ABSTRACT

Title of Document: THE EFFECTS OF USING MENTAL IMAGERY AS A COMPREHENSION STRATEGY FOR MIDDLE SCHOOL STUDENTS READING SCIENCE EXPOSITORY TEXTS

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This study investigated the effects of mental imagery instruction using science expository texts on middle school students. Using a quasi-experimental pretest-posttest design, four intact classes (56 students) were randomly assigned to either an experimental or comparison group. Students in the experimental group received instruction on mental imagery strategies while comparison group students received no mental imagery instruction. After the 2-week intervention, students took Posttest 1. The comparison group students then received mental imagery instruction. Throughout the rest of the school year, all students were prompted at least two to three times a week to use mental imagery strategies. At the end of the school year, all participants took Posttest 2.

Results indicated that there was a statistically significant interaction of time and group for the selected response (SR) portion of expository science text

comprehension measure. Both groups appeared to make gains between Posttest 1 and Posttest 2, once both had received mental imagery instruction. The comparison group, which by chance included stronger readers, outperformed the experimental group. There were no statistically significant differences on the brief constructed response (BCR) measure.

Analysis of the performance of low-, middle-, and high-comprehenders revealed statistically significant main effects for time and for type of comprehender on the SR portion of the comprehension task. While all students appeared to make gains between Posttest 1 and 2, the high- and middle-comprehenders consistently outperformed the low-comprehenders. For the BCR, there were no statistically significant effects of time or interaction; however, there was a statistically significant effect for type of comprehender.

Pearson's product moment correlations revealed a statistically significant positive relation between vividness of mental imagery and motivation to read for middle-comprehenders and a statistically significant negative correlation between comprehension and vividness of mental imagery for high-comprehenders. Both experimental and comparison groups showed no statistically significant difference in motivation to read before and after mental imagery intervention.

These results suggest that middle school students may benefit from mental imagery strategies when reading science expository texts. It is recommended that these strategies be used as a continuous effort in the classroom rather than a short term “quick-fix.”

THE EFFECTS OF USING MENTAL IMAGERY AS A COMPREHENSION STRATEGY FOR MIDDLE SCHOOL STUDENTS READING SCIENCE EXPOSITORY TEXTS

By

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DEDICATION

This study is dedicated to my parents Kwan-Tung Ho and Shui-Fong To, who nourished in me a life-long yearning for learning; my husband, Kenneth, for his concern and support; to my children Syltinsy, Kennie, and Tze, for their patience and encouragement.

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CHAPTER I

INTRODUCTION

Purpose of the Study

Mental imagery has long been a subject that has fascinated researchers (e. g., Levin, 1981; Paivio, 1986; Sadoski, 1983). Prior research in the field suggests that mental imagery is not only an effective strategy to improve reading comprehension (Bourduin, Bourduin, & Manley, 1993; Gambrell & Bales, 1986; Pressley, 1976; Shriberg, Levin, McCormick, & Pressley, 1982), but it is also positively related to motivation to read (e. g., Cramer, 1980; Irwin, 1979; Macomber, 2001; Sadoski & Quast, 1990). Some studies have also shown that poor readers benefit more than good readers when given instructions or practice in forming mental images during reading (Gambrell, Koskinen, & Cole, 1981; Oakhill & Patel, 1991). However, most past research that used mental imagery as a comprehension strategy involved elementary students reading narrative texts (e. g., Bourduin, Bourduin, & Manley, 1993; Gambrell & Bales, 1986; Macomber, 2001; Oakhill & Patel, 1991; Pressley, 1976). There are very few studies that used mental imagery as a comprehension strategy for middle school students reading science expository texts (Gunston-Parks, 1985; Peters & Levin, 1986). Further, the few studies involving middle school students and expository text have left much to be investigated. For example, in the study by Gunston-Parks (1985), the focus was to investigate the effects of guided imagery. It was not designed to teach students how to use mental imagery as a comprehension strategy. In Peters and Levin's study (1986), the focus was to investigate recall of information, not reading comprehension. Peters and Levin (1986) used training and testing materials that consisted of sentences and short paragraphs (each three sentences long). The materials were not the typical expository texts students encounter when they read textbooks or take standardized tests. Thus, while prior investigators have accumulated a vast amount of knowledge regarding mental imagery, the area of teaching middle school students to use mental imagery as a comprehension strategy for expository texts has been underdeveloped.

The purpose of this study was to investigate the effectiveness of mental imagery as a comprehension strategy for sixth-grade middle school students reading science expository text. This study provided middle school students with mental imagery instruction over a two-week period so that students might learn and practice these strategies when reading science expository texts. In addition, this study examined whether there were sustained effects of using mental imagery strategies when, after the instructional period, students were prompted at least two to three times a week to use the strategies until the end of the school year. This investigation would add to that body of research that seeks to improve reading comprehension instruction by examining the effects of mental imagery instruction on students' comprehension of science expository texts in a regular classroom setting.

This chapter begins with an explanation of what mental imagery is, then continues with the need to improve students' reading comprehension, pointing out the importance of expository texts and why middle school students need strategies for comprehending them. Then the chapter presents the rationale for using mental imagery as a comprehension strategy to help middle school students when reading expository texts. Next, the following components are presented: mental imagery as a comprehension strategy, middle school students as participants, the adaptability of mental imagery strategies, mental imagery for whole class instruction, mental imagery with partners, mental imagery for small groups, the ease of use, cost-effectiveness of mental imagery, versatility of mental imagery in the regular classroom, mental imagery as a reading strategy to help students scoring “below-average,” improving student's attitude toward reading, research questions, summary of the chapter, and a brief discussion of the current study. This chapter closes with “Definition of Terms.”

What Is Mental Imagery

Mental imagery refers to any image created in the mind without the presence of the real object or event, including the images of sight, sound, taste, touch, smell, sensations, and feelings. Although mental imagery has been defined in various ways in the fields of psychology and education, it is generally agreed to be the process of forming internal sensations of objects or events not physically present (Hibbing & Rankin-Erickson, 2003; Paivio, 1986; Paivio & Csapo, 1969; Sadoski, 2001; Sadoski & Paivio, 2001). Many researchers think of mental imagery as visual imagery, and what they call “pictures in the mind” (Gambrell & Bales, 1986, Gunston-Parks, 1985). However, Sadoski and Paivio (2001) claimed that if there is a “mind's eye,” there is also the “mind's ear,” and other senses of the mind as well, since mental imagery is based on sensory memories (p. 11). Sadoski and Paivio (2001) claimed that “imagery pervades all aspects of our mental lives, including what we experience when we read and write” (p. 11). They explained mental imagery as the sensations and memories that people use to remember things and experiences. Sadoski (2005) argued that mental imagery is the “primary cognitive form of nonverbal representation” (p. 222). Mental imagery includes memories of sights, sounds, tastes, touch, smells, feelings, events, and stories that may be replayed in the mind (Long, Winograd, & Bridge, 1989). Douville and Algozzine (2004) stated that mental imagery serves as a kind of internal blackboard or personal movie screen that aids in dynamic problem-solving of both verbal and spatial tasks.

Researchers such as Goetz, Sadoski, Fatemi, and Bush (1994) claimed that mental imagery plays an important part with the complex task of reading. Researchers in reading have produced direct evidence linking reading and mental imagery (e. g., Levin, 1981; Sadoski, 1983). Research has also shown that being able to use mental imagery with reading positively impacts the affective domain, and that many readers who employ mental imagery tend to find texts more interesting as well as more comprehensible and more memorable (Goetz et al., 1994; Long, Winograd, & Bridge, 1989; Sadoski, 1984; Sadoski & Paivio, 2001; Sadoski & Quast, 1990). Nell's study (1988) presented anecdotal evidence that readers reported imagery during pleasure reading. Prior research in the field also supported the use of mental imagery as an enhancer of memory (Shriberg, Levin, McCormick, & Pressley, 1982) and as an effective strategy for improving reading comprehension (Gambrell, 1982; Gambrell & Bales, 1986; Oakhill & Patel, 1991; Pressley, 1976).

Imagery and Text

According to Long, Winograd, and Bridge (1989), one factor that seems likely to influence the spontaneous generation of imagery while reading is the genre of the text. Traditionally, reading texts are categorized into two types of writing: expository texts and narrative texts (Downing, Bakken, & Whedon, 2002; Weaver & Kintsch, 1984). Weaver and Kintsch (1984) stated that the main thrust of expository texts is "to communicate information so that the reader might learn something," and that the main focus of narrative texts is "to tell a story so that the reader will be entertained" (p. 230). Weaver and Kintsch further explained that expository texts have rhetorical structures that may be categorized into three main groups: (a) General-particular relationships which include identification, definition, classification, and illustration; (b) Object-object relations which include comparison and contrast; and (c) Object-part relations which include technical analysis, structural analysis, functional analysis, and casual analysis. Other researchers in the field listed similar structures, including specific structures such as chronological order, listing, argument, problem and solution, description, and process (Barr, Blanchowicz, Katz, & Kaufman, 2002; Barr, Kamil, & Mosenthal, 1984; Langan, 1992; Olsen & Gee, 1991).

Expository texts include writings in textbooks, training manuals, and software documentations (Weaver & Kintsch, 1984). Based on the definition that expository text relates information, this study also categorizes as expository reading material such as graphs, charts, maps, instructions, diagrams, memos, manuals, news, Internet articles, and other similar materials.

As mentioned before, many researchers have examined mental imagery with narrative texts. Long, Winograd, and Bridge (1989) explained that one reason for this is the intuitive assumption that narrative texts would be more compatible with imagery use than expository texts because of "the chronological event structure and the subjective, experiential stance of the author" (p. 357). However, studies by

McCallum and Moore (1999) and Sadoski (1983, 1984) indicated that participants reported using imagery when reading expository texts. Based on the idea that readers can generate mental imagery when reading expository texts, this study investigated the effects of teaching middle school students various mental imagery strategies to use when reading expository texts similar to what may be found in sections of a science textbook or portions of a typical state or national assessment.

Statement of the Problem

The Need to Improve Reading Comprehension

Most educators would agree that reading comprehension is very important. Mason (2004) claimed that reading comprehension is the essential key not only to in-school academic learning, but also to life-long learning. Other people may argue that with new technology, many people need to read less. In fact, Griswold (2001) claimed that America no longer has a “reading culture” because power and influence of the society are shared with “less-than articulate” sports stars, pop musicians, wealthy businessmen, and talk show queens (p. 5). In today's world, icons represent words on sales registers or doors, recordings may give instruction or present an entire novel in audio format, and many people choose television and movies for entertainment over books. However, even Griswold acknowledged that many influential people still hold that reading is important and that to be well-read is one way to access power (p. 4).

In order to fully function in society and be able to tackle problems and have access to important texts (whether literary, philosophical, or technical), people need to read. Allington and Cunningham (2002) presented a projection indicating that the shifting U.S. economy will require a future workforce in which the workers, and not just the people in charge, will need some college or some form of post-secondary education. They also argued that our nation's literacy needs for the 21st-century require "strong academic skills, thinking, reasoning, teamwork skills, and proficiency in using technology" (Allington & Cunningham, 2002, p. 2).

Yet today many students nationwide are not achieving in reading. According to the National Center for Educational Statistics, in the 2007 National Assessment of Education Program (NAEP) report, only 33% of the fourth-grade students and 31% of the eighth-grade students in the nation scored at or above "Proficient" in reading. While the fourth-grade sample group of students made a 2% gain since 2005, the eighth-grade sample group of students remained at the same proficient rate.

In addition to national testing, some educators use the students' state test performance as another indicator for reading achievement. For instance, one mid-Atlantic state assessment for 2006 indicated that 46.9% of the sixth-grade students scored at the "Basic" level, and 53.1% of the students scored at the "Proficient" level and above. While these state assessment scores appear to be better than the NAEP scores, some researchers have noticed that the standards for state tests are quite different than the NAEP (McGill-Franzen & Allington, 2006). McGill-Franzen and Allington (2006) noted disparity between the NAEP and state assessments; in fact they claimed that some of the state assessments allow for more accommodations for students with deficits and disabilities, therefore allowing for more "improvement" than the NAEP (p. 765). For example, some state accommodations may include verbatim reading of the entire reading test; however, that is not allowed on the NAEP

(National Center for Educational Statistics, NAEP Inclusion Policy, 2007). Another researcher, Lee (2006), found that nearly all the 43 states which have both NAEP and state assessments showed lower standards on their state assessments.

Furthermore, state assessments may also be quite different from the normed standardized tests such as the *Gates-MacGinitie Reading Test* (2000). When some students who score at or above the “Proficient” range on a state test take a standardized normed reading test such as the *Gates-MacGinitie*, they may score below grade level. For example, in the 2005-2006 school year, I used the *Gates-MacGinitie Reading Test* (2000, Form S) to test my sixth-grade students. Results showed that one of my classes had an average reading level of 3.7 (grade equivalence). Yet on average, these students were scoring in the “Proficient” range according to the state assessment.

While it is a challenge to help the students who score “Basic” improve their reading, it is also a challenge to make sure that the students who score “Proficient” for a given year have the skills to do well the following year. The students who score “Proficient” may not necessarily be “Proficient” with a different test. In addition, as students progress through the grades, assessments become more challenging. One way to help students perform well on any reading task is to provide them with reading strategies that they can use.

The seriousness of the need to improve students’ reading achievement is evident to many educators and administrators. For intervention, some school systems have adopted expensive reading programs that publishers have guaranteed to be “research based” and “tested,” with the hope that these programs will be a quick answer to the problem. Most of these “canned” reading programs are expensive. For example, the *READ 180* program by Scholastic Incorporated is designed for students who read a year or more below grade level. It may cost $10,000 for initial setup for computer programs (software only) and reading materials for one classroom. The classroom also needs to be equipped with at least seven computers linked to a mainframe, which also adds to a sizable sum for computer hardware. The optimal class size for that program to be effective is between 7 to 14 students (Scholastic, *READ 180* Classroom, 2008).

Other intervention reading programs such as *Soar to Success* published by the Houghton- Mifflin Publishing Company (2007) may be useful in small group tutorial settings only, and may not be practical for the classroom teacher, with 25 students or more, to implement. The Houghton-Mifflin Publishing Company designed the reading intervention materials to be used with a group size of no more than seven, and the price in 2007 was about $948 for a set of materials of 18 titles, seven copies each, with six consumable student guides (Houghton-Mifflin, 2007).

Some of these reading programs also may be “scripted,” which means using one model of teaching for all students. The teacher would have to read directly from the manual, and not be able to adjust to the learning styles or interests of her students. An example of a scripted reading program is Scholastic's *Guided Reading Program* (2005). Scripted programs may not be the answer to all students’ needs. Some teachers such as Ms. Soran, who was interviewed for an article in the *NEA Today* magazine, spoke against the use of scripted programs, claiming that scripted programs remove “teacher creativity” (Winans, 2005). In view of these problems, many school systems are looking into various inexpensive, teacher-friendly, student-oriented, and result-producing approaches to teaching reading strategies that may be implemented in the regular classroom. Thus, this study used one such approach--teaching mental imagery strategies to students in a regular classroom with the intent of helping students improve reading comprehension when they read expository texts. Mental imagery instruction does not need extra money, and it is teacher-friendly and student-oriented. Since results from my informal study in the school year 2005-2006 indicated that the instruction benefitted my students, I began this study (a more refined model compared to the informal study) with the assumption that mental imagery instruction would benefit the current group of students as well. Information regarding my informal study is included in Appendix H.

The Need to Improve Expository Text Comprehension

When students read or take tests, they commonly encounter narrative and expository texts. Narrative texts tell a story or relate a sequence of events. Narrative texts demonstrate a “story grammar” in which there is a setting, events that unfold, usually some problems, bringing forth reaction and more events, and then a solution and conclusion (Rumelhart, 1975). On the other hand, expository texts mainly relate information, and may use rhetorical structures such as cause and effect, analysis, compare and contrast, explanation, description, classification, illustration, argument and persuasion, and definition (VanderMey, Meyer, Van Rys, Kemper, & Sebranek, 2007).

When students first learn to read, they often read story books that are narrative in nature. As noted, narrative text refers to the type of writing that tells a story or presents a series of events (Smith & Ellis, 2003). The story grammar or schema in narratives is familiar to many children because they are used to the story-telling conventions (Rumelhart, 1975). Sheveland (1992) noted that narrative texts typically found in literature books are written to allow students "to comprehend, store, and retrieve a sense of story" (p. 11). However, when students reach the upper elementary grades, they are exposed to more expository texts as they read texts in subjects such as science and social studies. The importance of expository text seems to increase even more as students move into middle school since the students now have textbooks in science, mathematics, social studies, technical education, health, family consumer science, and maybe even a foreign language. The only narrative texts many students encounter in school are literature anthologies or selected novels in their reading or English classes.

