<td>28.65</td>
<td>35.45</td>
<td>14.92</td>
<td>27.49</td>
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<td>MM</td>
<td>n = 41</td>
<td>n = 42</td>
<td>(3.23)</td>
<td>(4.21)</td>
<td>(4.33)</td>
<td>(4.48)</td>
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<tr>
<td>GO</td>
<td>31.80 (9.59)</td>
<td>29.74 (9.58)</td>
<td>29.89</td>
<td>35.94</td>
<td>14.25</td>
<td>26.72</td>
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<td></td>
<td>n = 40</td>
<td>n = 42</td>
<td>(3.03)</td>
<td>(4.28)</td>
<td>(4.25)</td>
<td>(5.09)</td>
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<tr>
<td>MM</td>
<td>30.40 (7.67)</td>
<td>30.71 (8.70)</td>
<td>28.93</td>
<td>33.93</td>
<td>13.70</td>
<td>25.74</td>
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<tr>
<td></td>
<td>n = 43</td>
<td>n = 42</td>
<td>(2.73)</td>
<td>(4.76)</td>
<td>(4.27)</td>
<td>(5.11)</td>
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<tr>
<td>CG</td>
<td>34.59 (8.59)</td>
<td>34.60 (10.5)</td>
<td>28.11</td>
<td>36.71</td>
<td>16.00</td>
<td>26.68</td>
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<tr>
<td></td>
<td>n = 29</td>
<td>n = 25</td>
<td>(2.81)</td>
<td>(4.08)</td>
<td>(4.67)</td>
<td>(5.85)</td>
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<td>Total</td>
<td>31.29 (9.24)</td>
<td>31.43 (10.05)</td>
<td>28.94</td>
<td>35.30</td>
<td>14.90</td>
<td>26.64</td>
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<tr>
<td></td>
<td>n = 154</td>
<td>n = 151</td>
<td>(3.01)</td>
<td>(4.46)</td>
<td>(4.39)</td>
<td>(5.07)</td>
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</table>

(Note: GO + MM = Graphic Organizer + Metacognitive Monitoring, GO = Graphic Organizer, MM = Metacognitive Monitoring, and CG = Comparison Group)

Eight reading passage scores were also examined. It was determined that there was an unexplained drop in reading passage comprehension scores on the final passage for the three instructional conditions despite equivalent prior knowledge scores as well as interest scores. Student fatigue, stemming from the extended nature of the research project itself,
combined with the fact that the students were preparing for their first three-week vacation may have produced these results. Multilevel modeling was used to test for quadratic effects, but none were found; therefore, it was decided to continue with the analysis using percent correct scores from passages one through seven. The multilevel modeling analysis from passages one through eight can be found in Appendix G. Descriptive statistics for passage scores and prior knowledge scores for each passage are presented in Table 4.2.

Table 4.2

<table>
<thead>
<tr>
<th>Passage Comprehension Scores and Prior Knowledge (PK) Scores Per Passage</th>
</tr>
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<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Comp. Mean (SD)</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Glaciers</td>
</tr>
<tr>
<td>Forest</td>
</tr>
<tr>
<td>Atmosphere</td>
</tr>
<tr>
<td>Volcanoes</td>
</tr>
<tr>
<td>Hurricanes</td>
</tr>
<tr>
<td>Food</td>
</tr>
<tr>
<td>Chain</td>
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</table>
Table 4.2 Continued

<table>
<thead>
<tr>
<th>Passage 7: Simple Machines</th>
<th>.71 ( .25)</th>
<th>1.00 (1.79)</th>
<th>.70 ( .21)</th>
<th>.95 (1.64)</th>
<th>.74 ( .23)</th>
<th>2.11 (2.42)</th>
<th>.60 ( .28)</th>
<th>.50 (1.04)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 42</td>
<td>n = 42</td>
<td>n = 39</td>
<td>n = 46</td>
<td>n = 46</td>
<td>n = 30</td>
<td>n = 30</td>
<td></td>
<td></td>
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<tr>
<td>Total Percent Correct</td>
<td>4.44 (1.03)</td>
<td>19.82 (11.84)</td>
<td>4.44 (1.03)</td>
<td>17.17 (9.12)</td>
<td>4.44 (1.09)</td>
<td>16.27 (8.85)</td>
<td>4.25 (1.17)</td>
<td>*</td>
</tr>
<tr>
<td>n = 36</td>
<td>n = 33</td>
<td>n = 23</td>
<td>n = 33</td>
<td>n = 37</td>
<td>n = 26</td>
<td></td>
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</tbody>
</table>

Note: GO + MM = Graphic Organizer + Metacognitive Monitoring, GO = Graphic Organizer, MM = Metacognitive Monitoring, and CG = Comparison Group
* Students in the comparison condition did not complete the prior knowledge assessment for Forest Biomes.

**Bivariate Correlations**

Bivariate correlations were computed to examine relationships among key study variables. Correlation matrices for each of the four conditions can be found in Appendix E. Pearson correlation coefficients revealed changes in the magnitude of relationships for certain variables from pretest to posttest across the conditions. MSI pretest and posttest scores showed a moderate significant correlation with total passage score in the Metacognitive Monitoring Condition ($r = .40, p < .05; r = .48, p < .05$) and Comparison Group ($r = .62, p < .01; r = .65, p < .01$), but only the MSI pretest was correlated with total passage score in the Graphic Organizer + Metacognitive Condition ($r = .39, p < .05$). In the Graphic Organizer Condition, MSI scores were not correlated with total passage score, but were significantly related to the Gates-MacGinitie Comprehension posttest ($r = .51, p < .01; r = .52, p < .01$), as was the Jr.MAI posttest ($r = .50, p < .01$). Jr. MAI scores in the Graphic Organizer + Metacognitive Monitoring Condition did not show a significant relationship to the Gates-MacGinitie Comprehension at pretest but did show a significant
relationship by posttest \((r = .399, p < .01)\).

What is the impact of instructional condition on a standardized test of reading comprehension?

In order to determine if there was significant comprehension change from pretest to posttest across the conditions, Gates-MacGinitie Comprehension scores were analyzed using a 4 (conditions) X 2 (testing sessions) repeated-measures ANOVA. In this analysis the within-subjects factor was testing time (Gates-MacGinitie Comprehension pretest and posttest) and the between-subjects factor was instructional group (Graphic Organizer + Metacognitive Monitoring, Graphic Organizer, Metacognitive Monitoring, and Comparison Group). Results indicated that although overall comprehension scores did not change significantly over time \(F(3,143) = .45, p = .50, \eta^2 = .003\), there was a significant interaction between test score and condition \(F(3,143) = 2.83, p < .04, \eta^2 = .056\). Four separate one-way repeated measures ANOVAs were conducted to examine the source of the interaction. As seen in Figure 4.1, the Graphic Organizer + Metacognitive Monitoring Condition was the only condition showing a significant increase in Gates-MacGinitie Comprehension test scores over time \(F(1, 41) = 5.88, p < .02, \eta^2 = .128\). Neither the Metacognitive Monitoring Condition \(F(1, 40) = .08, p < .79, \eta^2 = .002\), the Graphic Organizer Condition \(F(1, 39) = 3.37, p < .07, \eta^2 = .08\), nor the Comparison Group \(F(1, 23) = .12, p < .73, \eta^2 = .005\) showed significant comprehension test score change over time.
Multilevel modeling (MLM) was used to analyze the impact of instructional condition on the seven weekly reading passage comprehension scores and to examine rates of comprehension change based on instructional condition. MLM is particularly well suited for education data because it allows individual change over time to be represented in a two-level, hierarchical model (Raudenbush & Bryk, 2002). MLM includes predictors at both the within- and between-subject levels of analysis, which is important for educational data, where individual observations are often interdependent due to the nested characteristics of the data (time within students, students within classes, classes within schools). In addition, MLM can be used to analyze unbalanced data sets and also can

Figure 4.1: Gates-MacGinitie Comprehension Test Score Change from Pretest to Posttest in the GO + MM and Comparison Group (CG) Conditions.
analyze a dataset in its entirety without removing observations due to missing data points. These qualities are extremely important when analyzing school data, where observations are interdependent and missing data points are common; therefore, it was decided that multilevel modeling would be the most appropriate method for analyzing the impact of the instructional conditions on the seven expository reading passage scores.

First, a preliminary analysis using a two-level fully unconditional model was conducted to determine if enough variability in comprehension within and between students was present to allow for further analyses. In this model, no term other than the intercept was included at any level. The fully unconditional model was represented by the following equation:

Level 1: \[ \text{Comprehension}_{it} = \beta_0i + r_{it} \]

Level 2: \[ \beta_0i = \gamma_{00} + u_{0i} \]

In this model, a student’s variability, such as change in comprehension over time, was represented as an intercept and slope at Level 1. At Level 2 the intercept became the outcome variable, and other student-level variables, such as condition, were included in later analyses as predictor variables. Results from this initial analysis indicated that 42% of the variability in passage comprehension assessment was between students (\( \sigma^2 = 224.14, z = 7.58, p = .0001 \)) and 42% was within students (\( \sigma^2 = 304.01, z = 23.7, p = .0001 \)). Therefore, the fully unconditional model indicated that there was sufficient variability to warrant further analyses.
What is the impact of instructional condition on comprehension scores across seven expository reading passages? Do students in different instructional conditions show different rates of comprehension change? (Model 1)

An intercepts and slopes as outcomes model (Raudenbush & Bryk, 2002) was run to determine whether reading passage comprehension scores differed depending upon whether students received both graphic organizer and metacognitive monitoring training or whether they received either graphic organizer or metacognitive monitoring training. In addition, this model also was run to determine if students within the four conditions showed different rates of comprehension change over time. The model was run using a sample of 162 students, and 1134 observations were included in this analysis. In this model, time was entered at Level 1 and the instructional condition was entered at Level 2.

Level 1: Comprehension_{it} = \beta_0_{it} + \beta_1_{it}(Time) + r_{it}

Level 2:
\[ \beta_0_{i} = \gamma_{00} + \gamma_{01}(GO + MM, GO, MM) + u_{0i} \]
\[ \beta_0_{i} = \gamma_{10} + \gamma_{11}(GO + MM, GO, MM) + u_{1i} \]

The results of this analysis indicated that although time was not significantly related to overall reading passage comprehension score ($\gamma_{10}$), there was a significant difference in reading passage comprehension scores based on instructional condition. As seen in Figure 4.2, students in the Graphic Organizer + Metacognitive Monitoring condition ($\gamma_{12}$) and students in the Metacognitive Monitoring condition ($\gamma_{13}$) exhibited comprehension increases significantly different than that of the comparison group. To compare scores from the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition, new dummy codes were created making the
Metacognitive Monitoring group score the intercept and follow-up tests were run. Results indicated that scores from the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12} = -.06$, $t = -.08$, $p = .94$) were not significantly different from those of the Metacognitive Monitoring Condition ($\gamma_{00} = 53.87$, $t = 17.66$, $p = .0001$). Although there was a significant random effect of time ($\tau_{10}$), there were no other significant main effects or interactions (See Table 4.3). This model accounted for 11% of the between-person variability ($\tau_{00}$) and 5% of the within-student variability ($\sigma^2$) in passage comprehension scores.

![Figure 4.2: Comprehension score change over time by condition.](image-url)
Does verbal ability moderate the relationship between instructional condition and reading passage comprehension? (Model 2)

To address this question, another intercepts and slopes as outcomes model was run using a sample of 150 students accounting for 1134 observations. In this model, Time remained a Level 1, within-person variable, while instructional condition and verbal ability were entered into the model as Level 2, between-person variables. All variable measures used in this analysis had a meaningful zero; therefore, no centering was needed.

Level 1: Comprehension\(_{it}\) = β\(_{0it}\) + β\(_{1it}\)(Time) + r\(_{it}\)

Level 2: β\(_{0i}\) = γ\(_{00}\) + γ\(_{01}\)(GO + MM, GO, MM) + γ\(_{02}\)(VerbalAbility) + u\(_{0i}\)

β\(_{1i}\) = γ\(_{10}\) + γ\(_{11}\)(GO + MM, GO, MM) + γ\(_{12}\)(VerbalAbility) + u\(_{1}\)

Results of this model indicated that although time (γ\(_{10}\)) was not significantly related to reading passage comprehension score, verbal ability (γ\(_{03}\)), as measured by the Gates-MacGinitie Reading Comprehension pretest, was significantly related to passage comprehension. In addition, as seen in Figure 4.3, controlling for verbal ability, the relationship between time and passage comprehension did depend significantly on the instructional condition as seen in significant interactions between time and the Graphic Organizer + Metacognitive Monitoring Condition (γ\(_{12}\)) and time and the Metacognitive Monitoring Condition (γ\(_{13}\)). To compare scores from the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition, new dummy codes were created making the Metacognitive Monitoring group score the intercept and follow-up tests were run. Results indicated that comprehension changes in
the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12} = -.47, t = -.60, p = .55$) were not significantly different from those of the Metacognitive Monitoring Condition ($\gamma_{00} = 11.72, t = 1.35, p = .18$). There were no other significant main effects or interactions (See Table 4.3). The model accounted for 77% of the between person variability ($\tau_{00}$) and 9% of the within-student variability ($\sigma^2$) in passage comprehension.

![Figure 4.3: Comprehension score change over time, controlling for verbal ability.](image-url)
Table 4.3

*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction, Time, and Verbal Ability on Reading Passage Comprehension*

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, β0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept, γ00</td>
<td>59.30*** (3.72)</td>
<td>8.81 (10.49)</td>
</tr>
<tr>
<td>Graphic Organizer, γ01</td>
<td>-2.98 (4.92)</td>
<td>-.90 (12.18)</td>
</tr>
<tr>
<td>Graphic Organizer+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive Monitoring, γ02</td>
<td>-8.38 (4.82)</td>
<td>-1.70 (11.57)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, γ03</td>
<td>-5.43 (4.8)</td>
<td>2.92 (12.62)</td>
</tr>
<tr>
<td>Verbal Ability (Gates-MacGinite), γ04</td>
<td>.78*** (.15)</td>
<td></td>
</tr>
<tr>
<td>Verbal Ability*GO, γ05</td>
<td>.01 (.18)</td>
<td></td>
</tr>
<tr>
<td>Verbal Ability*GOMM, γ06</td>
<td>-0.004 (.17)</td>
<td></td>
</tr>
<tr>
<td>Verbal Ability*MM, γ07</td>
<td>-0.7 (.19)</td>
<td></td>
</tr>
<tr>
<td>Time Slope, β11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept, γ10</td>
<td>.47 (.66)</td>
<td>.21 (1.41)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, γ11</td>
<td>1.38 (.87)</td>
<td>1.74 (.92)</td>
</tr>
<tr>
<td>Time*Graphic Organizer+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive Monitoring, γ12</td>
<td>2.21** (.85)</td>
<td>2.14* (.91)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, γ13</td>
<td>2.27** (.85)</td>
<td>2.63** (.90)</td>
</tr>
<tr>
<td>Time*Verbal Ability, γ14</td>
<td>.001 (.02)</td>
<td></td>
</tr>
</tbody>
</table>

**Random Effects**

| Passage Comprehension (τ00) | 200.44*** (33.96) | 49.98** (18.32) |
| Time slope (τ11) | 2.25* (1.08) | 2.71** (.93) |
| Within-person fluctuation (σ2) | 289.19*** (14.10) | 275.84*** (13.76) |

Note: *p < 0.05, **p < 0.01, ***p < 0.0001
Does Metacognition (Jr.MAI) moderate the relationship between instructional condition and reading passage comprehension?

To address this question, two intercepts and slopes as outcomes models were run. The first model used a sample of 148 students accounting for 1134 observations. In this model, Time remained a Level 1, within-person variable, while instructional condition and metacognition, as measured by the Jr.MAI, were entered into the model as Level 2, between-person variables.

Level 1: Comprehensionit = β0it + β1it(Time) + rit

Level 2: \[ \beta_0i = \gamma_{00} + \gamma_{01}(GO + MM, GO, MM) + \gamma_{02}({\text{Metacognition: Jr.MAI}}) + u_{0i} \]
\[ \beta_{1i} = \gamma_{10} + \gamma_{11}(GO + MM, GO, MM) + \gamma_{12}({\text{Metacognition: Jr.MAI}}) + u_{1i} \]

Results of this analysis indicated that although neither time (\(\gamma_{10}\)) nor metacognition, as measured by the Jr.MAI (\(\gamma_{04}\)), was significantly related to overall reading passage comprehension, the relationship between time and comprehension score did depend on condition. There were significant interactions between time and Graphic Organizer + Metacognitive Monitoring Condition (\(\gamma_{12}\)) and Time and Metacognitive Monitoring Condition (\(\gamma_{13}\)). As seen in Figure 4.4, controlling for the Jr.MAI, students in these two conditions increased more on passage comprehension than did students in the Comparison Group (\(\gamma_{00}\)). To compare scores from the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition, new dummy codes were created making the Metacognitive Monitoring group score the intercept and follow-up tests were run. Results indicated that changes in the Graphic Organizer + Metacognitive Monitoring
Condition ($\gamma_{12} = .15, t = .20, p = .84$) were not significantly different from those of the Metacognitive Monitoring Condition ($\gamma_{00} = 80.52, t = 2.70, p = .008$). There were no other main effects or interactions in this model (See Table 4.5). This model accounted for 6% of the between-person variability ($\tau_{00}$), and 7% of the within-student variability ($\sigma^2$), in passage comprehension scores.

*Figure 4.4:* Comprehension score change, controlling for metacognition (Jr. MAI).
Does metacognition (MSI) moderate the relationship between instructional condition and reading passage comprehension?

Another intercepts and slopes as outcomes model was run using a sample of 148 students accounting for 1134 observations. In this model, Time remained a Level 1, within-person variable, while instructional condition and metacognition, as measured by the MSI, were entered into the model as Level 2, between-person variables.

Level 1: Comprehensionit = β0it + β1it(Time) + rit

Level 2:  β0i = γ00 + γ01(GO + MM, GO, MM) +γ02(Metacognition: MSI) + u0i

β1i = γ10 + γ11(GO + MM, GO, MM) + γ12(Metacognition: MSI) + u1

Results of this analysis indicated that although Time (γ10) was not significantly related to passage comprehension score, metacognition, as measured by the MSI, was significantly related to overall passage comprehension (γ04). Students with higher MSI scores had significantly higher passage comprehension test scores. There were also significant interactions between time and the Graphic Organizer + Metacognitive Monitoring Condition (γ12) and time and the Metacognitive Monitoring Condition (γ13), which indicated that the relationship between time and comprehension depended upon these conditions. As seen in Figure 4.5, comprehension of students in the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Conditions (γ13) increased significantly more than students in the Comparison Group (γ00) when metacognition, as measured by the MSI, was controlled for. To compare scores from the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive
Monitoring Condition, new dummy codes were created making the Metacognitive Monitoring group score the intercept and follow-up tests were run. Results indicated that scores from the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12} = .06, t = .09, p = .93$) were not significantly different from those of the Metacognitive Monitoring Condition. There was also a significant interaction between Time and Metacognition (MSI) ($\gamma_{15}$), indicating that the relationship between Time and Comprehension depended upon Metacognition (MSI). There were no other main effects or interactions in this model (See Table 4.5). This model accounted for 6% of the between-person variability ($\tau_{00}$), and 7% of the within-student variability ($\sigma^2$), in passage comprehension scores.