Does this increased focus on expository text reflect the world and the tasks demanded of the average person? A report by the U.S. Department of Labor on achieving necessary skill (SCANS, 1992) identified eight areas considered essential to the preparation of all students, and reading achievement is one of them. It specifically mentions that future workers must be able to productively use information and have competence in reading. It states, “Without the ability to read a diverse set of materials, employees will not be able to locate the descriptive and quantitative information needed to make decisions or to recommend courses of action” (p. xvi). Bovee, Thill, and Schatzman (2003) claimed that with the advancement of technology such as the Internet, it is important for today’s worker to be able to read information and make good choices (pp. 6- 8). Many of these tasks require the reading of expository texts.

As Allington and Cunningham (2002) have predicted, the future worker needs to be literate, and highly effective with technology skills-- skills that require the understanding of expository texts since technical knowledge, manuals, and procedures are mainly written as expository texts. The high-tech world literacy revolves around expository texts-- from learning how to operate a computer program, doing research using the Internet, to putting a presentation ready for clients. Expository texts are very important to a student's future success in the job market.

Expository texts are also very important when it comes to testing. When students take high-stakes, state-mandated reading tests, many of the selections are expository in nature. An example is the National Assessment of Education Program (NAEP) reading test. For 2005, both the fourth- and eighth-grade tests contain four narratives and five expository passages (National Center for Educational Statistics, 2005). This means that for both the fourth- and eighth-grade NAEP tests, 44% are narrative and 56% are expository texts. An examination of the sixth-grade public release task of another standardized test, the California Standard Test (CST), reveals that three passages are narrative and thirteen text selections are expository (California Department of Education, 2007). This means that for the sixth-grade CST test, 19% are narrative and 81% are expository texts. Among the text selections are a form, a diagram, and a letter to the editor. Although these items are not the typical informational texts similar to those from science or social studies textbooks, they are included in the expository category based on the definition that expository texts provide information or explanation.

Similarly, in the sixth-grade *Gates-MacGinitie Reading Test* (Form S, 2000), half of the comprehension test portion uses expository passages. These various test samples show that expository texts form a large part of today's reading assessment. If students have difficulty understanding expository texts, how can they do well on the typical standardized tests or high-stakes state tests when half or more than half the test contains expository passages? Poor performance on tests may cause the students to be placed in lower level programs, or be placed in academic tracks where they have less opportunity to all the academic chances available. Thus, facility with expository texts appears to have a big impact on a student's future.

The Need to Teach Middle School Students Reading Strategies for Expository Text

It is important that middle school students learn strategies to comprehend expository texts and improve their reading skills. Performing well in school on a day-to-day basis depends largely on reading skills associated with expository texts, doing well on standardized tests and state tests depends on such skills, and achieving goals in the students' future jobs may also depend on them. The need to teach middle school students reading strategies for expository text is indeed intense. In addition to the greater demand for students to use expository texts, this type of text is usually more difficult for many students (Saenz & Fuchs, 2002). Furthermore, many content teachers usually do not teach reading strategies (Alverman & Moore, 1991; Armbruster, Anderson, Armstrong, Wise, Janisch, & Meyer, 1991), and the reading teachers often do not teach reading strategies for expository texts (Hoffman, Roser, &

Battle, 1993; Winograd & Greenlee, 1986). These points are explained in later sections of this paper.

As noted, there is a greater demand for students to use expository texts in the middle school when compared to that of the elementary school. In a typical day, middle school students may read a variety of materials. For example, they may read an excerpt from a novel in their literature-based basal in Reading class, directions for sewing in Home Economics class, directions for making a catapult in Tech Ed class, information on an ancient civilization in Social Studies class, steps for solving an equation in Math class, health information in Physical Education and Health class, and information about rocks and minerals from the science textbook in Science class. Other than the excerpt from a novel from the basal reader, the other types of texts may be classified as expository.

When students read narrative texts, they rely on sequence of events and a certain pattern that researchers term "story grammar" (Rumelhart, 1975). Students are exposed to this method of presenting information even at an early age, when they start listening to stories. Narration is usually the most familiar style of reading for students. In fact by fourth grade, the pattern of narratives comes so easily to the students that except for academically challenged students, most do not need to be taught story grammar (Dreher & Singer, 2001). However, when students read expository text, instead of story grammar, different structures are evident.

Expository writing includes various structures such as classification, cause and effect, argument and persuasion, compare and contrast, definition, description, explanation, and process (VanderMey et al., 2007). Expository texts may have technical vocabulary that may be difficult for students to decode and understand. For example, a typical sixth-grade science textbook such as Holt's *Earth Science* (2001) contains terms such as “photosynthesis” and “centripetal.” Smith and Ellis (2001) analyzed various expository texts and noted some special features. They stated that expository texts may have general statements in the opening and closing, repetitions of the topical theme, and unique structure for sentences, such as timeless verb constructions. For example, the statement, “The life cycle of every butterfly begins with an egg,” indicates a timeless verb construction (Smith & Ellis, 2003, p. 1). Students who are not accustomed to reading this type of writing may be confused about what the most important key word is and how the things mentioned are related. Smith and Ellis also pointed out generic noun constructions in expository texts, which may be difficult for some readers to grasp. For example, from the statement “Batik designers create a picture in wax on a piece of cloth” (Smith & Ellis, 2003, p. 1), students have to think about the noun phrase “batik designers” and who these people are in order to understand what they do. The task of identifying and understanding generic noun phrases is quite different and more complicated than reading about characters named Jack or Alice.

In addition, Sadoski and Paivio (2001) have argued that expository texts found in social studies and science textbooks are often written in a very dry and factual manner. They also noted that critics point out that much expository text is "lifeless" and "insipid," while some other expository texts contain "bland facts set off by dazzling graphics" (p. 264).

The average course load for a middle school student will result in the student encountering more expository reading than narrative reading. Yet reading strategy instruction for expository texts is often overlooked (Smith, Ellis, & Reed, 2003; Williams, Hall, Lauer, Stafford, DeSisto, & de Cani, 2005). In 2002, Barry conducted a survey of secondary teachers of all subject areas to find what strategies teachers claim they use. Of the 123 teachers who responded, 84% claimed that their top most favored instructional strategy was using visual aids. When the students go to science or other content classes, they are expected to already know how to read. Alverman and Moore (1991) noted that the content teachers are mainly focused on delivering their content. They suggested that students rely on the teacher's lecture and notes as the main source for information and that there is actually very little reading in many of the content classes. Yet to be successful, students need to read the text to complete tasks such as answering questions and taking tests.

Similarly, Raphael, Kirshner, and Englert (1989) noted that when children reach the upper elementary grades, they are not taught how to read and learn from informational or content area texts. The lack of reading instruction in science and social studies is carried over to the middle schools, where reading strategies are usually only taught in reading classes. It is quite ironic that despite the vast amounts of expository texts and expository reading tasks students have in the middle school, little is done to help them understand these texts or tasks. In their study, Armbruster, Anderson, Armstrong, Wise, Janisch, and Meyer (1991) documented that lecture and discussion type activity predominate in science and social studies classes, with actually very little reading of the content textbook or trade books.

In an informal survey of five science teachers in the middle schools where I have worked, I found that the science teachers claimed that they mainly used notes to teach the class because the science text book was "too hard." When students used the science book, they mainly looked at illustrations, graphs, charts, vocabulary, and located information to answer questions. Students were not expected to read the full text in its entirety. Most of the text was explained to the students. One science teacher said that she used the science book with her Honors class (also known as the Gifted class in other districts), although she did not use the textbook with the On-grade-level class except to look at charts, graphs, diagrams, graphics, or look for information to complete tasks. While there was little reading in these science classrooms, students were expected to complete tasks and take tests that require reading. As a result, many students experienced difficulty when taking their unit tests.

In their study, Saenz and Fuchs (2002) noted that their participants, 111 high school students in special education and remedial classes, did comparatively worse on reading comprehension tasks with expository texts than narrative texts. Saenz and Fuchs (2002) argued that features in expository texts such as headings, subheadings, topic sentences, cueing devices such as "first," "second," and "in contrast" were difficult for the students (p. 32). They explained that in contrast to expository texts, narrative writing has a pattern which is similar to the everyday language experienced by children, and therefore, their students performed better on the narrative texts (Saenz & Fuchs, 2002).

Even among expository texts, science expository text is particularly difficult for students when compared with social studies texts. Social studies texts may contain narrative components which may be easier to follow. The following excerpt from a sixth-grade social studies textbook titled *The World: Harcourt Brace Social Studies* (2000) demonstrates the narrative nature of a typical social studies passage:

> *Sargon the Conqueror*
>
> The first known conqueror in the region of Mesopotamia was a warrior named Sargon. He lived in the city-state of Kish. As a young man he served as an official in the king's government. Sargon later killed the king and took control of Kish. Gathering an army, Sargon then marched through Mesopotamia, establishing a vast *empire*. An empire is a conquered land of many people and places governed by one ruler. Sargon became the region's first *emperor*, or ruler of the empire. (p. 80)

Many students are familiar with narrative type development, consistent with stories and "story grammar" they have been exposed to at an early age. In contrast, the following excerpt from a sixth-grade science textbook demonstrates a different writing style, using expository writing structures-- explanation, definition, and cause and effect:

> *What causes earthquakes?*
>
> As tectonic plates push, pull, or scrape against each other, stress builds up along faults near the plates' edges. In response to this stress, rocks in the plates deform. Deformation is the change in the shape of rock in response to stress. Rock in a fault line deforms in mainly two ways-- in a plastic manner, like a piece

of molded clay, or in an elastic manner, like a rubber band. Plastic deformation ... does not lead to earthquakes. Elastic deformation, however, does lead to earthquakes. While rock can stretch farther than steel without breaking, it will break at some point... Like the return of the broken rubber pieces to their unstretched shape, elastic rebound is the sudden return of elastically deformed rock to its original shape... During elastic rebound, rock releases energy that causes an earthquake...

(Holt, Rinehart, & Winston, 2001, p. 197)

Informational texts such as the one above may be difficult for students who have not been reading much expository texts, especially if they have not been taught a reading strategy to use with such texts.

Tierney and Readence (2000) listed a variety of reading strategies available for classroom teachers to use-- from predictions, story mapping, questioning the author, investigating themes, to character analysis. These strategies are all useful for students to comprehend text and make connections with the text, and teachers mainly use them with narrative texts. What about specific instruction and reading strategies for expository texts? Since the students are not likely to get reading strategies in content classes, will they get them in reading class? The answer is probably not. Many schools systems still use literature based basal readers for reading instruction while other school systems may use novels and selected books. In both cases, the materials are mainly narrative. Many basal readers are literature-based with few expository texts. For example, in a typical literature-based sixth-grade basal reader, *Introduction* *to Literature* (Holt, 2000), there are eight units based on genres, each with about four or five short pieces of writing or excerpts from longer pieces of literary work. Of the eight units, only one is expository. The total number of narrative selections is 35 whereas the number of expository selections is 8, with the ratio of narrative to expository is 15:1. Another basal-- the Scott Foresman's sixth-grade *Literature* (2000)-- contains more expository texts compared to the Holt. It is organized by theme, and there are usually four or five selections for each theme, including short stories, poetry, and some informational writing. For example, in the first theme related to "growing up," the basal reader contains the following pieces of writing: (a) a diary entry by a thirteen year old student about her first experiences in junior high, (b) a short story about a young girl who is gifted in music but has challenges in reading, (c) a short article about growing up rites of passage from different cultures around the world, (d) a poem, and (e) a folk tale with a setting in Africa. An analysis of the section shows that out of the five selections, three are narrative. Some may consider the diary to be similar to documentaries, and therefore qualify as expository writing because it explains and gives information; yet the format of that piece is also narrative. The only informational piece of writing is the one about rites of passage, only two pages long. The ratio for the first unit for narrative versus expository is 4:1.

This information is similar to the findings of Flood and Lapp (1986). The researchers examined eight reading programs and found that on average, 65% of the selections and 72% of pages are narratives or poems. It is rather surprising that the reading basals, even today, do not reflect the recommendations of many researchers in the field who called for a "balanced program" and suggested that students read both narrative and information books (Dreher, 2003; Rasinski & Padak, 2004; Winograd & Greenlee, 1986). The two recent sample basal reading programs do not appear to be much different than the reading programs twenty years ago-- students are still not exposed to enough expository texts in their reading programs.

In addition to the small amount of expository texts in the basal readers, sometimes, the reading teachers may skip the teaching of expository selections. Researchers such as Armbruster et al. (1991) have found that some reading teachers do not feel as comfortable teaching expository texts when compared to teaching narrative texts, and opt to skip some expository selections. It is ironic that when the students go to reading class, they are usually not taught the strategies that may work well with expository texts because many reading teachers favor the narrative style. According to a survey of read aloud practices in 537 elementary classrooms nationwide, none of the most frequently read titles at any grade level were informational books (Hoffman, Roser, & Battles, 1993). Similarly, Yopp and Yopp (2000) surveyed 126 elementary teachers, and found that only 14% of the materials teachers reported reading aloud on a given day were expository. It is not surprising that many students struggle with expository texts.

Regardless of the how the expository text is written and whether students had reading strategies to handle expository texts or not, students are expected to read and comprehend the materials. The students who are more challenged or “at-risk” definitely need some extra help. Dreher (2000) stated that it is particularly important for “at-risk” students to have the opportunity to interact with information text (p. 73). Chall, Jacobs, and Baldwin (1990) pointed out that students from low income families who performed adequately in reading at an earlier age lag behind by middle school mainly due to the deficiency in academic vocabulary typically found in informational texts. Targeting a comprehension strategy that works well with expository texts may help all students, including the "at-risk" children, make gains in reading comprehension (Douville & Algozzine, 2004; Gambrell & Bales, 1986; Peters & Levin, 1986; Shriberg et al., 1982).

Rationale

This study investigated the effects of mental imagery instruction using science expository texts on middle school students. Research in the field provided sufficient evidence that mental imagery may be used as a comprehension strategy with expository texts (McCallum & Moore, 1999; Peters & Levin, 1986; Saenz & Fuchs, 2002), although there are few studies investigating mental imagery with expository texts using middle school participants. Mental imagery is fairly easy to use, adaptable in any classroom, and cost-effective. In addition to possibly improving comprehension, teaching students to use mental imagery may also improve their motivation to read (Gunston-Parks, 1985; Rose et al., 2000; Sadoski, 1983).

Mental Imagery as a Comprehension Strategy

Evidence from several sources suggests that mental imagery is involved in the process of reading comprehension (e. g., Finch, 1982; Levin, 1982; Sadoski, 1983). Studies by Bourduin, Bourduin, and Manley (1993), Gambrell and Bales (1986), Pressley (1976), and Rose, Parks, Androes, and McMahon (2000) showed that students who employed mental imagery as a reading strategy performed better on reading assessments than those students who did not. Some researchers termed the process of asking participants to create mental imagery while they read “induced imagery” (Gambrell, 1982; Gambrell, Koskinen, & Cole, 1980). Tierney and Readence (2000) explained that induced imagery is a "means of enhancing comprehension" (p. 362). Gambrell (1982), Gambrell, Koskinen, and Cole (1980), Rose, Parks, Androes, and McMahon (2000) used induced mental imagery as a comprehension strategy to help students improve their reading comprehension. These studies indicated that using mental imagery can assist the reader in comprehending text, interacting with text, and remembering text.

Furthermore, several studies point to the relationship between mental imagery and affect in text appreciation (Long, Winograd, & Bridge, 1989; Sadoski & Quast, 1990). Sadoski & Paivio (2001) argued that when students experience mental imagery, they tend to find the text more interesting, more comprehensible, and more memorable (p. 184). Macomber also claimed that imagery makes the text come to life in the imagination of readers, providing a medium for reader-text transactions (2001, p. 3). Gunston-Parks (1985) noted that there is a statistically significant relationship between frequent and vivid mental imagery and positive motivation to read.

In addition to positive affect, studies by Gambrell, Koskinen, and Cole (1981), Oakhill and Patel (1991), and Pressley (1976) also suggest that mental imagery may be a strategy that will benefit low-readers.

As noted, prior studies in mental imagery often use elementary students and narrative texts (e. g., Bourduin, Bourduin, & Manley, 1993; Gambrell & Jawitz, 1993; Oakhill & Patel, 1991). The few studies that have been done using expository texts suggested that mental imagery can work with expository texts. According to

McCallum and Moore's 1999 study of 33 students, second through fifth grade, students were able to generate mental imagery during and after reading science expository passages. In fact, students generated both relevant and non-constrained (irrelevant) mental images. Although the non-constrained mental images actually hindered comprehension somewhat, causing students to be off-task, or miss the point, McCallum and Moore's study (1999) demonstrated that students can generate mental images for science expository texts. In addition, Long, Winograd, and Bridge's study (1989) used both narrative and expository texts, and students demonstrated that mental images were generated both during and after reading using either types of texts. However, these researchers did not focus on using mental imagery as a strategy for comprehension. They focused on how students spontaneously generated mental imagery when they read passages. Long, Winograd, and Bridge suggested that imagery generated spontaneously may be different in some way from imagery used purposefully as a metacognitive strategy (p. 367).