![Comprehension score change over time](image)

*Figure 4.5: Comprehension score change over time, controlling for metacognition (MSI).*
Table 4.4

Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction, Time, and Metacognition on Reading Passage Comprehension

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 4 (Jr.MAI)</th>
<th>Model 5 (MSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, $\beta_0$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{00}$</td>
<td>5.83 (34.36)</td>
<td>35.79** (11.81)</td>
</tr>
<tr>
<td>Graphic Organizer, $\gamma_{01}$</td>
<td>54.83 (43.34)</td>
<td>4.94 (14.23)</td>
</tr>
<tr>
<td>Graphic Organizer +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive, Monitoring, $\gamma_{02}$</td>
<td>20.76 (40.36)</td>
<td>-3.31 (13.58)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{03}$</td>
<td>74.69 (43.46)</td>
<td>9.53 (13.45)</td>
</tr>
<tr>
<td>Metacognition*GO, $\gamma_{04}$</td>
<td>-2.00 (1.50)</td>
<td>-0.37 (.87)</td>
</tr>
<tr>
<td>Metacognition*GOMM, $\gamma_{05}$</td>
<td>-1.09 (1.42)</td>
<td>-0.24 (.84)</td>
</tr>
<tr>
<td>Metacognition*MM, $\gamma_{06}$</td>
<td>-2.83 (1.52)</td>
<td>-0.85 (.84)</td>
</tr>
<tr>
<td>Time slope, $\beta_1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>.79 (2.89)</td>
<td>-1.87 (1.17)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>1.56 (.92)</td>
<td>1.61 (.88)</td>
</tr>
<tr>
<td>Time*Graphic Organizer +</td>
<td>2.37** (.87)</td>
<td>2.63** (.85)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{12}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>2.22* (.88)</td>
<td>2.57** (.87)</td>
</tr>
<tr>
<td>Time*Metacognition, $\gamma_{14}$</td>
<td>-.02 (.10)</td>
<td>.14* (.06)</td>
</tr>
<tr>
<td>Random Effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passage Comprehension ($\tau_{00}$)</td>
<td>220.06*** (37.09)</td>
<td>170.36*** (31.33)</td>
</tr>
<tr>
<td>Time slope ($\tau_{11}$)</td>
<td>2.15* (1.13)</td>
<td>1.37 (.99)</td>
</tr>
<tr>
<td>Within-person fluctuation ($\sigma^2$)</td>
<td>282.23*** (14.34)</td>
<td>283.64*** (14.30)</td>
</tr>
</tbody>
</table>

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
Does prior knowledge moderate the relationship between instructional condition and reading passage comprehension?

To address this question, an intercepts and slopes as outcomes model was run using a sample of 162 students, accounting for 1067 observations. In this model, time and prior knowledge were entered into the model at Level 1 as within-person variables while instructional condition was entered into the model as a Level 2, between-person variable.

Level 1: \( \text{Comprehension}_{it} = \beta_{0it} + \beta_{1it}(\text{Time}) + \beta_{2it}(\text{PriorKnowledge}) + \beta_{3it}(\text{Time} \times \text{Prior Knowledge} + \text{rit}) \)

Level 2: \( \beta_{0i} = \gamma_{00} + u_{0i} \)
\( \beta_{1i} = \gamma_{10} + u_{1i} \)
\( \beta_{2i} = \gamma_{20} + u_{2i} \)
\( \beta_{3i} = \gamma_{03} + u_{3i} \)

Results of this analysis indicated that overall comprehension scores did not increase over time when prior knowledge was controlled for (\( \gamma_{10} \)) and that overall comprehension scores were not significantly related to prior knowledge (\( \gamma_{20} \)). Analysis did indicate that, controlling for prior knowledge, the relationship between comprehension and time did depend upon instructional condition. As seen in Figure 4.6, there were significant interactions between Time and the Graphic Organizer + Metacognitive Monitoring Condition (\( \gamma_{12} \)) and between Time and the Metacognitive Monitoring Condition (\( \gamma_{13} \)) indicating that comprehension increases in these two conditions were significantly different than increases of students in the Comparison Group. To compare scores from the
Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition, new dummy codes were created making the Metacognitive Monitoring group score the intercept and follow-up tests were run. Results indicated that scores from the Graphic Organizer + Metacognitive Monitoring Condition (γ_{12} = .04, t = .05, p = .96) were not significantly different from those of the Metacognitive Monitoring Condition. There were no other main effects or interactions in this model (See Table 4.6). This model accounted for 16% of the between-person variability (τ_{00}), and 4% of the within-student variability (σ^2), in passage comprehension scores.

![Figure 4.6](image)

*Figure 4.6:* Comprehension score change over time, controlling for prior knowledge.
Table 4.5

Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction, Time, and Prior Knowledge on Passage Comprehension

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, $\beta_0$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{00}$</td>
<td>57.95 (3.93)</td>
</tr>
<tr>
<td>Graphic Organizer, $\gamma_{01}$</td>
<td>-1.30 (.89)</td>
</tr>
<tr>
<td>Graphic Organizer + Metacognitive, Monitoring, $\gamma_{02}$</td>
<td>-9.34 (5.14)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{03}$</td>
<td>-6.71 (5.06)</td>
</tr>
<tr>
<td>Time slope, $\beta_1$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>.54 (.68)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>1.30 (.89)</td>
</tr>
<tr>
<td>Time*Graphic Organizer + Metacognitive Monitoring, $\gamma_{12}$</td>
<td>2.34** (.87)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>2.30* (.86)</td>
</tr>
<tr>
<td>Prior Knowledge, $\gamma_{20}$</td>
<td>0.88 (.94)</td>
</tr>
<tr>
<td>Prior Knowledge*GO, $\gamma_{21}$</td>
<td>-0.96 (.97)</td>
</tr>
<tr>
<td>Prior Knowledge*GOMM, $\gamma_{22}$</td>
<td>-0.05 (.89)</td>
</tr>
<tr>
<td>Prior Knowledge*MM, $\gamma_{23}$</td>
<td>-0.41 (.95)</td>
</tr>
<tr>
<td>Time*Prior Knowledge, $\gamma_{30}$</td>
<td>-0.03 (.15)</td>
</tr>
<tr>
<td>Random Effects</td>
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</tr>
<tr>
<td>Passage Comprehension ($\tau_{00}$)</td>
<td>188.05*** (37.09)</td>
</tr>
<tr>
<td>Time slope ($\tau_{11}$)</td>
<td>2.35* (1.11)</td>
</tr>
<tr>
<td>Prior Knowledge ($\tau_{22}$)</td>
<td></td>
</tr>
<tr>
<td>Within-person fluctuation ($\sigma^2$)</td>
<td>291.29*** (14.31)</td>
</tr>
</tbody>
</table>

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
What is the impact of instruction on metacognition, as measured by the Jr. MAI and the MSI?

In order to determine if there was significant change in metacognition over the course of the intervention, scores from both the Jr. MAI and the MSI were analyzed using separate 4 (conditions) X 2 (testing sessions) repeated-measures ANOVAs. In these analyses the within-subjects factor was testing time (Jr. MAI and MSI pretest and posttest) and the between-subjects factor was instructional group (Graphic Organizer + Metacognitive Monitoring, Graphic Organizer, Metacognitive Monitoring, and Comparison Group).

In the first analysis, results showed significant change in Jr. MAI scores over time $F(3,130) = 327.35, p < .0001, \eta^2 = .72$ as well as a significant interaction between Jr. MAI score and condition $F(3,130) = 3.6, p = .02, \eta^2 = .08$. Four separate one-way repeated measures ANOVAs were conducted to examine the source of the interaction. As seen in Figure 4.7, although students within each condition changed differently over time, students in the Graphic Organizer + Metacognitive Monitoring Condition $F(1, 38) = 99.92, p < .0001, \eta^2 = .724$, the Graphic Organizer Condition $F(1, 31) = 60.45, p < .000, \eta^2 = .661$, the Metacognitive Monitoring Condition $F(1, 39) = 64.86, p < .0001, \eta^2 = .624$, and the Comparison Group $F(1, 22) = 114.94, p < .0001, \eta^2 = .839$ all showed significant change in metacognition score, as measured by the Jr. MAI.
Figure 4.7: Change in Jr. MAI scores from pretest to posttest.