After reviewing other prior studies using mental imagery with expository texts (e.g., Gambrell, Koskinen, & Cole, 1980; Gunston-Parks, 1985; Peters & Levin, 1986; Shriberg, Levin, & McCormick, 1980), I concluded that there was sufficient evidence to suggest that students could be taught to use mental imagery with science expository texts if appropriate instructions and guidance were provided.

Middle School Students as Participants

Few studies in the area of mental imagery use middle school students, yet this group of students bridges primary and secondary levels. Some researchers are in a college environment, and they prefer college students who are more mature than elementary and middle school students (Peters & Levin, 1986). Other researchers may prefer elementary students. Elementary students or children before the age of 11 and 12 generally tend to want to please the teacher or adult in charge (Bee, 1989, p. 554). Many research studies in mental imagery use elementary students as participants (e. g., Bourduin, Bourduin, & Manley, 1993; Gambrell, 1982; Gambrell & Bales, 1986; Rose et al., 2000; Pressley, 1976). Researchers who study middle school students usually work in that environment and have established a rapport with the students. Middle school students are older than elementary students, yet not as mature as high school or college students. Sometimes these pre-teens and teenagers go through a rebellious state that may be referred as a "period of negativism" (Bee, 1989, p. 555). Adolescents may have conflicts with authority figures (which include teachers) centered on their independence and with what they want to do, not necessarily what the adult wants them to do (pp. 555-556). The impact of their peers plays a very important role (p. 556), and sometimes, the conflicts in the classroom arise because they want to impress their peers. Berman, Hornbaker, and Ulm (2000) noted the disruptive behaviors in classrooms and lack of respect for others in the middle school environment as an issue to be addressed. Knowing how to deal with middle school students as well as classroom discipline is something that is very important.

According to Sackett and Chun (1998), more middle school students demonstrate unacceptable behavior and disrespect in the classroom when the teacher or adult is considered "uncool" (p. 2). The students will perform better and have fewer discipline issues with the "cool" teachers, who according to Sackett and

Chun's findings through surveys, observations, and interviews, are the ones who have developed positive relationships with the students and showed that they care (p. 12). A researcher who does not regularly work with the middle school students needs to find time to develop relationships with the students as well as some means to demonstrate caring if he or she wants to conduct a smooth study. Less research is done in the middle school level even though it is a very critical stage of a student's development because of these factors. This research used middle school students as participants since I work in a middle school and have been teaching middle school for twelve years. This age group of students is special to me.

Middle school students are required to take national and state reading tests; therefore, useful strategies that will improve their reading scores will be welcomed in most school systems. Furthermore, it is important that these students embrace strategies they can use for life-long learning. It is important that the middle school students grasp these reading strategies before they reach high school, because the middle school, in most districts, is the last place where there is any formal reading instruction in a regular classroom. High school students are expected to already know how to read. If students have not mastered their reading skills in middle school, they will most likely have a difficult time in high school. Teaching students a comprehension strategy that works well with expository texts may help them make gains in reading comprehension and establish a firm reading foundation for future learning.

Adaptability of Mental Imagery Strategies

A strategy that works well in a classroom should be adaptable, since classrooms may vary in student number, physical set-up, student ability, student cooperation and various other factors. While some classes could learn in small learning groups without problems, other classes may be very active and would need teacher direction at all times. Under certain circumstances, small group instruction may become a management feat because of students who wanted to do things such as socializing, establishing influence over others, playing, or even doing nothing instead of cooperating and learning. In a class with many challenging students, a reading comprehension strategy that is flexible enough to keep students interested and yet allow the teacher to maintain control is needed. Mental imagery is flexible enough to apply to a whole group or small cooperative group.

In one study, Gambrell (1982) used mental imagery for a whole class. In other studies by Gambrell, Koskinen, and Cole (1980) and Rose et al. (2000), the researchers used small groups. Evidence suggests that mental imagery is a flexible and adaptable strategy. The students may be organized as a whole group, paired with partners, or divided into smaller groups depending on their manageability and group dynamics.

Mental Imagery for Whole Class Instruction

Mental imagery can work well in a whole class situation because it provides a framework for the whole class, yet each student will relate in his or her own manner, calling up images that are based on personal experiences, hence differentiating on the individual level. At the same time, the teacher does not have to manage several small groups. Mental imagery instruction is useful for all classes, and will work even in classes with challenging students because behaviors can be monitored while the students' minds are kept active. For classes in which students are not cooperative, or in situations when the teacher wants the most direct way to give information, whole class instruction may be the model. After direct instruction, the teacher may lead discussions related to mental imagery that students formed. Seidenstricker's study (1999) pointed out that teacher-led whole class discussion has value because the teacher can guide the class in a positive direction related to the topic studied. This is important especially for students who needed more guidance. The teacher can guide the students toward images that relate to the text and away from unrelated or off-topic images. McCallum and Moore (1999) argued that unrelated or off-topic images, which they term “non-constrained” images, inhibit rather than facilitate reading comprehension.

Mental Imagery with Partners

Working with partners may be another effective way to use mental imagery. Conversing with another person to discuss ideas and sharing images derived from the text make the reading task more interesting to many students. Alverman, Dillion, and O'Brien (1987) and Kelch (2005) have shown that working with a peer may actively engage students and promote better comprehension.

Mental Imagery for Small Groups

Mental imagery can also work well in small groups because students may be able to share ideas and images. Rose et al. (2000) organized their students into small groups for mental imagery training and sharing. In addition, students acted out parts of the stories they read based on their imagery. Rose et al.'s study showed that students made statistically significant gains in factual understanding of the reading material. Studies in cooperative groups suggest that students in small groups have a more positive attitude toward learning when compared with students in whole class instruction (Johnson, Johnson, Holubec, & Roy, 1984; Slavin, 1983). Small group instruction also allows for differentiation in instruction (Anderson, 2007; Tomlinson, 2001). The mental imagery instruction presented in this study can be adapted for small groups so that students may benefit from sharing mental images and discussing reading text with their peers.

The Ease of Use

Mental imagery is easy to use once the teacher understands the basic concepts of how to activate students' imaging processes. The National Reading Panel (2000) mentioned its ease of use, and how imagery would "actively engage the reader to use mental processes..." (p. 4-104). Once the teacher has instructed the students, it is very easy to prompt the students to use mental imagery in most classroom situations. The mental imagery instruction procedure presented in this paper is user-friendly, and has incorporated some other popular strategies that work for entire groups such as metacognition (Pressley, 1999, p. 92), think-along think-aloud (Farr, 1997), and verbal-visual cue vocabulary (Pressley, 1999, p. 180). These points are further discussed in later portions of this paper to show the links these strategies have with mental imagery and how they are integrated into the mental imagery instruction for students.

Furthermore, a single classroom teacher can use this instructional method for a whole class of 23- 30 students, even if some students are reading below grade level. There is no need for an assistant. Prompting students to use mental imagery strategies throughout the year may ensure that the students maintain their skills. Another reason to choose mental imagery as a comprehension aid for the classroom is that it is so flexible and versatile. Once the students have been instructed in mental imagery, a teacher may pick and choose any part of the mental imagery-inducing strategies to use with students as needed, and the lesson may be tailored to fit the needs of students, even with classes with some behavior challenges. There are several parts to the mental imagery instruction. The Method section of this paper explained the instruction in detail. As a brief overview, these parts include teacher-guided imagery, self-generated imageries, and self-generated illustrations. The strategies may also be adjusted for reading comprehension or vocabulary learning.

Cost-Effectiveness of Mental Imagery

While many pre-canned reading intervention programs cost a lot of money, mental imagery strategy does not cost any extra. Programs such as the READ 180 and *Soar to Success* are quite expensive. Another set of materials that included pre-reading, during reading, and after reading strategies is the *9 Good Habits* (Zaner-Bloser, 2007). The price in 2008 was about $24.99 per copy. For a class set of 25 resource books, that would cost about $625 per classroom. In addition, to effectively use this set of materials, the teacher would need a *Teacher Resource Package* costing $127.99. Yet the book *9 Good Habits* is designed as a resource, not a main textbook or basal because there is not enough material in that book to cover a whole school year. The resource book does not take the place of a basal reader. Another reading resource book is *The Reader's Handbook* (Houghton-Mifflin, 2006). In 2008, a soft cover student book cost $19.95 and a hardcover student book cost $23.75. Such resource books with strategy instruction may complement the basal textbook, but they all cost. On the other hand, mental imagery can be used with any material that the schools already have, eliminating the need to spend extra money.

Versatility of Mental Imagery in the Regular Classroom

Mental imagery strategies are very versatile and may be used in the classroom in many ways to help students connect with the text and vocabulary.

Mental imagery for improving comprehension. As noted, prior research in the field has documented gains in reading comprehension when students were instructed to use metal imagery (e. g., Gambrell & Bales, 1986; Oakhill & Patel, 1991; Pressley, 1976). This study builds upon the insights gained from other studies to provide sufficient instruction for the students to learn this strategy so they may become better readers when reading expository texts. In addition to helping students improve comprehension, mental imagery is also effective for helping students improve vocabulary.

Mental imagery for improving vocabulary. It is generally accepted by many researchers that in order for students to read well, they need a wide vocabulary (National Reading Panel, 2000; Wood, Watson, & Soares, 2006). Yet in order for students to have a wide range of vocabulary, they need to read more. One problem that students face when reading expository texts is that many students do not take time or use strategy to learn new vocabulary. Science terms are particularly difficult for many students. Mental imagery may also be an effective strategy to help students learn new vocabulary. One such activity is the visual-cue vocabulary cards. For example, if the teacher finds that the text has a lot of difficult vocabulary, he or she may elect to use mental imagery to focus on learning certain vocabulary words. Researchers such as Bean, Valerio, and Stevens (1999), and Tierney and Readence (2000) have noted the effectiveness of visual-cue cards, or its equivalent-- the LINCS vocabulary card. In visual-cue vocabulary, students are prompted to create mental imagery as well as illustration links and written links for the vocabulary words. This process was explained in detail in the Methodology section of this paper.

This visual-cue vocabulary strategy is even marketed by some SAT prep books such as *Picture These SAT Words* by Geer and Geer (2004), *Vocabbusters SAT: Make Vocabulary Fun, Meaningful and Memorable* by Howell and Howell (2004), and *Vocabulary Cartoons: Building an Educated Vocabulary with Visual Mnemonics* by Burchers, Burchers, and Burchers, III (1998). The difference between these vocabulary training books and visual-cue cards made by students in the classroom is that the SAT prep books provide for students the vocabulary, the visual image, and the connection as a prepackaged product. All the student has to do is to memorize them. It is considered easier by many people to learn vocabulary this way because of the imagery provided. The continued sales and production of these books show evidence that people are finding them useful, and there is a good market for these books. The visual-cue vocabulary cards made in the classroom is even better because there are no extra costs. Furthermore, the students make their own cards and they find the links that are unique for them based on their own prior knowledge, and they draw the pictures themselves. All these processes activate mental imagery. Prior research related to imagery and vocabulary learning has shown that activating mental imagery has helped students recall better (Shriberg, Levin, McCormick, & Pressley, 1982; Zhang & Schumm, 2000).

Peters and Levin (1986), and Hibbing and Rankin-Erickson (2003) demonstrated that illustrations also helped students understand and remember expository texts. For example, Peters and Levin used illustrations to cue students about certain key concepts. For Hibbing and Rankin-Erickson, students were prompted to draw scenes and stages of what may be happening after reading a portion of the text or the whole text. Rose et al. (2000) also found that the drawing of scenes had been useful for elementary students using narrative texts. Based on the evidence from prior research, drawings are likely to help middle school students as well, whether they are reading narrative or expository texts. This portion of the imagery instruction can be used anytime in the classroom when the teacher may find this strategy useful.

Mental Imagery as a Reading Strategy to Help Students Scoring "Below-average"

The *No Child Left Behind Act* (2001) has made all public schools accountable for the students' achievement, requiring these schools to be evaluated by certain acceptable measures. One such measure is the standardized state reading assessment. Students in public schools are expected to score successfully on these state assessment tests. While the most challenged students in special education programs are allowed to take an alternative test, the majority of the students (including students with low achievement, students with special education accommodations, and students with limited English proficiency) are not exempt from the standardized assessment. It is no surprise that some students will end up scoring “below-average” or in the “Basic” range for the reading assessment. How can teachers help these children achieve more in reading is a big question, and it is more complex than what one person or one program can do. Of the many reading strategies that have been researched and shown to be easily adaptable and successful in a typical classroom, mental imagery strategies show lots of promise for the students who are scoring “below-average.” Good readers read well already, and while there are activities the teachers can do to encourage them to advance even more, it is undoubtedly true that the teachers need to reach the students who scored “below-average.” Studies by Gambrell, Koskinen, and Cole (1981), Oakhill & Patel (1991), and Pressley (1976) showed that induced mental imagery helped all students, but the low-comprehenders benefitted the most.

Mental Imagery for Improving Students' Attitude toward Reading

Other than reading ability, a reader's attitude often affects his or her achievement in reading. Cramer' study (1980) using elementary students showed that a reader's general attitude toward reading was significantly related to comprehension as well as imagery vividness. Irwin's study (1979) showed essentially similar findings, except that he used college students. Macomber's study (2001) using middle school participants indicated that students with more vivid mental images had better attitudes towards reading. While the main purpose of this study was to investigate the effects of mental imagery strategies on middle school students reading expository texts, it was hoped that students might develop better attitudes toward reading after instruction, as some prior studies have shown (Gunston-Parks, 1985; Hibbing & Rankin-Erickson, 2003). Better attitudes toward reading would hopefully encourage students to read more and achieve more.

Research Questions

In past research about imagery, there are very few studies that focused on how to induce imagery for comprehending text in a step-by-step process (Center, Freeman, Robertson, & Outhred, 1999; Finch, 1982; Gambrell & Bales, 1986; Gambrell, Kapinus, & Wilson, 1987; Pressley, 1976). Fewer still, are studies that used mental imagery instruction with expository texts (Gunston-Parks, 1985; Shriberg et al., 1982; Peters & Levin, 1986). To ensure that students learn how to use mental imagery strategies, this study used step-by-step processes to guide middle school students to create mental images.

This study addressed the following main questions:

1. What are the effects of mental imagery strategies on students' reading comprehension achievement when they read science expository texts?
2. How do the low-, middle-, or high-comprehenders compare in their reading achievement after mental imagery instruction?
3. Are there relationships between the variables of comprehension achievement, vividness of mental imagery, motivation to read, and the types of comprehenders?
4. Is attitude toward reading improved after mental imagery strategies?

Summary

The reasons for choosing mental imagery as a comprehension strategy with expository text in this study can be summarized as follows:

1. Prior research in the field demonstrated that mental imagery may be an effective reading strategy (Bourduin & Bourduin, 1993; Gambrell & Bales, 1986; Pressley, 1976; Rose, Parks, Androes, & McMahon, 2000). Studies by Long, Winograd, and Bridge (1989) and McCallum and Moore (1999) showed that mental images could be created when students read expository texts; therefore, mental imagery strategies may be useful to middle school students reading expository texts.
2. Mental imagery is fairly easy to use. As explained in the procedures that follow in the Methodology portion of this paper (Chapter III), the teacher guides the students to create mental images. In one of Gambrell's studies (1986), she asked the students to make pictures in their minds. The result of her study was positive, and it is an example that demonstrates the ease of prompting students to use mental imagery strategy.
3. The instructional method encourages students to participate. Mental imagery is not difficult for most students to do, although some students may not have memory experiences as vivid as others. However, using this instructional method, the students have a chance to share their mental images with partners, small groups, or with the whole class. Sadoski and Paivio (2001) noted that mental imagery is positively related to engagement and motivation to read.
4. The mental imagery strategy calls for easy classroom management; it can be

used with the entire class or small groups, and even with more challenging classes.

5. There is no need to purchase new text books or materials. The teacher can continue cueing students to use imaging strategies for any reading task after students have been instructed.

6. Mental imagery instruction may also be helpful in improving students' motivation and attitudes toward reading.

Brief Description of the Study

This study used a quasi-experimental pretest-posttest research design. My coworker and I, certified reading teachers who taught in a mid-Atlantic public middle school, provided the instruction. Each teacher taught two reading classes and three Language Arts classes a day. For this study, each teacher randomly assigned one intact reading class as the experimental group and the other intact reading class as the comparison group. After some pre-assessments, the experimental group received mental imagery instruction for two weeks using science expository passages as reading materials. The comparison group used the same reading materials without mental imagery instruction. After the two week period, all students took the reading post-assessments. Students of the comparison group then received mental imagery instruction. (Details are included in Appendix G, in the Auxiliary Instruction section.) After instruction, students in all the participating classes were cued to use mental imagery at least two to three times a week. At the end of the school year, sequential sampling was used with all classes to investigate any sustained effects for the experimental group and to measure any possible gains for the comparison group since this group of students also received mental imagery instruction.

Definition of Terms

The following definitions are pertinent to this investigation:

Combination instruction-- training method that combines the various mental imagery instructional techniques, both representational and transformational aspects, so that whatever constrained image comes to the readers' mind, they will be able to relate to the text.

Comprehension-- the understanding of text and the ability to extend and have personal interactions with the text (Anderson & Pearson, 1984).

Constrained imagery-- mental imagery that is limited or consistent with the text that is read (McCallum & Moore, 1999).

Expository text-- written text that gives information and explanations, often employing various text structures such as definition, analysis, comparison and contrast, cause and effect, persuasion and argument (VanderMey et al., 2007). Although graphs, charts, lists, and various other textual aids are generally considered expository in nature, those were not considered in this study.

Imagens-- mental images that involve any of the senses, activating nonverbal processes of the brain (Sadoski & Paivio, 2001).

Induced mental imagery-- mental imagery that formed as a result of some purposeful strategy, cues, or prompts (Gambrell, 1982).

Learning strategy-- a learning strategy is “in education, a systematic plan, consciously adapted and monitored, to improve one's performance in learning” (Harris & Hodges, 1995, p. 244).

Logogens-- the graphic representations such as words, numbers, or icons, activating the verbal processes of the brain (Sadoski & Paivio, 2001).

Mental imagery-- Mental imagery refers to any image created in the mind without the presence of the real object or event, including the images of sight, sound, taste, touch, smell, sensations, and feelings. Sadoski and Paivio (2001) explained mental imagery as the sensations and memories that people use to remember things and experiences. Long et al. (1989) claimed that mental imagery includes memories of sights, sounds, tastes, touch, smells, feelings, events, and stories that may be replayed in the mind.

Narrative text-- written text that tells a story or relates a series of events (Weaver & Kintsch, 1984).

Non-constrained imagery-- mental imagery that is not limited to the ideas of the texts, and may be off target (McCallum & Moore, 1999).

Representational instruction-- instruction method that prompts the students to generate sensory images to link with the text, using images that represent the idea on the printed text. It is the “fairly direct translation of the text into an image” Oakhill & Patel, 1992, p. 108). For example, the term “buttery popcorn” may invoke the following representational images: yellow puffy kernels (sight) with a delicious aroma (smell), crunchy noise and feel when one bites a popcorn kernel (hearing and feeling), plus a salty and buttery taste in the mouth (taste). The popcorn may also invoke the feeling of fullness in the stomach (gustatory), or a general sense of happiness (emotional). Some people may recall the sensations of eating popcorn while watching a movie (event).

Think-aloud Think-along-- the ideas that come to a reader's mind when interacting with the text. In this study, think-along ideas are preferred because students may write them down for sharing later rather than everyone talking out loud. These ideas may be questions, summaries, reactions, connections, clarifications, or predictions.

Transformational instruction-- instructional method that prompts the students to use other linking mechanisms to help them understand the text or words from the text. This includes any mnemonic, keyword, hook, latch, or linking device that helps a person understand a vocabulary term, a date, a detail, a name, or an event (Peters & Levin, 1986). For example, to get the idea that explosive volcanic eruptions can be associated with soda shaken in the bottle, some students may link "magma" to "soda," and the idea of the magma from inside the earth will become gaseous and pop out during an eruption will be similar to the soda that will fizz and pop out of a shaken bottle. Mnemonic devices may be used if it is helpful.

CHAPTER II

REVIEW OT THE LITERATURE

Overview

This chapter begins with the historic use of mental imagery, continuing with reviews of the basic theories of mental imagery and contemporary experimental use of mental imagery. Then the chapter presents various studies in mental imagery, mental imagery instructional strategies in the past, and ends with an explanation of how this study may extend previous research efforts in the field.

Historic Use of Mental Imagery

The use of mental imagery dates far back in human history. The ancient Greeks have been known to use mental imagery to aid memory (Pressley, 1976). The ancient method of Loci was attributed to Simonides of Keos (556 BCE). This “loci” method focused on using memory “hooks” or mnemonic devices to help people recall the sequence of events. Another Greek philosopher, Aristotle (384-322 BCE), gave imagery a prominent place in his teaching, and even claimed that thought never occurred without a mental image (Sadoski & Paivio, 2001, p. 15). The Roman teacher and rhetorician, Quintilian (30-96 A.D.), taught his students to remember key objects as reminders for them to address certain issues. For example, an anchor would remind them to speak about matters of the navy, and a spear would remind them to address military operations (Sadoski & Paivio, 2001, p. 13).

Basic Theories of Mental Imagery

While the method was used in the ancient days, few reasons were given as to why the strategy was employed. Recent theories in mental imagery that attempted to explain what it is and how it works started in the fields of philosophy and psychology.

Theorists who studied mental imagery agree that thought processes may be nonverbal, and that verbal stimuli may activate the nonverbal processes, and vice versa (Paivio, 1986; Sadoski & Paivio, 2001; Sadoski & Quast, 1990). Vygotsky (1962) claimed that "thought and speech have different roots... At a certain point these lines meet, whereupon thought becomes verbal and speech rational" (p. 44). He also mentioned that sensory material and words join together for concept formation (p. 52).

Other researchers link mental imagery to schema theory (Anderson & Pearson, 1984; Rumelhart, 1975). According to Rumelhart, schema theory is about knowledge (1980, p. 3). He stated that schema is data structure for representing the generic concepts stored in memory. There are schemata representing all concepts. These include objects, situations, events, and actions. Rumelhart claimed that human knowledge consists of schemata based on the procedures used to interpret events. As people meet new conditions, they will constantly create new schemata based on the existing knowledge (Rumelhart & Norman, 1983). Rumelhart also explained that the human brain processes information using parallel computational devices which are different than that of a traditional computer (Rumelhart, Widrow, & Lehr, 1994). Using schema is how a person links new experiences to past experiences. In relation to reading, a reader links new information that is read to past experiences to make sense of it. Anderson and Pearson (1984) discussed schemata as the reader's knowledge already stored in memory, functioning in the process of interpreting new information and allowing the new information to be part of the combined knowledge. The "interaction of new information and old knowledge" is what is termed as “comprehension” (Anderson & Pearson, 1984, p. 225). Schema may be stored as verbal information or nonverbal information. Researchers in the field of mental imagery may find overlapping concepts with the schema theory. To be more explicit about the understanding of mental imagery, which is nonverbal in nature, Paivio and Sadoski's Dual Coding Theory can explicate its nature and process.

Paivio has been studying the connections of words, imagery, and memory codes since the 1960s. Throughout these studies, he noted that when words are interpreted, they are in turn processed through memory organization, generating retrieval of information and mental imagery. The relations are complex, and interdependent upon many factors such as the individual's memory organization or memory capacity. Even imagery itself is dependent upon the attributes of words, such as their frequency of usage, their meaningfulness, and their concreteness (Paivio, 1983). In 1986, Paivio studied the use of mnemonic techniques to help participants recall symbolic modes and their sensorimotor counterparts. His study prompted him to formulate the basis of the Dual Coding Theory. He theorized that verbal and nonverbal stimuli may operate independently, parallel, or connected to each other. He later conducted many other studies, some in conjunction with other researchers (Paivio & Clark, 1988; Paivio, Clark, & Lambert, 1988).

In 2001, Sadoski and Paivio published a book titled *Imagery and Text*, which further clarified how the dual-coding works. They explained that people receive two types of stimuli: verbal stimuli (logogens) and nonverbal stimuli (imagens). Examples of logogens or verbal stimuli include words that people hear or read. Examples of imagens or nonverbal stimuli may include a setting, smells, music, noises, and various other sensory input, including feelings of happiness or anger. These logogens and imagens may operate independently, parallel, or connected to each other. Sadoski and Paivio further explain that the imagens enhance comprehension of verbal stimuli (p. 53). When people read texts, the verbal stimuli may be processed as such and understood, or the verbal stimuli may activate other stimuli (verbal and nonverbal), which in turn give the readers sensory experiences. Furthermore, sensory experiences may activate other verbal stimuli and build a deeper experience and understanding. Sadoski and Paivio (2001) theorized that the activation of sensory experiences helps people make sense of the text, relate to the text, and remember the text.

The most popular idea about mental imagery is that it is the ability to create pictures in the mind's eye, a form of mental representation with visual properties (Macomber, 2001, p. 3). Some readers can invoke a series of images while reading novels that their reading experience may be more entertaining than a movie. However, mental imagery is not limited to just the visual sense. Sadoski and Paivio (2001) stated that mental imagery is comprised of representations that refer to internal forms of information used in memory (p. 43). Therefore, the sensations and memories one gets from reading or listening in the absence of the real experience or any gross motor movements that pertain to sight, touch, taste, hearing, smell, even gustatory sensations and the sense of being may be categorized as mental imageries (Sheehan, 1972). Several studies point to the relationship between mental imagery and affect in text appreciation (Long, Winograd, & Bridge, 1989; Macomber, 2001; Sadoski & Quast, 1990). When students experience mental imagery, they tend to find the text more interesting, more comprehensible, and more memorable (Sadoski &

Paivio, 2001, p. 184). Furthermore, imagery makes the text come to life in the imagination of readers, providing a medium for reader-text transactions (Macomber, 2001, p. 3).

Induced imagery may be perceived as a "means of enhancing comprehension" (Tierney & Readence, 2000, p. 362). The study by McCallum & Moore (1999) revealed that mental imagery is not a precondition for understanding written text; however, many good readers report that they employ mental imagery while reading. Studies by Bourduin and Bourduin (1993), Gambrell and Bales (1986), Pressley (1976), and Rose, Parks, Androes, and McMahon (2000) showed that students who employed mental imagery as a reading strategy performed better on reading assessments than those students who did not. These studies suggest that using mental imagery in reading comprehension may assist the reader in comprehending text, interacting with text, and remembering text.

Early Experimental Use of Mental Imagery

Early experimental use of mental imagery can be traced back to Sir Francis Galton in 1893, who created the first questionnaire regarding images (Holt, 1964). In this measure of individual imaging differences, Galton attempted to measure an individual's imaging ability by asking people to describe what they had for breakfast. Later, another researcher, Betts (1909), studied the frequency and clarity of the occurrences of seven sensory modalities (vision, auditory, olfactory, touch, gustatory or taste, sense of movement or action, and sense of feel). He came to the conclusion that most participants imaged more than they recognized; however, it is possible to think without imaging.

In the 1960s, Paivio did extensive studies with imagery. He worked with young children and picture-word pairs, and he found that picture-word pairs promoted more recall and imagery than picture-picture pairs. He suggested that while pictures facilitate associative learning stimuli, they hindered the verbal response of the four- to six-year-olds (Paivio & Yarmey, 1966). He also noted that participants performed better with imaging and recall when he used concrete nouns as opposed to abstract nouns (Dilley & Paivio, 1968). In another study, Paivio and Csapo (1969) found that memory for sequential order was poorer for pictures than for words, but pictures were superior to words in non-sequential tasks.

Contemporary Experimental Use of Mental Imagery

Despite the amount of research in the field, all of which are enlightening, mental imagery has not been studied extensively as a reading strategy, nor has it received much attention as such. However, mental imagery is listed as one of the useful comprehension strategies by many experts (Mowey & Conahan, 1995; National Reading Panel, 2000; Pearson, 1984; Tierney & Readence 2000).

Research reviews on mental imagery as a reading strategy, in general, has not attributed great success to its use. In one study, Alverman and Moore (1986) investigated and reported research studies in secondary school reading practices. Among these varied reading practices for improving comprehension, they included the use of mental imagery. Their report on the mental imagery strategy is not all that positive. Out of the seven experimental studies on mental imagery that they reviewed (Anderson & Kulhavy, 1972; Cramer, 1982; Gunston-Parks, 1985; Peters & Levin, 1986; Rasco et al, 1975; Weinstein, 1982; and Warner, 1977), only two were reported to have brought forth some positive gain (Peters & Levin, 1986; Weinstein, 1977). However, the report did not do full justice to all the studies. For example, Cramer's study (1981) was not designed to use mental imagery as treatment; it was designed to understand the relationships between mental imagery, attitudes, and learning. The study by Weinstein (1982), though reported as bringing positive gains in comprehension, was not a study for mental imagery but for training students to use elaboration learning strategies. The students were taught to use elaboration to enhance learning, and while students elaborated and retold, they might have drawn upon imagery. However, the study did not specifically teach students to use mental imagery as a technique; therefore, it should not even be included in the category of using mental imagery as a strategy.

In another instance, Alverman and Moore (1986) rated the outcome for Rasco, Tennyson, and Boutwell's study (1973) to be negative. However, that is not all true. Rasco et al. investigated the use of mental imagery instructions and drawings in enhancing verbal learning on three populations: college, high school, and fourth- and fifth-graders. Although the study reported no gains for the high school experimental group, there was a statistically significant main effect for the college experimental group that used the imagery instructional strategy. The college group showed no significant effects on the use of drawings though. For the elementary experimental group, using either the imagery strategy or the drawings significantly improved the posttest comprehension performance.

Alverman and Moore’s study (1991) was insightful in mentioning that the seven mental imagery studies they investigated did not use materials that were part of regular classroom instruction. A more careful observation showed that of these seven studies, only two studies provided students with instruction on how to use mental imagery. In one study, Warner (1977) provided 30 minutes on visual imagery instruction for students with learning disability. His study did not indicate that there was any comprehension gain for the students. The other study in Alverman and Moore's report that provided students with instruction on how to use mental imagery was the study by Peters and Levin (1986). They provided the students with instructions on how to create images with the text as well as pneumonic devices for recall. That study reported positive gains for students.

The National Reading Panel (2000) also reviewed several experimental studies in mental imagery (Bourduin, Bourduin, & Manley, 1994; Gambrell & Bales, 1986; Peters & Levin, 1986; Pressley, 1976; Shriberg, Levin, McCormick, & Pressley, 1982). The Panel did not give a strong report to recommend its use except a statement that claims "the main effect of imagery is to increase memory for the sentence imagined" (p, 4-77). Some of these studies were explored more fully in the following sections.

This study reports 27 contemporary studies using mental imagery to enhance students' reading comprehension in some manner. Of these studies, the school levels of the participants vary. Fourteen of the studies had elementary participants, 7 studies had middle school participants, 3 studies had high school participants, and 5 had college participants. One study, Rasco et al. (1975) used three different groups of participants (college, high school, and elementary), and is counted repeatedly for each group of students. Examination of these studies showed a different scenario from

Alverman and Moore's report: twenty-two of these studies reported some form of positive result, whether the gain is in one aspect of reading comprehension or the affective domain. Only four showed no positive results at all. In these studies, the type of text used also vary: 16 studies used narrative texts, 7 used expository texts, 3 used both types of texts, and 1 study used sentences only. It is interesting to note that the amount of mental imagery strategy instruction also varies: 14 studies provided no instruction at all while 13 provided students with some sort of instruction. Within the studies that gave students instruction on how to use mental imagery with their reading task, the amount of time spent on instruction varies from several minutes to 30 minutes per week for six sessions. The following sections discussed the two divisions—experimental studies that provided no instruction, and the studies that gave students instructions on how to use some form of mental imagery.

Experimental Studies in Mental Imagery as a Comprehension Strategy with No Instruction

It is fascinating to note that many of the studies using mental imagery as a comprehension strategy really did not give participants any instruction on how to create mental images that may enhance the text they are reading. For most of these studies, the researchers simply told the participants to create mental images during reading. Some of these studies in metal imagery with no instruction did not report any positive gains.

Studies with No Instruction and No Reported Gains

An example of a study that investigated whether mental imagery facilitates learning from prose reading without focusing on mental imagery instruction is the study by Anderson and Kulhavy (1972). They investigated the effects of prompting students to engage in mental imagery while these students read a 200-word textbook (Social Studies type) expository passage. The 62 high school seniors were randomly assigned to be in the experimental group or comparison group. The experimental group received no instruction in how to form mental images. They were just told to form vivid pictures of everything described in the booklet. The comparison group was asked to read carefully. The results showed that there was no statistical difference between the learning of the two groups. On a post-experiment questionnaire, more than half of the students in the comparison group claimed they used imagery even though they did not receive any prompts to do so, while about a third of the experimental group did not use any imagery. There is also a relationship between the amount of learning and the amount of time during which imagery was reported as being used. Since the researchers did not give any instruction on how to create mental imagery, it is not surprising that a third of the students in the experimental group did not engage in mental imagery. Nor is it surprising that there is no evidence of better learning. Why do half the students in the comparison group report that they used imagery? Is it because it is natural for them to do so? Are many of these students already proficient readers with many strategies? The study does not explain, but it does offer some interesting things to consider when using mental imagery as a strategy for comprehension in the future.

Another study in mental imagery that Alverman and Moore (1991) reported on was Cramer's study (1982). Cramer's purpose was to better understand the relationship between mental imagery, attitude towards reading, and higher reading achievement; therefore, not having an instructional method is not a deficit of his study.