In order to determine if there was significant change in metacognition from pretest to posttest across conditions pre- and post-MSI scores were analyzed using a 4 (conditions) X 2 (testing sessions) repeated-measures ANOVA. In this analysis the within-subjects factor was testing time (pretest and posttest) and the between-subjects factor was instructional group (Graphic Organizer + Metacognitive Monitoring, Graphic Organizer, Metacognitive Monitoring, and Comparison Group). Results showed significant change in MSI scores over time $F(1,101) = 667.39, p = .0001, \eta^2 = .87$ and a significant main effect of condition $F(3,101) = 1.40, p = .02, \eta^2 = .08$ meaning that MSI scores improved significantly across all instructional conditions over time.
CHAPTER FIVE
Discussion

Overview of Findings

In this study, explicit instruction in a graphic organizer strategy was combined with explicit instruction in metacognitive monitoring strategies to determine if teaching these strategies together had a greater impact on reading comprehension than if the strategies were taught independent of each other. As seen in the first RM-ANOVA, only 5th grade students taught matrix-building and metacognitive monitoring strategies showed significant improvement on a standardized test of reading comprehension. Moreover, only students explicitly taught metacognitive monitoring strategies showed significant improvement in reading comprehension passage scores over time. Thus, findings from this study indicate that metacognitive monitoring instruction played a significant role in improving reading comprehension on both a standardized comprehension test and on classroom-based reading passage assessments.

With respect to the Reading Panel’s recommendations (2000) for multiple-strategy instruction the results of this study are interesting. When looking only at comprehension improvement on a standardized reading test, the benefits of multi-strategy instruction can be seen. Students in the Graphic Organizer + Metacognitive Monitoring condition performed significantly better than students in the other instructional conditions on the Gates-MacGinitie Reading Comprehension test. These findings relate favorably to the multi-strategy recommendations made by the National Reading Panel in 2000 and can possibly be attributed to the added benefits gained by teaching students matrix-building
and metacognitive monitoring strategies simultaneously. Even though students in the Graphic Organizer + Metacognitive Monitoring Condition were unable to write on the Gates-MacGinitie Comprehension test, it is possible that they were able to internalize the matrix-building and monitoring processes, which may have allowed them to discern text structure, infer relationships between text concepts, and regulate their use of their comprehension monitoring and fix-up strategies more effectively. This study adds to previous graphic organizer and metacognitive monitoring research by examining the effects of combining the strategies, utilizing intact classrooms of 5th grade students, and by providing an extended instructional timeframe.

When comparing reading passage comprehension gains across the conditions, significant gains over time were seen in both the Graphic Organizer + Metacognitive Monitoring and the Metacognitive Monitoring Conditions, yet when follow-up tests were run there were no significant differences between the two conditions. The remainder of the multilevel modeling analyses provided similar results. Even when controlling for individual differences, such as verbal ability, metacognition, and prior knowledge, students in the Graphic Organizer + Metacognitive Monitoring Condition and students in the Metacognitive Monitoring condition continued to show significant increases in reading passage comprehension scores. Students with higher verbal ability, prior knowledge, and metacognition scores outperformed students with lower verbal ability, prior knowledge, and metacognition scores in these two conditions. Students in the comparison group and students taught only the graphic organizer strategy did not show significant increases in passage comprehension scores.
Prior reading comprehension research suggests that although students of all ability levels can benefit from metacognitive strategy instruction (Artelt, Schiefele, & Schneider, 2001; Borkowski, Schneider, & Pressley, 1989) students with higher levels of verbal ability, prior knowledge, and metacognition show the highest levels of comprehension (Paris & Meyer, 1981). Students with better monitoring proficiency comprehend text better than students with who are unable to monitor their understanding effectively (Oakhill et al., 2005). The ability to monitor comprehension also is related to levels of prior knowledge because prior knowledge frees up working memory, allowing readers to monitor comprehension more effectively (Kinnunen & Vauras, 1995). Because proficient readers are those with high levels of verbal ability, metacognition, and prior knowledge, all of which assist the reader in creating accurate situation models (Kintsch, 1983, 1992, 1998, 2005, van Dijk & Kintsch, 1983), the hypothesis that verbal ability, metacognition, and prior knowledge would moderate the relationship between instruction and comprehension when metacognitive monitoring instruction was provided proved to be true. Results showed that although students in the Graphic Organizer + Metacognitive Monitoring Condition and students in the Metacognitive Monitoring Condition showed comprehension improvement over time, students with higher levels of verbal ability, metacognition, and prior knowledge showed the largest improvements. This finding has implications for both classroom instruction and future research where explicit reading strategy instruction has often been reserved for students with the lowest levels of verbal ability, metacognition, and prior knowledge.
Prior graphic organizer research suggests that students with low verbal ability and prior knowledge should benefit the most from graphic organizer strategy instruction because the task of actively reorganizing text information leads to better memory, deeper processing, and more generative learning in these students (Alverman, 1981; Mayer, 1979; Schnozt, 2002). The results of this study, which occurred in a more naturalistic setting than many other graphic organizer studies, show that students taught only the matrix-building strategy exhibited no significant comprehension improvement over time either on a standardized comprehension test or on the seven expository reading passages. Comprehension scores of students in the Graphic Organizer Condition did not improve significantly over time, were not significantly different than the scores of students who received no instruction, and were not moderated by verbal ability or prior knowledge. Research suggests that extraneous cognitive load created by the task of building a graphic organizer can hinder comprehension (Stull & Mayer, 2007), but students in the Graphic Organizer + Metacognitive Condition outperformed students in the Graphic Organizer Condition despite the fact that they were creating matrices while monitoring their comprehension. The systematic monitoring steps taught in the Graphic Organizer + Metacognitive Monitoring condition may have served to reduce extraneous cognitive load while increasing germane load.

Prior graphic organizer research has shown that graphic organizers help readers construct knowledge by making interrelationships between text concepts more explicit, leading to deeper levels of learning (Horton, Lovitt, & Bergerud, 1990), but much of this research utilized author or teacher-constructed graphic organizers. The findings are mixed
with regard to student-constructed organizers. Some studies have shown that high levels of extraneous cognitive load created by high activity levels disrupt generative processing when learners are charged with creating their own graphic organizers from text (Katayama & Robinson, 2000; Stull & Mayer, 2007). On the other hand, there is evidence for greater learning gains when students are taught to construct their own graphic organizers (Hawk, 1986). Depth of processing and activity theory both suggest that the creation of a graphic organizer helps the reader actively reorganize information into an explicit structure, resulting in better memory for text information (Meyer et al., 1980). The results of this study seem to contradict these earlier findings.

Students in the Graphic Organizer Condition did not show the comprehension gains seen in students in the Graphic Organizer + Metacognitive Monitoring Condition despite the fact that students in both conditions produced statistically significant equivalent matrices over the course of the study. Perhaps the task given to the students in the Graphic Organizer + Metacognitive Monitoring Condition required more active thinking and elaboration, leading to higher levels of generative learning or perhaps the learning gains resulted primarily from the metacognitive monitoring instruction. The benefits of metacognitive monitoring instruction were clearly seen in this study. That the performance of students in the Graphic Organizer + Metacognitive Monitoring Condition and that of those in the Metacognitive Monitoring Condition were statistically the same when examining change in reading passage comprehension scores leads one to believe that the metacognitive strategy instruction played a role over and above that of the graphic organizer instruction. On the other hand, the benefits of combining a graphic organizer
strategy with metacognitive monitoring strategies were clearly seen when examining the improved standardized comprehension test scores of students who received both graphic organizer and metacognitive monitoring instruction.

**Limitations of the Current Study**

Although the results of this study will extend what is currently known about the benefits of teaching graphic organizer and metacognitive monitoring strategies in particular and multi-strategy instruction in general, the current study has potential limitations that warrant discussion. The primary limitations center on the demographics of the participating school as well as the limitations of conducting research within elementary school classrooms. The participating school in this study was selected based on prior relationships that the researcher had developed with school personnel and the willingness of the principal and all fifth grade teachers to allow the study. Although this school’s population was larger than the populations of other elementary schools in this particular district, the school’s population was less diverse than that of other elementary schools in the district, which may have led to less variance in both passage and test scores. Larger effects may have been found within a more diverse population.

The school’s year-round schedule was another limitation in this study. The schedule made it impossible to start all of the students in all of the conditions at the same time. Some classes were a few weeks ahead of other classes; therefore, cross-contamination between classes could have occurred as students discussed the study among themselves in the cafeteria or on the playground. Also, some of the classes were getting ready to “track out” for their three-week vacation just as the study was ending and the
students were reading their final passages and taking their posttests. The end of the nine-week session in year-round schools can be disruptive because teachers and students often do not return to the same classroom after vacation; therefore, before vacation begins the classroom has to be cleaned and packed. The students play an integral role in this process, which limits instructional time and student motivation for academic tasks.

In addition to the difficulties encountered conducting a study on a year-round calendar with an entire grade level, the everyday ebbs and flows of a school schedule were disruptive during such a complex study. Although there was a set schedule so that classes in the instructional conditions received two 50-minute blocks of instruction per week, there were often last-minute schedule changes related to field trips, fire drills, guest speakers, or other common school-related activities. There were multiple occasions where the instructional blocks had to be rescheduled. The rescheduling was not a problem, but the frequent schedule changes affected student behavior and their ability to focus on the reading tasks.

Absenteeism was also problematic the summer this study was conducted. Because this school operates on a year-round schedule, meaning the school year begins in early July, this elementary school was one of the first schools in the county with students who contracted the H1N1 virus during the 2009 outbreak. The virus circulated through every 5th grade classroom and sick students were often absent for about three days. In addition, because many students had siblings at other schools operating on traditional schedules, parents often pulled students out of school for summer vacations. The levels of absenteeism meant that students in the intervention classrooms did not all receive the same
levels of instruction, but efforts were made to have the students complete the reading passages, matrix-building activities, and assessments as soon as they returned to the classroom. Despite the best efforts of the researcher and the teachers, instructional time and data were lost.

The reading passages used in this study and the length of the intervention also presented potential limitations. Although all of the passage topics were pulled from the North Carolina Standard Course of Study for 5th grade science and every effort was made to make the passages equivalent, some passages seemed to be more difficult for students than others. This was evidenced in the amount of variability in prior knowledge that students had for the passage topics. For instance, students across conditions knew a lot about glaciers, volcanoes, and hurricanes but did not have the same levels of prior knowledge for other passage topics, such as food chains, and simple machines. After examining the 4th grade science curriculum it appears that some of the topics were extended from material learned in 4th grade while some of the science topics were new to the 5th graders. The passages used in this study were also limited to a single compare and contrast text structure and therefore were not representative of the more complex science text that students might see in their textbooks. Another limitation of the study was the length of time the students received instruction. More instruction time likely would have resulted in greater treatment effects.

**Recommendations for Future Research**

The findings of this study suggest the benefits of metacognitive monitoring instruction and multi-strategy approaches for improving reading comprehension.
Subsequent studies are needed to determine whether some types of strategy instruction are more efficacious than others as well as what combinations of strategies improve reading comprehension the most. In addition, more research is needed to replicate the effect produced here by the metacognitive monitoring instruction. Studies also are needed to examine the impact of graphic organizer instruction and metacognitive monitoring instruction over extended periods of time to see if the results of this study remain with a longer instructional time frame. Perhaps with extended training, combined graphic organizer and metacognitive monitoring instruction would result in improved reading passage comprehension over and above that of metacognitive monitoring instruction alone. Reading strategy instruction adds to a conditional knowledge base that grows incrementally. Students need explicit exposure over time to develop their graphic organizer and metacognitive monitoring skills; therefore, future studies should utilize teacher training and researcher observation, so that the teachers could provide instruction over the course of the school year.

The ability to comprehend expository text is crucial for students of all ages; therefore, more research is necessary to determine which strategies lead to the greatest learning outcomes for the majority of students. Future studies should incorporate passages containing more complex combinations of text structures across multiple content areas to better represent text that students might encounter in a textbook. In addition, future research should utilize different form of graphic organizers to determine if some are more effective than others. In addition, research examining the efficacy of particular reading strategies and combinations of strategies should be extended to content area classrooms in
middle and high schools where teachers are less likely to have knowledge of reading strategies and where there is a higher level of expectation for students to have the ability to learn from textbooks. It would also be beneficial to follow students as they move from grade to grade, especially when they make the transition from elementary to middle and from middle to high school, to see which strategies students are able and willing to use on a consistent basis as they advance through school.
REFERENCES


APPENDICES
Appendix A. Passage 1: Glaciers

Glaciers

Valley Glacier  Ice Sheet  Iceberg

Glaciers are large, moving masses of ice. They cover about 10% of the Earth’s land area and most often are found near the North and South Poles. Glaciers are usually found in areas that have cold, snow winters and cool summers. These conditions ensure that all of the snow is not lost during the summer. Glaciers form when snow remains in an area long enough to turn into ice. Ice builds up with each snowfall and the weight of the glacier grows. When it gets heavy enough flows outward and downward. Glaciers are often called rivers of ice, but they do not really move like a river. A river is moving, flowing water, while a glacier is a thick layer of ice that moves in two different ways. Glaciers can slide on top of a thin layer of water that has melted beneath the glacier or water can work its way through cracks in the glacier. Glaciers also move when ice layers deep within the glacier “creep” over one another.

There are many types of glaciers. Valley glaciers are long, narrow glaciers that are found all over the world. They fill the valleys between mountains. Ice sheets are very large, flat glaciers that occur only in Antarctica and Greenland. To be called an ice sheet a glacier must be over 50,000 square kilometers. When the edges of a large ice sheet extend out over water they are called ice shelves. When a large chunk of ice breaks off an ice shelf and falls into water it is called an iceberg.
This process is called calving. Most of an iceberg is located under the water; only 10% can be seen above the water line. *Ice caps* are small, flat ice sheets that form on land in high elevations. They can be found in parts of Iceland. Ice caps are less that 50,000 square kilometers in size. *Ice fields* are valleys where large glaciers run together. The shape of the ground beneath the ice influences the way the ice flows. Mountaintops can often be seen jutting through ice fields. *Hanging glaciers*, also called ice aprons, cling to the steep slopes of mountains. Hanging glaciers are wider than they are long. These glaciers are common in the Alps, a mountain range in Europe. They often cause avalanches when the ice becomes so heavy that they slide down the steep slopes.

1. Valley glaciers can be described as
   
   A. Flat and wide.  
   B. Short and thick.  
   C. Long and narrow.  
   D. Curved and shelf-like.

   0%  
   100%

   Confident  Confident

2. Glaciers are often called “rivers of ice” even though glaciers

   A. Do not move like rivers.  
   B. Are really frozen rivers.  
   C. Are not made out of ice.  
   D. Move faster than rivers.

   0%  
   100%

   Confident  Confident
3. Calving occurs when

A. A calf is born.
B. A large chunk of ice breaks off a glacier and creates an iceberg.
C. A glacier slides down a mountain on a sheet of water.
D. An ice apron slides down a mountain creating an avalanche.

4. The word *creep* as it is used in this reading passage means

A. To move slowly and gradually.
B. To move quickly.
C. A strange person.
D. To grow or spread.

5. What does a person see when they are looking at an iceberg from the deck of a ship?

A. The largest part of the iceberg.
B. The smallest part of the iceberg.
C. The whole iceberg.
D. Exactly half of the iceberg.
6. Which of these would be a good title for this passage?
   A. How Glaciers Erode the Land.
   B. Many Types of Glaciers.
   C. Birth of an Iceberg.
   D. Avalanche.

7. The second half of the reading passage is primarily about
   A. How glaciers move.
   B. Different types of glaciers.
   C. Why glaciers form.
   D. How icebergs form.

8. Why do you think so many glaciers are found near the North and South Poles?
   A. The snow never totally melts.
   B. The high temperatures help create glaciers.
   C. There are many rivers there that can freeze.
   D. They have many different types of ice fields.
9. What two things might cause a hanging glacier to fall?

A. They are near water and shelf-like.
B. They are at high elevations and take the shape of the ground underneath them.
C. They are heavy and are located on a steep mountainside.
D. They melt easily and are usually very flat.

10. Which glaciers can be found only in Antarctica and Greenland?

A. Valley glaciers
B. Ice sheets
C. Ice fields
D. Hanging glaciers

On a scale between 1 and 10 with 1 being low and 10 being high, how well did you like this passage?

(2009/5.5/394)
Appendix B: Metacognitive Reading Checklist (Matrix)

Before reading:

_____ I scanned the material.
_____ I thought about what I already know about the topic.
_____ I thought about my purpose for reading the text.

I am reading this text:

_____ to learn.
_____ to complete a task.
_____ for fun.

During Reading:

_____ I underlined information that should go in my matrix
_____ I marked the text with a * (star) when I did not understand or lost my concentration.
_____ I circled any vocabulary words that I am not able to figure out.
_____ I re-read as a “fix-up” strategy.
_____ I used context-clues as a “fix-up” strategy.
_____ I continued on as a “fix-up” strategy
_____ I began constructing my matrix.

After reading, I checked my understanding by:

_____ Asking myself if the text made sense to me. Did I understand it?
_____ Reviewing my matrix to make sure I put all the important information in it.

_____ Thinking about whether I could explain this text well to one of my friends.
Appendix C. Jr. MAI

NAME___________________________

Jr. MAI

We are interested in what learners do when they study. Please read the following sentences and indicate the answer (never, sometimes or always) that is related to you and the way you are when you are doing school work or home work. Please answer as honestly as possible.

<table>
<thead>
<tr>
<th>NEVER</th>
<th>SOMETIMES</th>
<th>ALWAYS</th>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

_____ 1. I know when I understand something.

_____ 2. I can make myself learn when I need to.

_____ 3. I try to use ways of studying that have worked for me before.

_____ 4. I know what the teacher expects me to learn.

_____ 5. I learn best when I already know something about the topic.

_____ 6. I draw pictures or diagrams to help me understand while learning.

_____ 7. When I am done with my schoolwork, I ask myself if I learned what I wanted to learn.

_____ 8. I think of several ways to solve a problem and then choose the best one.

_____ 9. I think about what I need to learn before I start working.

_____ 10. I ask myself how well I am doing while I am learning something new.

_____ 11. I really pay attention to important information.

_____ 12. I learn more when I am interested in the topic.
Appendix D. Metacomprehension Strategy Index

Directions: Think about what kinds of things you can do to understand a story better before, during, and after you read it. Read each of the lists of four statements and decide which one of them would help you the most. There are no right answers. It is just what you think would help the most. Circle the letter of the statement you choose.

I. In each set of four, choose the one statement, which tells a good thing to do to help you understand a story better before you read it.

1. Before I begin reading, it’s a good idea to
   A. See how many pages are in the story.
   B. Look up all of the big words in the dictionary.
   C. Make some guesses about what I think will happen in the story.
   D. Think about what has happened so far in the story.

2. Before I begin reading, it’s a good idea to
   A. Look at the pictures to see what the story is about.
   B. Decide how long it will take me to read the story.
   C. Sound out the words I don’t know.
   D. Check to see if the story is making sense.

3. Before I begin reading, it’s a good idea to
   A. Ask someone to read the story to me.
   B. Read the title to see what the story is about.
   C. Check to see if most of the words have long or short vowels in them.
   D. Check to see if the pictures are in order and make sense.

4. Before I begin reading, it’s a good idea to
   A. Check to see that no pages are missing.
   B. Make a list of words I’m not sure about.
   C. Use the title and pictures to help me make guesses about what will happen in the story.
   D. Read the last sentence so I will know how the story ends.