Cramer used 30 eleventh-grade students as participants to determine whether students who reported higher degrees of mental imagery would score better on a reading comprehension test and also have a more positive attitude towards reading when compared to students who had lower mental imagery scores. The students all took the Estes Reading Attitude Scale. Three days later, the students read two prose passages, one of a high image-evoking nature, and the other of a low image-evoking nature. Students then took a short answer test and a modified cloze test. A visual-recall task was also given, following a brief questionnaire in which the students had to reveal whether or not they used imagery, how much imagery, which passage was easier, and whether or not they liked to read. The results indicated that students who claimed they used lots of imagery scored best on comprehension, and also had the best attitude towards reading. The students who reported the least imagery also performed the worst on reading comprehension, yet surprisingly, the moderate imagers had the lowest mean score on the attitude test. Cramer suggested that the study supported the idea that imagery is related to comprehension as well as attitude.

Although Alverman and Moore's critique about Cramer’s research as not providing instruction is unjustified (since it is not a treatment design), their other comments about the experiment being contrived, carried on by the experimenter and not the classroom teacher, and that the testing and reading materials are designed just for the study, and hence not part of a normal classroom routine are true. Another limitation to Cramer’s study is the relatively small sample size pertaining to high school seniors, so it may not be representative of other situations; however, his study did give others more understanding about the relationships between imagery, reading achievement, and attitudes.

Yet another study without imagery instruction is Gunston-Parks' study (1985). She investigated how mental imagery audio prompting may improve the reading comprehension of low readers using science-type texts. She termed it “text-bound guided imagery,” and defined it as “a guided imagery procedure which provides little to no elaboration of the text passage beyond reorganization and condensation of the material” (p.36). Gunston-Parks used 160 students (grades 7, 8, and 9 from two middle schools) who are considered low readers, as indicated by them scoring at or below the fourth Stanine on the IOWA test. She randomly divided the students into four groups. Group one received a science text for reading followed by the text-bound guided imagery, group two only listened to the text-bound guided imagery, group three only read the text, and group four is the comparison and received no treatment. Students then took a ten-item test measuring knowledge of the passage content. The students who listened to the text-bound guided imagery really did not receive any other instruction such as how to create imagery in their minds as they listen to the audio tape. The results did not show there is any significant difference in comprehension achievement between the groups; however, the researcher did find a statistically significant main effect of imagery ability on the comprehension of expository science-type texts. Her study supported the idea that students can create imagery while using expository science-type texts. Gunston-Parks suggested that more could be done with the instruction of the students. She also concluded that the students who are low readers and have low imaging ability are at a deficit, and more research is needed to help these students.

Another study that was designed to investigate the effects of two comprehension strategies, text-relevant illustrations and mental imagery, on the reading comprehension recall of adult learners in a teacher college showed no statistical differences between the scores of the experimental and comparison groups. Walker, Truscott, Gambrell, and Almasi (1994) engaged 78 university students in a study in which participants were asked to read and respond to an African folk tale. The participants were randomly assigned to four groups: (a) students used illustrated text and were asked to attend to the illustrations and form mental images, (b) students used non-illustrated text and were told to use mental imagery only, (c) students used illustrated text and were given general instructions to remember, and (d) students were given non-illustrated text and were given general instructions to remember. The researchers asked the participants to recall and answer questions about the story one week later. Walker and her colleagues found no statistical difference in recall performance between the groups; however, they presented some interesting insight. In an interview after the experiment, 95% of the participants claimed that they were using mental imagery while reading, whether they were cued to do so or not. These participants were, after all, university students in a teacher preparatory program who probably had many reading strategies that they might call upon. The reading passage was a narrative text about Anansi the Spider, which also followed a typical story-telling schema that might not be difficult to these college students.

Studies with No Instruction and Positive Gains

Several studies in mental imagery fit in this category. In some instances, simply prompting the students to create mental images was sufficient for them to make some type of gain-- whether it is in literal comprehension or motivation towards reading. The following section described the studies that fall in this category.

A researcher who did several studies using mental imagery is Linda Gambrell. In one of the earlier models, Gambrell, Koskinen, and Cole (1980) used 63 sixth-grade students and two expository passages, “Blue Swamp,” or “Pine Folks.” These passages were classified as expository (Social Studies type), and they relate to the description of a special place and the people who lived there. The students were randomly assigned to two conditions-- listen first and then read, or read first and then listen. For instruction, she mainly told all the students to make pictures in their minds to help them remember. Student were interviewed later about whether they were able to create imagery or not, and they had to retell the information they heard or read. The results show that there was no difference between the creating of imagery whether they read or listened, and that the good readers responded to the prompt of creating pictures more than the low readers. Some poor readers (17%) claimed that they could not create any imagery even while listening, whereas only very few (3%) of the above level readers claimed they could not create a mental image. The study supported the finding that poor readers suffer from specific comprehension difficulties not related to decoding. The researchers also suggested that they look into methodology when trying to induce mental imagery.

Another study that only prompted students to form pictures in their heads is the study by Finch (1982). Eighty fifth-grade students from six schools participated in this study, either in the experimental or comparison group. The experimental students were prompted to form pictures in their heads as a way to remember what they have read. Those in the comparison group were simply told to remember what they have read. Students read two stories each-- one familiar text and one unfamiliar text. Results indicated significant differences between the two groups in the cued recall test only, not on the free recall test. In a post-evaluative questionnaire, 90% of the above readers in the study reported that they used mental imagery during reading and 65% of the below average students reported that they used mental imagery. Students also scored better when they use familiar as opposed to unfamiliar text. Finch proposed more extensive instruction in the use of mental imagery.

After examining the above mentioned studies, it is clear that some definite instructional program should be used to help students learn how to create mental images. It cannot be assumed that just telling the students once will be sufficient to bring on mental images when students read. Furthermore, without instruction, some students may not know what to image. McCallum and Moore (1999) reported that sometimes students generate random spurious images not related to the text which may hinder rather than help comprehension. Students need to be guided toward strategies that help create images related to what they read. This study was designed based on the premise that students needed strategies that would keep generated mental images in sync with the text.

Experimental Studies in Mental Imagery with Instruction

Many of the studies that included mental imagery instruction showed positive effects on reading comprehension. Some of these studies used sentences as training materials, or very short passages containing three sentences each (Peters & Levin, 1986; Shriberg et al., 1982). As a result, the National Reading Panel has concluded that mental imagery is effective with sentence recall and sentence comprehension. This conclusion, while valid, did not give credit to mental imagery being useful for longer passages. The studies that employed instructional methods were discussed in the section under the various instructional models. This study combined the best practices in imagery instruction to use with middle school students and science-type expository text, which is usually challenging for the average middle school student. Of the many studies reviewed that used middle school students reading science texts, there is only one study (Warner, 1977) that provided some instruction for the students, yet there was no reported gain. Warner's study was briefly described in the next section.

A Mental Imagery Study with Instruction and No Statistically Significant Gains

In 1977, Michael Warner investigated whether instructing junior high students with learning disability in the use of visual imagery would result in improved recall in prose passage content. His definition of students with learning disability are those already in remedial reading or intervention programs, who are reading at least a year below grade placement, yet not functioning below the third-grade level. He had 30 participants from five different schools. These students range from seventh to ninth-grade, with the average age being 14 years old.

Warner's study used science and social studies type expository texts from a series titled *Reading for Concepts* published by Liddle, 1970. The passages were about 160-200 words long, and used controlled vocabulary that ranged from 2.9 to 4.3 reading level. Warner used parochial students in regular education classes to rate the passages that he would use for pretest, instruction, and posttest. The students rated passages sentence by sentence, deciding whether or not each sentence helped them effectively create a visual image using a scale from one to four. Warner used the averages to classify the passages into high imagery or low imagery passages, and he included one of each type for the pretest and posttests. High imagery passages rated around 3.2, and low imagery passages rated around 2.3.

After a paraphrase recall pretest, Warner instructed the students by giving them five concepts and having them practice creating visual images line by line. The five concepts are as follows: (1) Making a picture in your head can help one better remember what one has read. (2) Images should represent as much of the content as possible. (3) Sentences vary in the difficulty associated with making images for them. (4) Use sentence boundaries as cues for imagery. (5) Images can be used to link sentences together.

The study took three sessions. The first session was mainly for the pretest. Warner gave participants a pair-association test to determine whether they are in high, medium, or low pair-associate groups. Then he gave the students a paraphrase recall pretest. The second session was instruction, which took about 30 minutes. The third session, which took place ten days later, was for the posttest.

From his study, Warner noticed that the type of text made a difference. He found statistical evidence that students recall better on high imagery passages than on low imagery passages. Students who were in the high pair-associate group also had slightly higher scores when compared to the other students although there was no statistical significance. His conclusion suggested that he may need more time with these students with learning disabilities-- instructing them once may be too little. Warner's study, though did not show any gains, provided insight and guidance for future researchers in the field. Some ideas to note include providing students with interesting text that could yield imagery, and to provide more instruction to ensure that students can use this imagery strategy. Warner also targeted visual imagery alone. It is possible that students may invoke more images if they were prompted to create mental images that included all the senses, such as touch, taste, smell, and feel. Warner used pair-association as an indicator of whether or not students were good with creating imagery; however, that process does not necessarily measure the ability to create mental imagery. Students might use rote memory, they might use verbal clues, or they might use other strategies to remember rather than use mental imagery.

Background of Mental Imagery Instructional Techniques

Past studies show that researchers have used various mental imagery methods. These methods can be divided into two main types: representation instruction and transformational instruction. Representational imagery is the direct translation of the text into an image. Transformational imagery is the use of mnemonic device, keyword, or other indirect link to represent the text (Oakhill & Patel, 1991).

Representational Imagery Instruction

Some researchers use representational imagery in a pure mental sense. For example, Gambrell (1982) used first- and third-grade students to study the effects of induced mental imagery and reading comprehension. She randomly divided 58 students into experimental or comparison groups and informed all participants that they were to read a story about a "monfur." In the experimental group, she gave the students these instructions: "make pictures in your head about what you read to help you remember..." The comparison group had instruction such as "think about what you read to help you remember" (p. 132). The results indicated that the students who were prompted to use mental imagery performed significantly better than the comparison group in factual recall and predictions based on statistical analysis.

In another study, Gambrell and Bales (1986) studied imagery and comprehension-monitoring in fourth and fifth graders. The researchers developed three high imagery sentences, two high imagery paragraphs, and four expository passages for training and testing. The 30-minute instructional session for the experimental group involved acquainting students to making mental pictures and guiding students to make images with the full details, such as the kind of car and the type of road it was on. Students were reminded to "make pictures in your mind" (p. 458). The students in the comparison group were told to do whatever they can to understand and remember. The results show that the use of mental imagery is positively associated with comprehension-monitoring performance.

A study by Rose, Cundick, and Higbee (1983) investigated the effectiveness of two separate strategies-- verbal rehearsal, and visual imagery. They used 30 students with learning disabilities from 10 elementary schools, the average age being 9.7. The children were randomly assigned to one of three groups: a verbal rehearsal group, a mental imagery group, and a comparison group. The instruction or reading assignment was done in one session, although the students were tested twice-- once immediately after reading and once after one week. The instructional materials were narrative in nature, about five paragraphs long, and had no pictures. The examiner demonstrated to both treatment groups how to verbally rehearse or form a mental image. Students in the verbal rehearsal group talked about what they read at certain stopping points. Students in the mental imagery group formed mental images at certain stopping points in the story. The comparison group students had “unaided” practice.

The results of Rose, Cundick, and Higbee's study indicated that both the verbal rehearsal group and mental imagery group outperformed the comparison group. They concluded that students with learning disabilities could benefit from these strategies.

Another study that uses representational mental imagery instruction is the study by Bourduin, Bourduin, and Manning (1993). In fact, these researchers used both visual and verbal representations. These researchers investigated the effectiveness of mental imagery instruction for young children in second grade. Twenty-eight students from four different classrooms participated in the study which took 30 minutes of instruction over six weeks, totaling six sessions. One group had imagery instruction which included visual and verbal representations, two groups had corrective feedback from different teachers, and the last group was the comparison group with another teacher. The students took a comprehension test after the instruction, and then they took another test again as a follow-up after six weeks. The findings indicated that students in the imagery instruction group outperformed all the other groups by follow-up time in the inference portion of the comprehension test. There was also a marginal significance ($p <.07$) in this group outperforming all the other groups in the details portion of the comprehension test. It is not clear what these students initial performance was like, but it is apparent that the study showed that mental imagery is a useful comprehension strategy for young children in second grade.

Other than visual representations and verbal representations, researchers such as Douville and Algozzine (2004) discussed using all the sensory modalities in a method they call SAM, which stands for Sensory Activated Model. They suggest the activation of all sensory modalities, including auditory, kinesthetic, gustatory, and olfactory because that process of sensory activation was more elaborated and therefore more memorable for students. In a prior study by Douville (1998), she noted that fifth grade students who used the SAM method constructed significantly more images in written responses to reading that reflected both literal and applied text knowledge than those students who only used the visual imagery method.

Another study that used representational imagery is the study by Clark, Deshler, Schumaker, Alley, and Warner (1984). They used six students in special education (one 8^{th} grade, four 9^{th} grade, one 11^{th} grade) in their study. They gave the students seven pretests and then instruction using visual and verbal representations. First the students established their baseline through the pretests. For example, Student 1 took the tests and the results showed that the pretest for ability-level reading comprehension without prompt for mental imagery was 23%, and the pretest for grade-level reading comprehension without prompt for mental imagery was 50%. The pretest for ability-level reading comprehension with prompt for mental imagery was 28% and the pretest for grade-level reading comprehension with prompt for mental imagery was 33%. The students then were instructed in mental imagery following procedures that showed them five steps. The steps were as follows:

One: Read the first sentence.

Two: Try to make an image-- a picture in your mind

Three: Describe your image (with more guided details)

Four: Evaluate your image for completeness (with more details)

Five: Repeat. Read the next sentence and repeat the steps.

During the seven instructional sessions (about a class period of 45 minutes long each), students practiced on ability-level materials and then grade-level materials. Then they took the posttest on the four conditions again-- using ability-level materials, without prompt, and then with prompt, and then grade-level materials with prompt and then without prompt. It was not mentioned whether these passages were narrative or expository in nature. Results show that there were gains after mental imagery instruction. What is perplexing is that the student who was in the 9th grade but read on a 5th grade level scored higher on grade-level materials than ability-level materials. For the posttest, using ability-level materials, Student 1 scored 63% without prompt and 72% with prompt; using grade-level materials, Student 1 scored 78% without prompt and 100% with prompt. Detailed statistics for other students were not shared.

While the instructional method is viable, it is unusual that a low-achieving student would perform better on grade-level materials rather than ability-level. The researchers reported that they used passages from a book titled *66 Passages to Develop Reading Comprehension* by Gilmore, Sack, and Yourman. An analysis into the text and topics for fifth-grade level material and ninth-grade material may provide more information. Could it be that some passages were expository and others narrative? It may be easier for some high school students to identify with narrative writing about a young person training for a boxing match written on ninth-grade level, as opposed to reading about the formation of the Mariana Trench written on fifth-grade level. There was no discussion of the types or topics of passages the students were using. Aside from the materials used, the researchers also claimed that their student sample was very small, and that they recommend replication with a larger sampling with alternative procedures. However, the study did show that mental imagery worked for that group of special education students, and that the study used representational instruction alone for the mental imagery portion.

The strength of the pure mental imagery instructional method is that it requires no additional text preparation or illustrations. It is relatively easy to do and can be done in a short instructional period. The drawback is that some students may need imagery techniques that are more concrete, such as illustrations.

Researchers in the field used illustrations as a method to form representational mental imagery. After showing students pictures about the passages, the researchers may then guide students to create their own pictures either by drawing, making an image in the head, or even acting it out. In his 1976 study with eight-year old students, Pressley first showed the students in the experimental group pictures that went along with certain sentences. Then he prompted these students to make mental images using a booklet that consisted of alternating text and blank pages. Students in the comparison group were told to do whatever they could to remember. Results indicated that students who had mental imagery instruction had statistically significant higher comprehension scores than the students in the comparison group although the differences between the scores were relatively small. Pressley (1976) speculated the idea that since the students in the comparison group were told to do whatever they could, some students might be imagining anyway (p. 358). Using factor interaction analysis, Pressley concluded that poor readers benefit from learning mental imagery strategy more than good readers.

Pressley's (1976) method using illustrations has been modified and used in various other studies (Peters & Levin, 1986; Shriberg et al., 1982; Rose et al., 2000); however, no other study used the method of using text pages with blank pages. There may be many reasons why although these are just conjectures. The preparation of these special texts with blank pages may require extra work. Also, each participant had to take the test individually, so the whole process would take a long time. There may also be a concern that some students may not be able to project their images on the blank pages.

In a different study, Rose, Parks, Androes, and McMahon (2000) used a drama-based imagery method to help fourth-grade students improve reading comprehension. The 20-day program spanned over 10 weeks. At different stages, leaders or trainers guided the students in the experimental group to read stories, to visualize what they read in their heads, to illustrate scenes, to discuss sensory details, and to dramatize self-selected episodes. The students in the comparison group received the standard reading curriculum, which emphasized the "read-and drill" exercises. The results indicated that the higher scores of the experimental group for factual comprehension were statistically significant. However, the scores for inference questions did not reach statistical significance. There was also no statistical significance between groups for verbal scores. The researchers discussed the idea that their method was open to refinement, and that through interviews with the trainers, they found out that some classrooms did not finish the final stages, which were linked to inferential skills.