5. Before I begin reading, it’s a good idea to
   A. Decide on why I am going to read the story.
   B. Use the difficult words to help me make guesses about what will happen in the story.
   C. Reread some parts to see if I can figure out what is happening if things aren’t making sense.
   D. Ask for help with the difficult words.
6. Before I begin reading, it’s a good idea to
   A. Retell all of the main points that have happened so far.
   B. Ask myself questions that I would like to have answered in the story.
   C. Think about the meanings of the words which have more than one meaning.
   D. Look through the story to find all of the words with three or more syllables.

7. Before I begin reading, it’s a good idea to
   A. Check to see if I have read this story before.
   B. Use my questions and guesses as a reason for reading the story.
   C. Make sure I can pronounce all of the words before I start.
   D. Think of a better title for the story.

8. Before I begin reading, it’s a good idea to
   A. Think of what I already know about the things I see in the pictures.
   B. See how many pages are in the story.
   C. Choose the best part of the story to read again.
   D. Read the story aloud to someone.

9. Before I begin reading, it’s a good idea to
   A. Practice reading the story aloud.
   B. Retell all of the main points to make sure I can remember the story.
   C. Think of what the people in the story might be like.
   D. Decide if I have enough time to read the story.

10. Before I begin reading, it’s a good idea to
    A. Check to see if I am understanding the story so far.
    B. Check to see if the words have more than one meaning.
    C. Think about where the story might be taking place.
    D. List all of the important details.

II. In each set of four, choose the one statement which tells a good thing to do to help you understand a story better while you are reading it.

11. While I’m reading, it’s a good idea to
    A. Read the story very slowly so that I will not miss any important parts.
    B. Read the title to see what the story is about.
    C. Check to see if the pictures have anything missing.
    D. Check to see if the story is making sense by seeing if I can tell what’s happened so far.

12. While I’m reading, it’s a good idea to
    A. Stop to retell the main points to see if I am understanding what has happened so far.
    B. Read the story quickly so that I can find out what happened.
    C. Read only the beginning and the end of the story to find out what it is about.
    D. Skip the parts that are too difficult for me.
13. While I’m reading, it’s a good idea to
   A. Look all of the big words up in the dictionary.
   B. Put the book away and find another one if things aren’t making sense.
   C. Keep thinking about the title and the pictures to help me decide what is going to happen next.
   D. Keep track of how many pages I have left to read.

14. While I’m reading, it’s a good idea to
   A. Keep track of how long it is taking me to read the story.
   B. Check to see if I can answer any of the questions I asked before I started reading.
   C. Read the title to see what the story is going to be about.
   D. Add the missing details to the pictures.

15. While I’m reading, it’s a good idea to
   A. Have someone read the story aloud to me.
   B. Keep track of how many pages I have read.
   C. List the story’s main character.
   D. Check to see if my guesses are right or wrong.

16. While I’m reading, it’s a good idea to
   A. Check to see that the characters are real.
   B. Make a lot of guesses about what is going to happen next.
   C. Not look at the pictures because they might confuse me.
   D. Read the story aloud to someone.

17. While I’m reading, it’s a good idea to
   A. Try to answer the questions I asked myself.
   B. Try not to confuse what I already know with what I’m reading about.
   C. Read the story silently.
   D. Check to see if I am saying the new vocabulary words correctly.

18. While I’m reading, it’s a good idea to
   A. Try to see if my guesses are going to be right or wrong.
   B. Reread to be sure I haven’t missed any of the words.
   C. Decide on why I am reading the story.
   D. List what happened first, second, third, and so on.

19. While I’m reading, it’s a good idea to
   A. See if I can recognize the new vocabulary words.
   B. Be careful not to skip any parts of the story.
   C. Check to see how many of the words I already know.
   D. Keep thinking of what I already know about the things and ideas in the story to help me decide what is going to happen.
20. While I’m reading, it’s a good idea to
   A. Reread some parts or read ahead to see if I can figure out what is happening if things aren’t making sense.
   B. Take my time reading so that I can be sure I understand what is happening
   C. Change the ending so that it makes sense.
   D. Check to see if there are enough pictures to help make the story ideas clear.

III. In each set of four, choose the one statement which tells a good thing to do to help you understand a story better after you have read it.

21. After I’ve read a story, it’s a good idea to
   A. Count how many pages I read with no mistakes.
   B. Check to see if there were enough pictures to go with the story to make it interesting.
   C. Check to see if I met my purpose for reading the story.
   D. Underline the causes and effects.

22. After I’ve read a story, it’s a good idea to
   A. Underline the main idea.
   B. Retell the main points of the whole story so that I can check to see if I understood it.
   C. Read the story again to be sure I said all of the words right.
   D. Practice reading the story aloud.

23. After I’ve read a story, it’s a good idea to
   A. Read the title and look over the story to see what it is about.
   B. Check to see if I skipped any of the vocabulary words.
   C. Think about what made me make good or bad predictions.
   D. Make a guess about what will happen next in the story.

24. After I’ve read a story, it’s a good idea to
   A. Look up all of the big words in the dictionary.
   B. Read the best parts aloud.
   C. Have someone read the story aloud to me.
   D. Think about how the story was like things I already knew about before I started reading.

25. After I’ve read a story, it’s a good idea to
   A. Think about how I would have acted if I were the main character in the story.
   B. Practice reading the story silently for practice of good reading.
   C. Look over the story title and pictures to see what will happen.
   D. Make a list of the things I understood the most.

Appendix E. Bivariate Correlation Matrices

Bivariate Intercorrelations: Graphic Organizer + Metacognitive Monitoring

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** Correlation is significant at the .01 level (2-tailed)
* Correlation is significant at the .05 level (2-tailed)
### Bivariate Intercorrelations: Graphic Organizer Group

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** Correlation is significant at the .01 level (2-tailed)
- Correlation is significant at the .05 level (2-tailed)
Bivariate Intercorrelations: Metacognitive Monitoring

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** Correlation is significant at the .01 level (2-tailed)
* Correlation is significant at the .05 level (2-tailed)
# Bivariate Intercorrelations: Comparison Group

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** Correlation is significant at the .01 level (2-tailed)
* Correlation is significant at the .05 level (2-tailed)
Appendix F. MLM Analyses of Levels of Verbal Ability, Metacognition, and Prior Knowledge (Passages 1-7)

*How does level of verbal ability impact reading comprehension across the instructional conditions?*

Another intercepts and slopes as outcomes model was run using a sample of 162 students accounting for 1073 observations. In this model, Time remained a Level 1, within-person variable, while instructional condition and verbal ability level were entered into the model as Level 2, between-person variables. The verbal ability level variable was created using a median split of the Gates-MacGinitie pretest scores. Students scoring in the top 50% were labeled one, while students scoring below 50% were labeled zero. On average, students with higher verbal ability scores recorded higher reading passage comprehension scores ($\gamma_{04}$). Controlling for verbal ability levels, the relationship between passage comprehension score and time did depend on condition. As shown in Figure F.1, passage score for students in the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{11}$) and in the Metacognitive Monitoring Condition ($\gamma_{12}$) were significantly higher than passage score for students in the Comparison Group. To compare scores from the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition, follow-up tests were run using new dummy codes, making the Metacognitive Monitoring group score the intercept. Results indicated that scores from the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12} = -.05, t = -.07, \rho = .94$) were not significantly different from those of the Metacognitive Monitoring Condition. See Table 6.
This model accounted for 59% of the between person variability ($\tau_{00}$) and 6% of the within-student variability ($\sigma^2$) in passage comprehension scores.

*Figure F.1:* Comprehension change controlling for levels of verbal ability.
Table F.1.

*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction and Levels of Verbal Ability on Reading Passage Comprehension*

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<td>Intercept, ( \gamma_{00} )</td>
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<td>Graphic Organizer, ( \gamma_{01} )</td>
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<td>Graphic Organizer + Metacognitive Monitoring, ( \gamma_{02} )</td>
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<td>Metacognitive Monitoring, ( \gamma_{03} )</td>
<td>-1.66 (5.43)</td>
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<td>Verbal Ability High/Low, ( \gamma_{04} )</td>
<td>15.08** (5.34)</td>
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<td>Time*Graphic Organizer, ( \gamma_{11} )</td>
<td>1.37 (.89)</td>
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<td>Time*Metacognitive Monitoring, ( \gamma_{13} )</td>
<td>2.18* (.89)</td>
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<td>Time*Verbal Ability High/Low, ( \gamma_{14} )</td>
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<td>Verbal Ability High/Low*Graphic Organizer + Metacognitive Monitoring, ( \gamma_{16} )</td>
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<td>Verbal Ability High/Low*Metacognitive Monitoring, ( \gamma_{17} )</td>
<td>4.32 (6.55)</td>
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| Random Effects | |
| **Comprehension Score, \( \beta_0 \)** | | |
| Intercept, \( \tau_{00} \) | 92.91*** (23.40) |
| Time slope, \( \tau_{11} \) | 2.94** (1.04) |
| Within-person Fluctuation, \( \sigma^2 \) | 287.26*** (13.89) |

Note: * \( p < 0.05 \), ** \( p < 0.01 \), *** \( p < 0.0001 \)
How does level of metacognition, as measured by the MSI, impact comprehension across the instructional conditions?