The strength of the multi-sensory drama method is the various techniques students can employ. The difficulty in the instruction lies in having teachers and students dramatize certain parts of what they read. The researchers had actors to come into the classroom as part of the program, but most schools will not be able to provide such a resource, and some teachers and students may not feel comfortable acting out a scene. A more easily adapted method of imagery instruction is preferable for most public schools.

In a qualitative study, two teacher practitioners, Hibbing and Rankin-Erickson (2003), described their work with children in the classroom using a variety of mental imagery techniques to build comprehension for middle school students. These reported strategies were all representational in nature. They used prompts, drawings, and illustrations in texts, picture books, and movies.

One strategy Hibbing and Rankin-Erickson used to instruct their students was to tell students to read and form images as if they were watching "television in their heads." At various times, students were also asked to illustrate their images. In addition, they used text illustrations to help students build background. They stated that sometimes a simple spatial diagram-- whether it was about the setting or about a device-- was helpful because the students might need some guidance. Some students might needed clarification when they came to a static spot, where a lack of background or context became a hindrance to comprehension. For example, they described one student who read about a man paying off his Caterpillar. The student did not know that a Caterpillar could be the name of a tractor. He thought a caterpillar was a type of worm and so the story did not make sense to him. After he saw a picture of one, he could read on without confusion.

When Hibbing and Rankin-Erickson noted that their students need more background, they chose to use a movie clip to introduce the setting and characters before reading. Then the students might watch the next segment of the movie clip and read some more. They describe this as the W-R-W-R cycle, in which students watch and then read, watch and then read. They found this method particularly useful with the reluctant and low-achieving students as indicated by their positive comments. Some students claimed that after the W-R-W-R cycle, they were "getting it." At times, the researchers asked students whether they preferred the movie or the book, and many of the students said they preferred the book because it gave more details and allowed them to understand the characters more. Many students also claimed that they preferred the images they created in their heads more than those shown in the movie.

In their study, Hibbing and Rankin-Erickson provided some insights into how students felt about their mental imagery and how these related to the text they were reading. Providing external visual images for students appears to be a positive way to help students get a basic understanding of the setting and context so they may improve their comprehension. The constant reminders to create mental imagery also appear to be beneficial for students in the middle school classroom to help them make connections to the texts. The text examples described in Hibbing and Rankin-Erickson's study appear to be narrative in nature, but it was likely that students may respond positively to expository texts if given similar external visual supports.

Transformational Instruction

Another mental imagery method is transformational instruction, also known as the keyword method, or the mnemonic method. The keyword is simply a concrete word that resembles or links to an unfamiliar vocabulary. The study by Shriberg et al. (1982) applied the keyword method to a prose-learning task. In that study, the researchers trained eighth-grade students to use mnemonic imagery to picture famous people with their accomplishments. For example, in order to remember that Charlene McKlune was famous for training a cat that could count, students could transform McKlune into a similar-sounding word-- raccoon, and then generate a picture of a cat counting raccoons jumping over a fence. The results show that the students who had imagery instruction out-performed those who did not receive the instruction in text comprehension. Shriberg et al. showed that the keyword method is effective for recalling important names and difficult facts. However, the instruction in their study was limited to sentences and their purpose was to test recall.

Peters and Levin (1986) also studied the use of mnemonic imagery to aid comprehension using seventh- and eighth-grade students. In the first phase of instruction, students learn the keyword method using pictures that offer them a link to a name or event when they read the first eight short passages (three sentences per passage). The passages were stories about famous people, and the students were supposed to remember important facts about them, such as what they invented. The experimenters then shuffled the passages and asked students in the experimental group to say the keyword aloud for each passage and make mental connections with the main concept. Students in the comparison group read the cards silently the first time and then read them aloud when the cards were shuffled. In the recall test, students who had keyword imagery instruction had higher comprehension scores when compared to students of the comparison group. Even one week later, the good readers who had the keyword method were able to score higher than the good readers in the comparison group, although there was no statistical difference between the poor readers of both groups. Their study mainly showed that imagery and mnemonics helped students recall passages better.

The mnemonic or transformational imagery instruction is useful when helping students retain factual information such as names and numbers. This method, however, may not help with the comprehension of the overall longer text since only the keywords are targeted.

Although the use of mnemonics has shown that students improved on their comprehension scores, the focus is mainly recall of important facts. Therefore, while these studies are helpful in understanding the different ways mental imagery can work, this study did not include mnemonic instruction since the focus was on the improvement of students' reading comprehension when using expository passages. The students were able to look back at the reading passage at any time, similar to the standardized tests.

Combination Instruction Using Representational and Transformational Strategies

Some researcher combined various methods to instruct their students, sometimes using transformational strategies, and other times using representational strategies. An example of this is Hodes' study (1994), in which she provided instruction for participants using elaboration and mnemonics. According to Hodes, elaboration could be mental imagery or adding anything to make connections, and that elaboration strategies “require learners to actively adding information to the information they are learning” (p. 54). Hodes did not describe the full details of this elaboration instruction or the mnemonic instruction, but she found that there was a speed-accuracy trade off using mental imagery as indicated in her study.

Hodes' study investigates the effectiveness of mental imagery in a recall task. Forty college students participated in her study, with 20 in the experimental group and 20 in the comparison group. Hodes used a single independent variable, posttest-only comparison group design, giving instruction to the experimental group prior to the one session of task-completion and test-taking. Participants read a 5-page, 1200-

words instructional manual about a graphic user interface computer operating system. Afterwards, participants took a survey, a drawing test, and a recognition test on twenty of the graphic user interface component. Hodes' study indicated that the experimental group took significantly longer to read the materials (94 seconds more), but took a shorter amount of time for the recall tasks (103 seconds faster) when compared to the comparison group. There was no difference between the performance accuracy of the two groups.

In her discussion, Hodes concluded that mental imagery is an activity high in the continuum that improves retention, and that it may be a useful device for remembering things that may later be brought upon for split-second decisions. One reason that there was no difference in performance between the two groups may be that she used college students as participants. They are usually the successful ones throughout school and may have many strategies to call upon. Hodes' study is useful in finding out the speed and accuracy trade-off using mental imagery among college students.

Researchers such as Oakhill & Patel (1991) also used combination instruction. The researchers Oakhill and Patel studied 192 children aged 9-10 years. They used four passages for instruction and five passages during testing. The imagery instruction took three sessions on different days.

For Oakhill and Patel's first instructional session, students read stories and saw representational drawings of the sequence of events. They were then asked to form the pictures in their minds and they discussed their images with the researchers. The story and pictures were taken away before the students answered questions on the story.

In the second instructional session, both representational and transformational drawings were used. The students learned that the transformational drawings were used to help them with specific details and they discussed the images with the trainers. Then the students answered questions after the researchers put away the story and pictures.

In the third instructional session, students were not shown any drawings. The students were to use their own mental pictures. The students again discussed their images with the researchers and then answered questions.

Students in the comparison group read the same stories and spent the same amount of time with the researchers, but they did not receive any imagery instruction. The researchers told the students that they had to read the stories very carefully. The results of Oakhill and Patel's study showed that there was a statistically significant difference between the comprehension recall scores of the experimental group and the comprehension recall scores of the comparison group. Poor readers of the experimental group also performed significantly better than the poor readers of the comparison group. Furthermore, the poor readers of the experimental group performed about the same as the good readers of the comparison group after they had mental imagery instruction. Oakhill and Patel's study showed great promise for using combination mental imagery instruction, even though the instruction was fairly short (three sessions) and the texts were all narrative.

The Oakhill and Patel’s study (1991) demonstrated an effective model for mental imagery instruction; however, this study did not replicate Oakhill and Patel's method since that study tested recall. For this study, students had their passages in front of them for reference when they took the post-assessments. Similar to most of the reading tasks in the classroom and the state assessment in reading, students were not assessed on recall, therefore, transformational strategies or mnemonics instruction were not used here.

Difficulty in Measuring Mental Imagery

It is difficult to measure mental imagery. The nature of mental imagery makes it difficult to measure. People evoke different images even if they read the same text. A simple word “chair” may evoke different images to different people. For some, the chair is soft with padding, for others the chair is made of hard wood. The chair may be of various colors, from red to brown. It may be large as a sofa chair or small as a child's chair. Some people imagine what it feels like to sit in one, others think of events related to a chair, from reading on mother's lap in a big armchair to the time when another 3^{rd} grader pulled the chair from under oneself, or to the memory of sitting in a comfortable chair in a fine restaurant, ready to order. A couple of people even have the image of the word “chair” as if it were written on a flash card. The concept that different people create different mental images is one reason that the researchers McCallum and Moore (1999) warned about the non-constrained imagery. This is the same reason that researchers such as Rumelhart (1981), Anderson and Pearson (1984) linked comprehension with schema. If readers form imagery within the context of the passage, then the images are constrained and will promote understanding.

Not only does each person's imagery vary, the vividness of mental imagery evoked is also another issue. Gunston-Parks (1985) claimed that people with more vivid imagery were more motivated to read. But how does one measure the ability to create mental imagery? It is not an easy task. Two measures researchers in the field use are the *Revised Minnesota Paper Form Board Test* (Quasha & Likert, 1937) and the *Sheveland Vividness of Imagery Questionnaire* (1992), which was modified from the "Betts QMI Vividness of Imagery Scale" (Betts, 1909).

These two instruments, though frequently used, are not perfect. For example, the *Revised Minnesota Paper Form Board Test* is based on students performing tasks of spatial reasoning-- visualizing and mentally manipulation 2-dimensional objects to form other 2- or 3-dimensional objects. This only tests one part of mental imagery-- mainly visual, which leaves out all the other sensations. Furthermore, the task requires students to use some logic, which is not directly related to vividness of imagery. The other measure, the *Sheveland Vividness of Imagery Questionnaire*, is a self-assessment. It covers the senses of vision, sound, feel, taste, action, taste, sound, and sensations. It is a very useful instrument to measure students' self-perceived vividness of imagery, with the drawback that sometimes students do not accurately rate themselves.

To better understand my students, I gave the *Sheveland Vividness of Imagery Questionnaire* to the students in my on-grade-level Language Arts classes. Many students tend to rate themselves excellent on everything (school years 2005, and

2006). It might be exactly how the students felt, but their true ability to image was questionable. Some studies indicated that students who reported more vivid mental imagery scored better on reading comprehension (Cramer, 1980, 1981). In Anderson and Kulhavy's study (1972), results based on students' self-generated reports on a questionnaire showed that the amount of learning was directly related to the amount of time during which imagery was reportedly used. Using self-assessments means that the teacher or researcher has to trust the students to accurately report what they experienced, and not to just select the highest ratings just because they may perceive higher ratings to be what the teacher or researcher would want. These difficulties in measuring mental imagery remain. Researchers who used qualitative interviews had better understanding of when, how, and what imageries are generated (McCallum & Moore, 1999), but there is no absolute measure to decide what is considered high imaging ability or what degree of imaging is considered most vivid. Researchers need to use the existing measures with caution.

One of the questions this study investigated was whether vividness of imagery has a relation to comprehension achievement and motivation to read. This study did not focus on whether vividness of imagery was increased after mental imagery instruction.

Difficulty in Teaching and Creating Mental Imagery

Other than the difficulty of measuring the degree of vividness of mental imagery and how actively students are using that strategy, another big issue is teaching the skill. Mowey and Conahan (1995) claimed that there are learning strategies and there are teaching strategies. Mental imagery is a learning strategy that teachers expect students to employ, yet very few studies really teach the students how exactly to create mental images. The study by McCallum and Moore (1999) showed that unrelated incongruous mental images which they termed “non-constrained images” can actually hinder comprehension; therefore, it is important that mental imagery strategy is taught to the students properly. The students need to know that the imagery created must be within the context of the passages they are reading.

In addition to non-constrained mental images, students may be side-tracked by seductive details presented in the texts, which also deters comprehension. Seductive details in reading refer to the highly entertaining and personally appealing extra details that do not support the main ideas of the text (Choi, 2006). For example, the idea that monarch butterflies taste bad to a bird may be considered as a seductive detail in an article about the monarch butterflies’ migration habits. Researchers claim that “the negative effects on comprehension were due to a combination of reduced attentional allocation and disruption of text coherence” (Lehman, Schraw, McCrudden, & Hartley, 2007). Students needed to focus on only important information and create relevant images for those that support the main points. Studies that target the issue of seductive details in the text report that seductive details detract from students' comprehension and recall (Choi, 2006; Harp & Maslich, 2005; Lehman, Schraw, McCrudden, & Hartley, 2007). Therefore, the passages used in this study did not intentionally include any seductive details. Furthermore, this study did not focus on teaching students what details are relevant and what are not relevant. The passages for this study were written with the intent to inform and explain with factual details. They were written based on interesting topics suggested by students in the 2005-2006 school year, and the new additions were added in the year 2007-2008. It was not within the scope of this study to introduce text with seductive details or instruct student how to manage these details. If any seductive details happened to be in the passages, they were not the original intent.

Another issue that emerged when teaching students mental imagery is the concept of concrete and abstract words. It was argued that concrete words would generate more imagery and that abstract terms do not generally promote imagery or better recall (Sadoski, Goetz, & Fritz, 1993; Sadoski, *Goetz, & Rodriguez, 2000*). Early researchers in the field, Toglia and Battig (1978), had published a handbook that rated a total of 2854 terms according to dimensions of concreteness, imagery, categorizability, meaningfulness, familiarity, number of attributes or features, and pleasantness. Words such as "sun" rated high on the scale as being concrete and imaginable, with many other favorable attributes. On the other hand, the word "fault" rated low on concreteness and imaginableness. Researchers such as Marschark and Surian (1992) noted that the presence or absence of concreteness effects in free recall depends on the relative salience of distinctive and relational information.

What happens when a passage contains lots of abstract words or concepts? Can students create mental imagery with abstract words? A study by Franco-Watkins and Dougherty (2006) investigated the effects of word concreteness and encoding instructions on context-dependent discrimination in verbal contexts. They used a theoretic framework that targeted the item, the context, and the ensemble. One hundred and fifty undergraduate college students participated in the study. They were randomly assigned to one of the three treatment groups: rote, mental imagery, and item only. Sixty word pairs (30 concrete and 30 abstract) were randomly presented on a computer screen for a three-second duration. In the rote condition, the participants were instructed to repeat both words in the word pair over and over (subvocally) until the words disappeared from the screen. In the imagery condition, the participants were instructed to integrate both words into a vivid image. In the item-only condition, the participants were instructed to repeat once (subvocally) the word that appeared in green. All the participants were told that they would be tested for the words that appeared in green. The results indicated that context-dependent discrimination is not dependent solely on the use of interactive imagery instructions or on word concreteness. They noted that mental imagery occurred for both concrete and abstract words, and that the rote memory group was able to create contextual links for both sets of words as well. Although the abstract pairs had fewer imaginable properties (as reflected in imaginableness ratings in word norms), the results indicated that the interactive imagery encoding instruction was successful even when the words were relatively abstract. However, concrete pairs seemed to have had an advantage in comparison with abstract pairs, but only for the imagery condition. This is consistent with previous findings that it is possible to form images for abstract pairs of words. Toglia and Battig (1978) rated abstract words such as “Happiness” relatively low on concreteness, yet moderately high for imaginableness.

Regardless of concreteness or imaginableness of the words, the purpose of this study was to investigate the effects of mental imagery instruction on middle-school students using science expository texts. The topics of the instructional materials as well as pre- and posttests were based on interests expressed by the students. In addition, these topics were concrete items that actually exist. For example, topics span the deepest part of the ocean to the tallest mountain, from objects in space such as Mars and the moon to interesting sea creatures such as piranhas and puffer fish. The pretest and posttests were about creatures such as crocodiles, alligators, octopus, squid, butterflies, and moths. It was not the intent of this study to introduce abstract themes and therefore this issue would not be one of importance for this study. If abstract terms were introduced in the passages, such as scientific names for the animals, they were explained. Any other abstract terms in the passage might have been part of any explanation, but they were not intentional, not should they present a major problem with the mental imagery instruction.

Even without worrying over concreteness and imaginableness of words, one main question for mental imagery instruction still exist. How exactly does one teach others how to create mental imagery? Some protocol for creating imagery included the dimming of lights and playing soft music-- the practices which Gunston-Parks (1985) felt unnecessary. Some studies did not teach students to image at all, but only told them to create images in their heads (Anderson & Kulhavy, 1972; Gambrell, Koskinen, & Cole, 1980; Gunston-Parks, 1985). Gambrell (1986) later improved on her instructional strategy and suggested that there should be a purpose established, then teacher modeling, after which the students are told to “make pictures in your mind” (p. 458). Her method was also cited in Tierney and Readence's *Reading Strategy Instruction in the Primary Grades: A compendium* (2000) as an effective way for mental imagery instruction. While Gambrell and Bales were able to get some positive gains in comprehension monitoring, there needs to be more inquiry into the various ways to instruct students to create mental imagery, and also explore more than just relying on the visual sense. In some cases, students who created mental images still may not fully understand or can interact with the text to perform well on a test or assessment. It may be like a person watching a movie and not paying close attention, so some of the meaning or purpose may be lost to that person. As more research is available in the field, researchers may look into various methods to instruct students and do more than a mere prompt to use mental imagery. While creating mental imagery can help the students relate to the text they are reading (the input mode), students also need rehearsing-- whether it is verbal or written-- to express what they have understood (the output mode). This study included both the input and output modes of mental imagery instruction so students might actively respond to their mental imagery, make sense of the text, and interact with the text, which in turn, might lead to better reading comprehension.