Another intercepts and slopes as outcomes model was run using a sample of 162 students accounting for 1073 observations. In this model, Time remained a Level 1, within-person variable, while instructional condition and verbal ability level were entered into the model as Level 2, between-person variables. Metacognition level was created using a median split of the MSI pretest scores. Students scoring in the top 50% were labeled 1, while students scoring below 50% were labeled 0. Overall results show that level of MSI pretest score was not significantly related to reading passage comprehension score ($\gamma_{04}$), but when controlling for metacognition levels, the relationship between passage comprehension score and time did significantly depend on condition. As shown in Figure F.2, passage score for students in the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12}$) and in the Metacognitive Monitoring Condition ($\gamma_{13}$) were significantly higher than passage score for students in the Comparison Group. To compare scores from the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition, new dummy codes were created making the Metacognitive Monitoring group score the intercept and follow-up tests were run. Results indicated that scores from the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12} = -.11, t = -.15, p = .88$) were not significantly different from those of the Metacognitive Monitoring Condition. There were no other significant main effects or interactions (See Table F.2)
This model accounted for 14% of the between-person variability ($\tau_{00}$), and 5% of the within-student variability ($\sigma^2$), in passage comprehension scores.

*Figure F.2:* Comprehension change, controlling for levels of metacognition (MSI).
Table F.2
*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction and Levels of Metacognition on Passage Comprehension*

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<td>Metacognition High/Low, $\gamma_{04}$</td>
<td>5.30 (6.40)</td>
</tr>
<tr>
<td>Time slope, $\beta_1$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>-.16 (.74)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>1.43 (.86)</td>
</tr>
<tr>
<td>Time*Graphic Organizer + Metacognitive Monitoring, $\gamma_{12}$</td>
<td>2.35** (.84)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>2.46** (.84)</td>
</tr>
<tr>
<td>Time*Metacognition High/Low, $\gamma_{14}$</td>
<td>0.99 (.57)</td>
</tr>
<tr>
<td>Metacognition High/Low*Graphic Organizer, $\gamma_{15}$</td>
<td>0.09 (7.93)</td>
</tr>
<tr>
<td>Metacognition High/Low*Graphic Organizer + Metacognitive Monitoring, $\gamma_{16}$</td>
<td>3.79 (7.79)</td>
</tr>
<tr>
<td>Metacognition High/Low*Metacognitive Monitoring, $\gamma_{17}$</td>
<td>-3.17 (7.78)</td>
</tr>
</tbody>
</table>

| Random Effects |         |
| Comprehension Score, $\beta_0$ | 191.74*** |
| Intercept, $\tau_{00}$ | (32.94) |
| (14% between) |
| Time slope, $\tau_{11}$ | 1.84* (1.03) |
| Within-person Fluctuation, $\sigma^2$ | 289.96*** |
| (14.13) |
| (5% within) |

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
How does level of prior knowledge impact comprehension across the instructional conditions?

Another intercepts and slopes as outcomes model was run using a sample of 162 students accounting for 1073 observations. In this model, time remained a Level 1, within-person variable, while instructional condition and prior knowledge level were entered into the model as Level 2, between-person variables. Prior knowledge level was created using a median split from the total prior knowledge score. Students scoring in the top 50% were labeled 1, while students scoring in the lower 50% were labeled 0. Although overall passage comprehension scores do not depend upon prior knowledge, results show that reading passage scores over time in both the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{16}$) and in the Graphic Organizer Condition ($\gamma_{15}$) do depend significantly on prior knowledge levels. Controlling for prior knowledge level, the relationship between passage comprehension score and time significantly depended upon condition. Passage scores for students in the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12}$) and in the Metacognitive Monitoring Condition ($\gamma_{13}$) were significantly higher than passage scores for students in the Comparison Group. To compare scores from the Graphic Organizer + Metacognitive Monitoring Condition and the Metacognitive Monitoring Condition, new dummy codes were created making the Metacognitive Monitoring group score the intercept and follow-up tests were run. Results indicated that scores from the Graphic Organizer + Metacognitive Monitoring Condition ($\gamma_{12} = -.11, t = -.15, p = .88$) were not significantly different from those of the
Metacognitive Monitoring Condition. There were no other significant main effects or interactions (See Table F.3).

Table F.3.

Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction and Levels of Prior Knowledge on Passage Comprehension

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, $\beta_0$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{00}$</td>
<td>58.86*** (4.90)</td>
</tr>
<tr>
<td>Graphic Organizer, $\gamma_{01}$</td>
<td>-10.51 (5.76)</td>
</tr>
<tr>
<td>Graphic Organizer + Metacognitive Monitoring, $\gamma_{02}$</td>
<td>-15.22** (5.58)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{03}$</td>
<td>-7.60 (5.44)</td>
</tr>
<tr>
<td>Prior Knowledge High/Low, $\gamma_{04}$</td>
<td>-0.11 (4.51)</td>
</tr>
<tr>
<td>Time slope, $\beta_1$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>1.05 (1.02)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>1.16 (.88)</td>
</tr>
<tr>
<td>Time*Graphic Organizer + Metacognitive Monitoring, $\gamma_{12}$</td>
<td>2.06* (.86)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>2.16* (.86)</td>
</tr>
<tr>
<td>Time*Metacognition High/Low, $\gamma_{14}$</td>
<td>-0.57 (.89)</td>
</tr>
<tr>
<td>Prior Knowledge High/Low*Graphic Organizer, $\gamma_{15}$</td>
<td>9.92* (4.70)</td>
</tr>
<tr>
<td>Metacognition High/Low*Graphic Organizer + Metacognitive Monitoring, $\gamma_{16}$</td>
<td>8.90* (4.43)</td>
</tr>
<tr>
<td>Metacognition High/Low*Metacognitive Monitoring, $\gamma_{17}$</td>
<td>3.24 (4.36)</td>
</tr>
</tbody>
</table>

Random Effects

| Comprehension Score, $\beta_0$                                                |                  |
| Intercept, $\tau_{00}$                                                       | 191.74*** (32.94)|
| Time slope, $\tau_{11}$                                                      | 1.84* (1.03)     |
| Within-person Fluctuation, $\sigma^2$                                        | 289.96*** (14.13)|

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
### Appendix G: Tables for MLM Models: Eight Passages

Table G.1

*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction, Time, and Verbal Ability on Passage Comprehension*

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept, $\gamma_{00}$</td>
<td>59.11*** (3.71)</td>
</tr>
<tr>
<td>Comprehension Score, $\beta_{0}$</td>
<td>Graphic Organizer, $\gamma_{01}$</td>
<td>0.31 (4.90)</td>
</tr>
<tr>
<td></td>
<td>Graphic Organizer +</td>
<td>-5.50 (4.81)</td>
</tr>
<tr>
<td></td>
<td>Metacognitive Monitoring, $\gamma_{02}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metacognitive Monitoring, $\gamma_{03}$</td>
<td>-1.58 (4.79)</td>
</tr>
<tr>
<td></td>
<td>Verbal Ability (Gates-MacGinita), $\gamma_{04}$</td>
<td></td>
</tr>
<tr>
<td>Time Slope, $\beta_{1}$</td>
<td>Intercept, $\gamma_{10}$</td>
<td>0.53 (.49)</td>
</tr>
<tr>
<td></td>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>0.30 (.65)</td>
</tr>
<tr>
<td></td>
<td>Time*Graphic Organizer +</td>
<td>1.25* (.64)</td>
</tr>
<tr>
<td></td>
<td>Metacognitive Monitoring, $\gamma_{12}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>1.00 (.63)</td>
</tr>
<tr>
<td></td>
<td>Time*Verbal Ability, $\gamma_{14}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verbal Ability*GO, $\gamma_{15}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verbal Ability*GOMM, $\gamma_{16}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verbal Ability*MM, $\gamma_{17}$</td>
<td></td>
</tr>
</tbody>
</table>

**Random Effects**

|          | Passage Comprehension ($\tau_{00}$) | 227.04*** (30.03) | 88.06*** (15.01) |
|          | Time slope ($\tau_{11}$) | 8.41 (6.51) | 6.02 * (2.64) |
|          | Within-person fluctuation ($\sigma^2$) | 294.74 *** (12.80) | 285.42*** (12.84) |

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
Table G.2
*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction and Levels of Verbal Ability on Reading Passage Comprehension (8 passages)*

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, β0</td>
<td></td>
</tr>
<tr>
<td>Intercept, γ00</td>
<td>48.05*** (4.71)</td>
</tr>
<tr>
<td>Graphic Organizer, γ01</td>
<td>-2.28 (5.86)</td>
</tr>
<tr>
<td>Graphic Organizer + Metacognitive Monitoring, γ02</td>
<td>-5.71 (5.56)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, γ03</td>
<td>3.02 (5.45)</td>
</tr>
<tr>
<td>Verbal Ability High/Low, γ04</td>
<td>17.17** (5.37)</td>
</tr>
<tr>
<td>Time slope, β1</td>
<td></td>
</tr>
<tr>
<td>Intercept, γ10</td>
<td>.97 (.58)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, γ11</td>
<td>0.27 (.67)</td>
</tr>
<tr>
<td>Time*Graphic Organizer + Metacognitive Monitoring, γ12</td>
<td>1.08 (.66)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, γ13</td>
<td>0.77 (.67)</td>
</tr>
<tr>
<td>Time*Verbal Ability High/Low, γ14</td>
<td>-.64 (.46)</td>
</tr>
<tr>
<td>Verbal Ability High/Low*Graphic Organizer, γ15</td>
<td>6.19 (6.51)</td>
</tr>
<tr>
<td>Verbal Ability High/Low*Graphic Organizer + Metacognitive Monitoring, γ16</td>
<td>8.83 (6.42)</td>
</tr>
<tr>
<td>Verbal Ability High/Low*Metacognitive Monitoring, γ17</td>
<td>3.82 (6.56)</td>
</tr>
</tbody>
</table>

Random Effects

| Comprehension Score, β0 |         |
| Intercept, τ00 | 128.29*** (24.26) |
| Time slope, τ11 | 0.43 (.61) |
| Within-person Fluctuation, σ² | 292.50*** (13.00) |

Note: * p < 0.05, ** p < 0.01, *** p < 0.0001
Table G.3

*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction, Time, and Metacognition on Reading Passage Comprehension*

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 1 (Jr.MAI)</th>
<th>Model 2 (MSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, $\beta_0$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{00}$</td>
<td>4.33 (.13)</td>
<td>31.93** (10.60)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>.57 (.70)</td>
<td>.48 (.68)</td>
</tr>
<tr>
<td>Time*Graphic Organizer +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{12}$</td>
<td>1.42* (.66)</td>
<td>1.52* (.66)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>1.00 (.66)</td>
<td>1.15 (.67)</td>
</tr>
<tr>
<td>Time*Metacognition, $\gamma_{14}$</td>
<td>-.07 (.08)</td>
<td>.08 (.05)</td>
</tr>
<tr>
<td>Metacognition*GO, $\gamma_{15}$</td>
<td>-1.78 (1.47)</td>
<td>-0.44 (.84)</td>
</tr>
<tr>
<td>Metacognition*GOMM, $\gamma_{16}$</td>
<td>-.97 (1.40)</td>
<td>-0.37 (.81)</td>
</tr>
<tr>
<td>Metacognition*MM, $\gamma_{17}$</td>
<td>-2.64 (1.5)</td>
<td>-0.78 (.82)</td>
</tr>
<tr>
<td>Time slope, $\beta_1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>2.41 (.27)</td>
<td>-0.79 (.90)</td>
</tr>
<tr>
<td>Metacognition, $\gamma_{12}$</td>
<td>1.96 (1.20)</td>
<td>1.74* (13.80)</td>
</tr>
<tr>
<td>Graphic Organizer, $\gamma_{01}$</td>
<td>50.65 (42.74)</td>
<td>9.51 (12.18)</td>
</tr>
<tr>
<td>Graphic Organizer +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{02}$</td>
<td>20.26 (39.90)</td>
<td>1.98 (13.18)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{03}$</td>
<td>72.75 (42.96)</td>
<td>12.92 (13.05)</td>
</tr>
<tr>
<td>Random Effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passage Comprehension ($\tau_{00}$)</td>
<td>236.43*** (32.91)</td>
<td>180.25*** (15.01)</td>
</tr>
<tr>
<td>Time slope ($\tau_{11}$)</td>
<td>1.28E-17</td>
<td>6.02 * (2.64)</td>
</tr>
<tr>
<td>Within-person fluctuation ($\sigma^2$)</td>
<td>289.59*** (22.08)</td>
<td>288.94*** (12.84)</td>
</tr>
</tbody>
</table>

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
Table G.4

*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction and Levels of Metacognition on Reading Passage Comprehension (8 passages)*

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, $\beta_0$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{00}$</td>
<td>54.93*** (5.37)</td>
</tr>
<tr>
<td>Graphic Organizer, $\gamma_{01}$</td>
<td>.24 (6.73)</td>
</tr>
<tr>
<td>Graphic Organizer + Metacognitive Monitoring, $\gamma_{02}$</td>
<td>-6.16 (6.49)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{03}$</td>
<td>1.15 (6.37)</td>
</tr>
<tr>
<td>Metacognition High/Low, $\gamma_{04}$</td>
<td>6.59 (6.28)</td>
</tr>
<tr>
<td>Time slope, $\beta_1$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td>.18 (.56)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>.33 (.65)</td>
</tr>
<tr>
<td>Time*Graphic Organizer + Metacognitive Monitoring, $\gamma_{12}$</td>
<td>1.32* (.64)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>1.11 (.64)</td>
</tr>
<tr>
<td>Time*Metacognition High/Low, $\gamma_{14}$</td>
<td>.56 (.43)</td>
</tr>
<tr>
<td>Metacognition High/Low*Graphic Organizer, $\gamma_{15}$</td>
<td>.81 (7.76)</td>
</tr>
<tr>
<td>Metacognition High/Low*Graphic Organizer + Metacognitive Monitoring, $\gamma_{16}$</td>
<td>3.10 (7.64)</td>
</tr>
<tr>
<td>Metacognition High/Low*Metacognitive Monitoring, $\gamma_{17}$</td>
<td>-3.22 (7.60)</td>
</tr>
</tbody>
</table>

Random Effects

| Comprehension Score, $\beta_0$                                             |                  |
| Intercept, $\tau_{00}$                                                     | 210.87*** (28.55) |
| Time slope, $\tau_{11}$                                                    |                  |
| Within-person Fluctuation, $\sigma^2$                                      | 294.45*** (12.79) |

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
Table G.5  
*Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction, Time, and Prior Knowledge on Reading Passage Comprehension (8 Passages)*

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, $\beta_0$</td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{00}$</td>
<td>56.88** (3.86)</td>
</tr>
<tr>
<td>Time slope, $\beta_1$</td>
<td>0.71 (.53)</td>
</tr>
<tr>
<td>Intercept, $\gamma_{10}$</td>
<td></td>
</tr>
<tr>
<td>Prior Knowledge, $\gamma_{12}$</td>
<td>1.70* (.84)</td>
</tr>
<tr>
<td>Graphic Organizer, $\gamma_{01}$</td>
<td>1.86 (5.09)</td>
</tr>
<tr>
<td>Graphic Organizer + Metacognitive, Monitoring, $\gamma_{02}$</td>
<td>-5.65 (4.99)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, $\gamma_{03}$</td>
<td>-1.88 (4.91)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, $\gamma_{11}$</td>
<td>.42 (.66)</td>
</tr>
<tr>
<td>Time*Graphic Organizer + Metacognitive Monitoring, $\gamma_{12}$</td>
<td>1.47* (.65)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, $\gamma_{13}$</td>
<td>1.15 (.64)</td>
</tr>
<tr>
<td>Time*Prior Knowledge, $\gamma_{14}$</td>
<td>-0.17 (.11)</td>
</tr>
<tr>
<td>Prior Knowledge*GO, $\gamma_{15}$</td>
<td>-1.33 (.85)</td>
</tr>
<tr>
<td>Prior Knowledge*GOMM, $\gamma_{16}$</td>
<td>-0.69 (.78)</td>
</tr>
<tr>
<td>Prior Knowledge*MM, $\gamma_{17}$</td>
<td>-0.41 (.84)</td>
</tr>
</tbody>
</table>

| Random Effects | |
| Passage Comprehension ($\tau_{00}$) | 222.77*** (29.95) |
| Time slope ($\tau_{11}$) | 0 |
| Prior Knowledge ($\tau_{12}$) | 0 |
| Within-person fluctuation ($\sigma^2$) | 296.14*** (12.95) |

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$
Table G.6

Unstandardized Estimates (and Standard Errors) of Multilevel Models of Conditional Effects of Instruction and Levels of Prior Knowledge on Reading Passage Comprehension (8 Passages)

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehension Score, β0</td>
<td></td>
</tr>
<tr>
<td>Intercept, γ00</td>
<td>61.57*** (4.58)</td>
</tr>
<tr>
<td>Graphic Organizer, δ01</td>
<td>-7.73 (5.77)</td>
</tr>
<tr>
<td>Graphic Organizer + Metacognitive Monitoring, δ02</td>
<td>-12.96* (5.63)</td>
</tr>
<tr>
<td>Metacognitive Monitoring, δ03</td>
<td>-4.11 (5.49)</td>
</tr>
<tr>
<td>Prior Knowledge High/Low, δ04</td>
<td>-3.43 (3.77)</td>
</tr>
<tr>
<td>Time slope, β1</td>
<td></td>
</tr>
<tr>
<td>Intercept, γ10</td>
<td>0.39 (.67)</td>
</tr>
<tr>
<td>Time*Graphic Organizer, γ11</td>
<td>0.26 (.65)</td>
</tr>
<tr>
<td>Time*Graphic Organizer + Metacognitive Monitoring, γ12</td>
<td>1.32* (.64)</td>
</tr>
<tr>
<td>Time*Metacognitive Monitoring, γ13</td>
<td>0.92 (.64)</td>
</tr>
<tr>
<td>Time*Prior Knowledge High/Low, γ14</td>
<td>0.23 (.57)</td>
</tr>
<tr>
<td>Prior Knowledge High/Low*Graphic Organizer, γ15</td>
<td>10.02* (4.07)</td>
</tr>
<tr>
<td>Prior Knowledge High/Low*Graphic Organizer + Metacognitive Monitoring, γ16</td>
<td>9.06* (3.88)</td>
</tr>
<tr>
<td>Metacognition High/Low*Metacognitive Monitoring, γ17</td>
<td>3.67 (3.94)</td>
</tr>
<tr>
<td>Random Effects</td>
<td></td>
</tr>
<tr>
<td>Comprehension Score, β0</td>
<td></td>
</tr>
<tr>
<td>Intercept, τ00</td>
<td>217.97*** (29.91)</td>
</tr>
<tr>
<td>Time slope, τ11</td>
<td>0</td>
</tr>
<tr>
<td>Within-person Fluctuation, σ²</td>
<td>293.40*** (12.79)</td>
</tr>
</tbody>
</table>

Note: * p < 0.05, ** p < 0.01, *** p < 0.0001