Summary

The concept of using mental imagery strategies to improve reading comprehension is still an area waiting to be explored, particularly when pertaining to the use of mental imagery with expository text. Related studies are summarized in three tables that follow. Table 1 reports the use of mental imagery as a comprehension strategy for high school and college students. Some studies do not show any positive gains in reading or recall, and the reason may be that most of these studies did not instruct the students at all regarding how to create mental imagery. The two studies that show positive gains in reading comprehension had imagery instruction for the students. Another reason that some of these studies may not show gains may be that many high school and college students already have enough reading strategies to make them successful so far, and in fact, some of them may be already using mental imagery. Oakhill and Patel (1991) as well as Pressley (1975) discussed this condition, in which good readers were already using various reading strategies, including mental imagery. One of the two studies in this category that showed gains is the study by Clark et al. (2001), in which the researchers used mental imagery instruction (5- 7 hours) with learning disabled students who were reading at least two years below grade level. These students had made gains. Another study with positive results is the study by Hodes (1994). Using college students as participants, Hodes provided some mental imagery instruction and then tested the participants on comprehension and recall. Results indicated that the experimental group performed better than the comparison group in regards to the speed of recall; however, there was no difference between the two groups regarding comprehension. (Mental Imagery studies for high school and college students are summarized in Table 1.)

Table 1

Mental Imagery Studies for High School & College Students

Researcher(s) & Year	***Student Number***	***School Level of Parti-cipants***	***Type of Study***	***Type of Text Used***	***Result Positive?***	***Length of Study***	***Were Mater-ials Part of Regular Class?***	***Train-ing***
Anderson & Hidde, 1971	24	Col	#	sen-tences	Yes	1 session	No	No
Anderson & Kulhavy, 1972	62	HS	#	Expo-SS type	No	1 session	No	No
Clark, Deshler, Schumaker, Alley, & Warner, 1984	6	HS LD	#	"imagin-able" text	Yes	Total 5-7 hours	No	Yes
Hodes, 1994	40	Col	#	Nar	Yes-speed of recall No-compre-hension	1 session	No	Yes
Rasco, Tennyson, & Boutwell, 1975	91, 80	Col, HS	#	Expo, SS-type	No-drawings Yes-imagery	1 session	No	No
Sadoski & Quast, 1990	54	Col	#	Nar	Yes	1 session	No	No
Walker, Truscott, Gambrell, & Almasi, 1994	78	Col	#	Nar	No	1 session	No	No

KEY: Qualitative (*) Quantitative (*) Elem= Elementary Mid= Middle School
HS= High School Col= College Nar= Narrative Expo = Expository
SS-type = Social Studies type

There are few studies in mental imagery research using middle school students. An interesting point to note is that for the seven studies included in Table 2, more than half of these used expository text. This may be an indication that some researchers are aware that expository texts are a major part of middle school curriculum. However, many of these studies did not have any instruction for the students at all. Most of these studies took only one session and used contrived materials that were not part of regular classroom instruction. The exceptions are Hibbing & Rankin-Erickson's study (2003) and Warner's study (1977). Yet interestingly, most of these studies yield positive results in at least some area of learning. One study in this group that did not yield positive results is Gunston-Parks' study (1985), which used expository science type text, but gave no instruction to the students. The other study that shows no statistically significant gain is Warner's study. He provided students with one session of instruction, and noted in his conclusion that since the participants were students with learning disabilities, he perhaps needed to give them more time to learn the strategy. In a later study with Clark, Deshler, Schumaker, and Alley (1984), Warner and his team of researchers offered seven training sessions for some high school students with learning disabilities and found some positive gains. (See Table 2 for a summary of middle school studies.)

Table 2

Mental Imagery Studies with Middle School Students

Researcher(s) & Year	***Stud-ent Num-ber***	***School Level of Parti-cipants***	***Type of Study***	***Type of Text Used***	***Result Positive?***	***Length of Study***	***Were Mater-ials Part of Regul-ar Class?***	***Train-ing***
Gambrell & Koskinen, 1982	47	6^{th} gr. Below av.	#	Nar	Yes-literal questions No-paraphrase	1 session	No	No
Gambrell, Koskinen, & Cole, 1980	63	6^{th} gr.	#	Expo	Yes	1 session	No	No
Gunston-Parks, 1985 (#)	160	8^{th} 9^{th}	#	Expo	No	1 session	No	No
Hibbing & Rankin-Erickson, 2003	?	Mid	*	Nar	Positive statements by students	No mention	Yes	Yes
Peters & Levin, 1986	638	Mid	#	Expo, SS type	Yes	1 session	No	Yes
Shriberg, Levin, McCormick, & Pressley, 1982	48, 48, 72	Mid	#	Expo, Senten ces	Yes	1 session	No	Yes
Warner, 1977	30	7^{th}, 8^{th}, 9^{th}	#	Expo	No	3 sessions	No	Yes

KEY: Qualitative (*) Quantitative (*) Elem= Elementary Mid= Middle School
HS= High School Col= College Nar= Narrative Expo = Expository
SS-type = Social Studies type

Most mental imagery studies in the field of reading comprehension use elementary school students. It is fascinating to note that all the studies reported in Table 3 showed a positive gain regarding some aspect of learning, yet six of the studies did not really provide the students with instructions on how to create mental imagery (Gambrell, 1992; Gambrell & Jawitz, 1993; Macomber, 2001; Oliver, 1982; Rasco et al., 1975; Sadoski, 1984). Students were just told to create pictures in their minds. Again, most of these studies took only one session to complete, and used materials made for the study and not materials that the students will normally use in the classroom. Only one study used expository texts (Rasco et al.), and three of the studies used some expository texts along with some narrative texts (Douville & Algozzine, 2004; Finch, 1982; Gambrell & Bales, 1986); all the other studies used narrative texts. From these studies, findings suggest that elementary students would benefit from using mental imagery as a reading strategy, although the use of this strategy with expository text was still not fully explored. (See Table 3.)

Table 3

Mental Imagery Studies with Elementary Students

Researcher (s)& Year	***Stud-ent Num-ber***	***School Level of Parti-cipants***	***Type of Study***	***Type of Text Used***	***Result Positive?***	***Length of Study***	***Were Mater-ials Part of Regul-ar Class?***	***Train-ing***
Bourduin, Bourduin, & Manley, 1993	28	Elem	#	Nar	Yes- Inference, Marginal gains for Details	6 sessions	No	Yes, 30 min. per wk
Douville & Algozzine, 2004	No mention	Elem	#	Nar & Expo	Yes	4 weeks (6 days)	Yes	Yes
Finch, 1982	80	Elem	#	Nar & Expo	Yes	1 session	No	Yes
Gambrell, 1982	28	Elem	#	Nar	Yes, more wds. No, in thought units	1 session	No	No
Gambrell & Bales, 1986	142	Elem	#	Nar & Expo	Yes	1 session	No	Yes,30 min.
Gambrell & Jawitz, 1993	120	Elem	#	Nar	Yes	1 session	No	No
Macomber, 2001	149	Elem	#	Nar	Positive attitude related Vivid imagery	2 sessions	No	No
Oakhill & Patel, 1991	44	Elem	#	Nar	Yes, for poor comprehenders	3 sessions	No	Yes

Researcher (s)& Year	***Stud-ent Num-ber***	***School Level of Parti-cipants***	***Type of Study***	***Type of Text Used***	***Result Positive?***	***Length of Study***	***Were Mater-ials Part of Regul-ar Class?***	***Train-ing***
Oliver, 1982	38, 40, & 36	Elem	#	Nar	Yes, only in top third of the students	1 session	No	No
Pressley, 1975	86	Elem	#	Nar	Yes	1 session	No	Yes, 20 min.
Rasco, Tennyson, & Boutwell, 1975	93	Elem	#	Expo	Yes-drawings Yes-imagery	1 session	No	No
Rose, Cundick, & Higbee, 1983	30	Elem, LD	#	Nar	Yes	1 session	No	Yes, several min.
Rose, Parks, Androes, & McMahon, 2000	178	Elem	#	Nar	Yes-Factual No-Inferential	10 wk progra m	No	Yes
Sadoski, 1984	26	Elem	#	Nar	Correla-tion between imagery & affect	1 session	No	No

KEY: Qualitative (*) Quantitative (*) Elem= Elementary Mid= Middle School
HS= High School Col= College Nar= Narrative Expo = Expository
SS-type = Social Studies type

How This Study Extends Prior Research

This study extends prior research efforts related to teaching students mental imagery as a comprehension strategy when reading expository texts in several important ways. First, this study used a combination method of representational instruction, including self-generated illustrations, think-along ideas, as well as vocabulary instruction, so students may use whatever it takes to help them comprehend better. Research in this area shows that many studies did not provide any instruction at all. This study employed a series of instructional strategies with students. Prior studies also show that the few studies that had instruction for the students often had limited instruction-- usually only one session. This study provided 10 sessions of mental imagery instruction during the two-week intervention period, and then frequent prompts (at least two to three times a week) for the rest of the school year to help students maintain the mental imagery skills. These methods were adopted to ensure that the students can create mental imagery in different ways to help them understand and make connections with the text, and to help students maintain their acquired mental imagery skills.

Second, this study targeted the reading materials to be science-type expository texts. Few studies in the field of mental imagery involve middle school students and expository texts (Gambrell, Koskinen, & Cole, 1989; Gunston Parks, 1985; Peters & Levin, 1986; Shriberg et al., 1982), and some of those training materials were just sentences (Shriberg et al., 1982). The lack of mental imagery studies using expository texts may even have led to some misconception that mental imagery is useful only for narratives. This study showed that mental imagery may be a useful reading strategy for expository texts as well (see Results section, Chapter IV). The study of McCallum and Moore (1999) paved the way to show that students do generate mental imagery when they read exposition, and this study builds upon that finding. This study showed various ways students may create mental imagery when reading science expository texts, helping them make connections and enhancing their reading comprehension. This study also provided more information on middle school students using mental imagery as a reading strategy with expository text.

This study is unique in combining the following: the use of a systematic two-week instructional period, the use of researched mental imagery strategies, the use of expository texts constructed similar to regular classroom materials, the use of middle school students, and the use of qualified regular classroom teachers to conduct the study, and the use of assessments typical of a middle school classroom. The findings of this study provide references for other educators and researchers when selecting reading strategies to help students comprehend expository texts, particularly for middle school aged students.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to investigate the effects of mental imagery instruction using science expository texts on middle school students. Specifically, this study examined a combination mental imagery instructional method that extended two weeks. The investigation took place in the early part of the year in 2008. During the week of January 14-18, 2008, students took pretests to establish baseline scores for reading achievement, vividness of mental imagery, motivation to read, and the comprehension of science expository text. The metal imagery instruction took two weeks, January 22, 2008, through February 4, 2008, one period (45 minutes) each day. Post-assessment took about two more days and data were collected. Then throughout the rest of the school year, experimental group students were prompted to use mental imagery strategies at least two to three times a week. After the initial two weeks of practice, comparison group students were taught the same imagery strategies experimental students had received. Comparison group students were also prompted to use mental imagery strategies at least two to three times a week until the end of the school year. Near the end of the school year, all participating students used one more expository passage similar to the other instructional materials to prepare them for one more task-- the second posttest.

This study posed four research questions: (a) What are the effects of mental imagery strategies for science expository texts on middle school students' reading comprehension achievement? (b) How do the low-, middle-, or high-comprehenders compare in their reading achievement after mental imagery instruction? (c) Are there relations between the variables of reading comprehension, vividness of mental imagery, and motivation to read for low-, middle- and high-comprehenders? (d) Is motivation to read improved after mental imagery instruction using science expository texts?

This chapter outlines the research methodology that is used to conduct the investigation. It provides detailed description of the following: (a) setting, (b) measures, (c) research design, (d) instructional materials, (e) instructional method, (f) summary of informal study (2005-2006), and (g) limitations of this study.

Setting

School

The study was conducted in the middle school where I had been teaching for the last six years. It was a rural-suburban school, located in the mid-Atlantic region, that had been in operation since the year 2000. For the 2007-2008 school year, it served 689 students from grade six to eight, of whom 209 were six-graders. The racial distribution for sixth-grade was 71.2% Caucasian, 25.5% African American, and 3% Hispanic. Other ethnicity such as Asian or Native American represented was less than 1%. Of the sixth-grade population, 10.2% were in special educational programs, and 20.9% receive free or reduced priced meals (FARMS).

In this middle school, students did not have one subject for English; instead they had a Reading class and a Language Arts class. Based on the curriculum, some of the skills in Reading class and Language Arts class overlap. The main difference was that the focus in Language Arts class was writing, whereas the focus in Reading class was reading and answering comprehension questions. Students in Reading and Language Arts classes were tracked for (a) Honors level (students reading approximately two grade levels above grade placement), (b) On-grade-level or Comprehensive level, and (c) Basic level (students reading approximately two grade levels below grade placement). The students placed in the Basic class do not receive special education services for Reading or Language Arts. The students' placements were based on teacher recommendation, state assessment scores, county benchmark scores, and *Gates-MacGinitie Reading Test* (2000) scores from the previous year. Most students did not take the *Gates-MacGinitie Reading Test* prior to entering middle school. Only students who were identified by their teachers as performing poorly in reading took the *Gates-MacGinitie Reading Test* to validate whether or not they should be placed in a Basic class. Within each class, there was still a range of reading ability.

Participants

Teachers

My co-worker and I were the teachers involved in this study. At the time of this study, both my co-worker and I had advanced certification in reading and had taught at the middle school level for over 12 years. We also had a common planning time so we could plan and discuss concerns. For the 2007-2008 school year, we both taught three Language Arts and two Reading classes a day. I taught one On-grade-level Reading class and one Basic Reading class. My co-worker taught two Honors Reading classes. Some of our Language Arts students were the same ones we had in Reading class; therefore, for this study, we only involved our Reading classes. In later parts of this report, I may refer to myself as Teacher One, and my co-worker as Teacher Two.

Student Participants

The student participants were from four intact classes of sixth-grade students that my co-worker and I taught. For the 2007-2008 school year, I taught a Basic class (13 students) and an On-grade-level Reading class (23 students). My co-worker taught two classes of Honors students (class numbers were 32 and 22 respectively). The students in these classes were expected to be somewhat diverse in ability even though they were assigned to be in a certain reading class level based on their past academic performance. For the random class assignment-- it was decided that the first class each teacher taught would be assigned as part of the experimental group, and the other class would be assigned as part of the comparison group.

Since the overall student sample was small and the experimental time period rather short (two weeks), I also used sequential sampling for this study. Although initially the students in the comparison group were not taught the mental imagery strategies, after two weeks of experimental study and the first set of data was collected, the students in the comparison group were also taught mental imagery strategies. All students were prompted to use these strategies throughout the rest of the year. At the end of the school year, all students took another posttest. Their data were collected and analyzed. According to Krathwohl (2004), in sequential sampling, data from samples are cumulatively analyzed to determine if the needed statistical precision has been met. It is useful where the study itself has not caused an increased awareness of the topic (Krathwohl, 2004, p. 174). In this case, since comparison students were not taught mental imagery strategies in the early part of the school year, they were not aware of the techniques. Instructing them later in the school year provided more data on the effects of mental imagery instruction on the comprehension of expository texts for a larger sample of students.

Before conducting the study, I gave the parents consents forms to allow their students' scores to be included in the study. Students whose parents agreed to let their scores be used in this study also signed an assent form so that they also showed agreement to allow their scores to be included in the study. Data for those students whose parents did not give consent or who did not sign assent forms were not used in the analysis of this study. The final numbers of students included in the study are as follows: (a) Experimental Group 1 (Basic level), 11 students-- 8 girls and 3 boys; Experimental Group 2 (Honors level), 14 students-- 6 girls and 8 boys; Comparison Group 1 (On-grade-level) 19 students-- 4 girls and 15 boys; Comparison Group 2 (Honors level), 12 students-- 8 girls and 4 boys. The total number of students involved was 56, with 25 in the experimental group (14 girls, 11 boys) and 31 in the comparison group (12 girls, 19 boys).

A summary of student information is presented in Table 4. The table provides information about the students in the four classes such as teacher, original class size, participating numbers, type of comprehenders, gender, free and reduced meal (FARMS) status, and ethnicity. The average age for this group of sixth-graders is between 11 and 12 years.

Table 4

Summary of Student Information by Classes

Class	**1**	**2**	**3**	**4**
Teacher	1	1	2	2
Original Class Size	13	23	32	22
Type of Class	Basic	On-grade-level	Honors	Honors
Number of Participants	11	19	14	12
Experimental or Comparison	Experimental	Comparison	Experimental	Comparison
Comprehender Level	Low- 11 Middle- 0 High- 0	Low- 6 Middle- 9 High- 4	Low- 0 Middle- 2 High- 12	Low- 0 Middle- 1 High- 11
Gender	Boys- 3 Girls- 8	Boys- 15 Girls- 4	Boys- 8 Girls- 6	Boys- 4 Girls- 8
Mean *Gates* Reading Level	3.48	6.4	11.38	9.46
FARMS	4	6	0	0
Ethnicity	African-American- 4 Caucasian- 7	African-American- 5 Caucasian- 14	African-American- 1 Caucasian- 11 Other- 2	African-American- 2 Caucasian- 10
Total Participants: 56 Average Age: Between 11 and 12 years Other ethnicity: Asian and Hispanic				

Measures

This study used several measures to identify the reading performance levels of students, imaging vividness, motivation to read, and their comprehension performance on expository passages. The *Gates-MacGinitie Reading Test* (2000) was used to help identify students as low-, middle-, and high-comprehenders. Two tests, *The Vividness of Imagery Questionnaire* (Sheveland, 1992) and *The Motivation to Read Profile* (Gambrell, Palmer, Codling, & Mazzoni, 1996) were used as both pre- and posttest. I developed the Pretest for science expository text: “Crocodiles and Alligators” and three different posttests. The posttest “Poisonous and Nonpoisonous Snakes of America” was first developed for an informal study in the 2005-2006 school year. The other two posttests, “Octopus and Squid” and “Butterflies and Moths,” were developed in the school year 2007-2008. These passages all used the comparison text structure and had similar comprehension questions (see Appendix C). These measures are explained with more details in the following section.

The Gates-MacGinitie Reading Test

The first baseline measure was the *Gates-MacGinitie Reading Test*, Form S (2000). This reading test, developed by W. MacGinitie, R. MacGinitie, K. Maria, and L. Dreyer, provided information about students' reading achievement in the categories of vocabulary and comprehension. Students’ reading level as indicated by grade equivalence results on this test and their state assessment scores were used to identify them as low-, middle-, or high-comprehenders for later data analysis. This test was not used as a posttest.

This test was needed because other than the state assessment scores which placed students in one of the three categories (Basic, Proficient, and Advanced), there was usually no other up-to-date standardized reading test information on the students. Students varied in their reading achievement within each class. *The Gates-MacGinitie Reading Test* (2000) showed normed reading performance levels of the students and offered a baseline of reading achievement as reference. In addition to the raw score, a stanine score, and an outcome indicator score, the test also provided each test-taker a grade equivalence score for vocabulary, comprehension, and total reading achievement.

The Vividness of Imagery Questionnaire

A measure that was used as pretest and posttest for this study was the *Vividness of Imagery Questionnaire* (Sheveland, 1992), which was designed to measure the vividness of a person's natural use of mental imagery. Sheveland (1992) adapted this questionnaire from *The Betts OMI Vividness of Imagery Scale* (1967), reducing the 35 items to 21 items. The instrument used 21 Likert-type items covering seven sense modalities-- visual, auditory, cutaneous, kinesthetic, gustatory, olfactory, and organic (p. 3). The items each had five possible responses, ranging from "Very Clear: Vivid" (4 point) to "No Image, Just Know" (0 point). This questionnaire was tested on 380 children in an elementary school in southern California, ranging from grade three to six. Statistical analysis among items indicated that the measure had internal reliability, with an overall Cronbach alpha reliability of .88.

In this study, students took the *Vividness of Imagery Questionnaire* (Sheveland, 1992) as both pre- and post- assessment. Prior studies in the field showed significant correlations between vivid mental imagery and affect (Cramer, 1980, 1981; Macomber, 2001) as well as vivid imagery and reading comprehension (Cramer, 1981). I was interested to learn if vividness of mental imagery may have an impact on sixth-grade students' affect and comprehension.

The Motivation to Read Profile

For this study, the *Motivation to Read Profile* (MRP) was also used as pretest and posttest. Developed by Gambrell, Palmer, Codling, and Mazzoni (1996), it was used to measure students' motivation to read and attitude towards reading. Past research literature suggested a link between reading motivation and reading achievement (Walbert & Tsai, 1985, Wigfield, 1997). I was also interested to learn if motivation to read increased after students receive mental imagery instruction.

According to Gambrell, Palmer, Codling, and Mazzoni (1996), the MRP was designed to elicit information about student's self-perceived competence in reading and self-perceived performance relative to peers. In addition, it also provides insight into the value students place on reading tasks and reading-related activities. The MRP consists of two basic instruments: The Reading Survey, and the Conversational Interview. For this study, only The Reading Survey was used. This portion contains selected response style questions that assess self-concept as a reader as well as value of reading. Questions include items such as whether the student thinks he or she is a good reader, and whether reading is important or not. Gambrell et al. (1996) took measures to ensure that the MRP was valid and reliable. To ensure construct validity of the items in the survey, they used the items that 100% of experienced teachers judged to measure self-concept and value of reading. Teachers also rated students as having low, average, and high reading performance. Using the data collected, Gambrell et al. found statistically significant differences in the mean scores of the self-concept subscale related to those groups. Based on teacher ratings of student performance, the students who had higher scores on the MRP also demonstrated better reading performance. To ensure internal consistency of the survey, Gambrell et al. examined the instrument and found a moderately high reliability for both subscales when using Cronbach's alpha statistic (Self-concept = .75; Value of Reading = .82).

Pretest and Posttests for Expository Text

In addition to the MRP, students took a pretest consisting of an expository passage titled “Crocodiles and Alligators,” which was followed by 10 multiple-choice questions also known as selected response questions (SR) and one short essay question, known as brief constructed response (BCR). Similar to state assessments, students may refer back to the text when they answer questions. The measure was designed for assessing reading comprehension using science expository texts and not for assessing recall. The text structure of this passage uses the compare and contrast model (Appendix C).

The posttest was also a task consisting of an expository passage about two similar animals. Three posttests were developed over the course of this study. In the school year 2005-2006, an informal study was conducted to investigate the use of mental imagery strategies with science expository texts. (For more information on the informal study, please refer to Appendix H.) The first posttest was written for that purpose, and was titled “Poisonous and Nonpoisonous Snakes of America.” (This posttest is also referred to as Posttest 1B or Alternative.)

When students take the posttests, they may refer back to the text when they answer questions since the assessment was for comprehension and not recall. The posttests were written similar to the pretest. Each has ten SR questions and one BCR. The expository pretest and posttests were used to compare students' reading achievement before and after the two-week intervention as well as their reading achievement at the end of the school year. The pre- and posttests are similar for several reasons. First, they are about natural science-- the topic is about two similar animals. Second, the texts used similar structure (compare and contrast) as the main exposition writing model. Third, all were leveled for sixth-grade readability. Fourth, all used similar test item construction. Each test contains questions in the following reading skill categories: main idea (1 question), author's purpose (1 question), details (2 questions), inference (1 question), prediction (1 question), compare and contrast (1 question), conclusion (1 question), fact and opinion (1 question), vocabulary in context (1 question).

The test items of the pretest “Crocodiles and Alligators” and the posttest “Poisonous and Nonpoisonous Snakes of America” were examined for construct reliability using item analysis in the 2005-2006 and the 2006-2007 school years. The SR questions for both tests were similar, with 10 questions each, matching item-by-item in comprehension skills such as main idea and vocabulary in context. The BCR questions were similar; both asked how to differentiate the two creatures. The test items for the posttests “Octopus and Squid” and “Butterflies and Moths” were examined for reliability in the school year 2007-2008. No one question seems to be more frequently missed than another. For the sake of simplicity, the pretest may be referred to as Pretest or “Crocodiles,” the expository posttest “Octopus and Squid” may be referred as Posttest 1A or “Octopus,” the expository posttest “Poisonous and Nonpoisonous Snakes of America” may be referred to ad Posttest 1B or “Snakes,” and the expository posttest “Butterflies and Moths” may be referred to as Posttest 2 or “Butterflies.”

Reliability Check for Pretest and Posttests for Expository Texts

In the Fall of 2005, I conducted a reliability check for the Pretest and Posttest 1B using an On-grade-level class. For this class of 24 students, half the class was randomly given the “Crocodiles and Alligators” passage as a pretest, and the other half of the class was given the “Poisonous and Nonpoisonous Snakes of America” passage as the pretest. The scores were then analyzed using the independent samples t-test. The categorical, independent variable was the class, and the continuous, dependent variable was the scores on the expository reading tests. Results indicated that there was no statistically significant difference when comparing students' performance on the two tests. For the posttest, those students who had the “Crocodiles” passage as pretest used the “Snakes” passage as posttest, and those who used the “Snakes” as pretest then used “Crocodiles” as posttest. Again, analysis show that the there was no statistical difference regarding students' performance. The Selected Response mean score was 68.5% (6.85 out of 10 questions) for the “Crocodiles” passage and 73.5% (7.35 out of 10 questions) for the “Snakes” passage. The Standard Deviation was 1.8. Analysis using t-tests indicated that there was no statistically significant difference between the two results. For the BCR, the mean scores were 2.1 and 1.8 respectively (on a 3 point scale), indicating that the students were, on average, performing in the “Proficient” or middle range. Again, there was no statistically significant difference between the students' performance on either test. The main difference between the “Crocodiles” passage and the “Snakes” passage is that the first passage uses a point-by-point method of comparison, whereas the second uses a one-side-at-a-time method of comparison. It was brought to my attention that the text structures, though both used compare and contrast, were not exactly alike. The “Snakes” passage was longer. There were a few more facts presented in the “Snakes” passage as well. In order to make this a better study with valid and reliable posttests, I designed two other posttests for this study.

In the Fall of 2007, I prepared and tested two more posttests: “Octopus and Squid” and “Butterflies and Moths.” These passages are better matches for the pretest “Crocodiles and Alligators” in text structure than the “Poisonous and Non-poisonous Snakes of America.” These passages use the point-by-point comparison structure. The questions were also designed to parallel the pretest. Each test contains questions in the following reading skill categories: main idea (1 question), author's purpose (1 question), details (2 questions), inference (1 question), prediction (1 question), compare and contrast (1 question), conclusion (1 question), fact and opinion (1 question), vocabulary in context (1 question). Even the BCRs basically ask the same question– How are the two creatures different? (Main text structures and supports for the expository pre- and posttests are presented in a comparison matrix in Table 5. Complete pretest and posttests are presented in the Appendix C section.)

Students in the Language Arts class (24 students) randomly read and answered the questions to any two of the three test passages. Paired samples t-test was conducted to evaluate the differences of the students' performance between the "Crocodiles and Alligators" test and the "Octopus and Squid" or "Butterflies and Moths" tests for both SR and BCR portions of the tests. In this analysis, each student had provided matching sets of test scores, and where work was avoided or a score is missing, the student's set of scores was not included in the analysis. The independent variable was time tested and the independent variables were the scores. Data analysis revealed that there were no statistical significant differences between the SR scores from Time 1 ("Crocodiles") [M = 62.08, SD = 20.85] to Time 2 ("Octopus") [M = 65.88, SD = 21.53, t (15) = -.239, p = .814], to Time 3 ("Butterflies") [M = 65.08, SD = 21.70, t (11) = .034, p = .973]. An analysis of the BCR scores also revealed that there were no statistical significant differences between the scores from Time 1 ("Crocodiles") [M = 55.23, SD = 32.86] to Time 2 ("Octopus") [M = 55.00, SD = 34.06, t (14) = .265, p = .795], to Time 3 ("Butterflies") [M = 53.00, SD = 32.68, t (8) = .800, p = .447]. Therefore, it appeared that the students performed similarly on all constructed tests for this study. It can be concluded that these tests can be used as reliable post-assessments. Table 5 provides information on the text structure for the four expository text assessments.

Table 5

Matrix for Expository Pretest and Posttests Text Structure

Expository Text Test	Text Structure	Points of Comparison
Pretest "Crocodiles & Alligators"	Comparison, point-by-point	A. Introduction- similarities 4 details B. Supports- (2 details ea.) 1. jaws 2. size 3. snout 4. skin C. Conclusion- 1 detail
Posttest 1A "Octopus & Squid"	Comparison, point-by-point	A. Introduction- similarities 4 details B. Supports- (2 details ea.) 1. arms 2. body shape 3. size 4. behavior C. Conclusion- 1 detail
Posttest 1B "Poisonous & Nonpoisonous Snakes of America"	Comparison, one side-at-a-time	A. Introduction- similarities 1 detail, differences 3 details B. Supports- 1. Poisonous snakes- a. Coral- 2 details b. Pit vipers- 8 details 2. Nonpoisonous snakes- Various species- 9 details C. Conclusion- 4 details
Posttest 2 "Butterflies and Moths"	Comparison, point-by-point	A. Introduction- similarities 5 details B. Supports- (2 details ea.) 1. feelers 2. bodies 3. wings 4. habits C. Conclusion- 1 detail

Scoring of the Expository Pretest and Posttests

Selected Response. For the selected response (SR) section, an answer key was used for scoring. There is only one correct answer for each question. The raw scores were then converted into percents.

Brief Constructed Response. For the brief constructed response (BCR) section, my colleague and I both read the short essays and scored them based on a scoring guide which is similar to the BCR scoring guide for state assessments. A score point of 0 represents performance below Basic level-- the response may be totally off topic, wrong, demonstrates little understanding; there may be even be no response or an "I don't know." A score point of 1 represents a Basic performance level-- the response demonstrates a limited amount of understanding of the text as well as providing limited support from the text. A score point of 2 represents a Proficient performance level-- the response demonstrates proficient understanding of the text and provides sufficient supports for the answer. A score point of 3 represents an Advanced performance level-- the response demonstrates excellent understanding of the text and provides plenty of supports for the answer. The raw score is then converted into percentages using the following guide: 0= 0%, 1= 50%, 2= 75%, 3= 100%.

All responses were scored by both teachers separately first. In most cases, the two raters gave similar scores. In the event where the scores were different, the essay was re-examined and final scores were agreed on based on consensus. The average percent of agreement between the two raters for all tests was 82.5%. According to Huck, Cormier, and Bounds (1974, p. 335), an agreement score of 85% between observers or raters is considered high. Therefore, the first time ratings for the BCRs for this study were close to the mark; in addition, the raters were able to meet and reach a consensus on each BCR for which there was an initial disagreement. BCR (first time scoring) results for rater consistency was 88.5% for the Pretest “Alligators and Crocodiles,” 84.8% for Posttest 1A “Octopus and Squid,” 71.4% for the Alternative Posttest 1B “Poisonous and Non-poisonous Snakes of America,” and 85.2% for Posttest 2 “Butterflies and Moths.” Based on the close match for initial scoring and the consensus scoring procedures, it may be concluded that the BCR scoring is consistent.

Research Design

This study employed a quasi-experimental pretest-posttest comparison group design. Students took the pre- and posttests in the following areas: (a) the reading comprehension tests for science expository texts, (b) the *Motivation to Read Profile* (Gambrell et al., 1996), and (c) the *Vividness of Imagery Questionnaire* (Sheveland, 1992). Information from these pre-assessments as well as other background information was gathered for later data analysis.

Independent variables were (a) group memberships (i. e. experimental group and comparison group in four different classes-- two experimental groups and two comparison groups) and (b) types of readers (i. e. low-, middle- and high-comprehenders).

Dependent variables were (a) *Vividness of Imagery Questionnaire* (Sheveland, 1992), (b) *Motivation to Read Profile* (Gambrell, Palmer, Codling, & Mazzoni, 1996), and (c) Expository Pretest and Posttests 1A, 1B, and 2.

In the beginning of the school year, students took the *Gates-MacGinitie Reading Test* (2000) to identify their reading achievement level. The *Gates* scores and the students' state assessment scores were used to categorize students into three types of comprehenders. Students who score in the grade equivalence range of 7.5 and above on the *Gates* test and in the “Advanced” range on the state assessment were considered high-comprehenders. Students who score in the grade equivalence range of 5.0 to 7.5 on the *Gates* test and in the “Proficient” range on the state assessment were considered middle-comprehenders. Students who score in the grade equivalence range of 4.9 and below on the *Gates* test and in the “Basic” range on the state assessment were considered low-comprehenders. Students whose scores vary greatly between the two measures were considered on an individual basis, where classroom performance and teacher input would also be considered when placing a student in a category. For example, a student who scored "Advanced" on the state test but scored at a 4.6 grade equivalence on the *Gates-MacGinitie* test may be categorized as a middle-comprehender when this student's overall performance in the classroom was also considered. Students' performance levels vary within the classroom. For example, an Honors class may have high-comprehenders as well as a few middle-comprehenders. An On-grade-level class may have all three types of readers. The identification of the three levels of performance was for data analysis only; students were not informed regarding what category readers they were. Information from these assessments as well as other background information such as ethnicity and FARMS data were used for analysis.

Instructional Materials

In the Spring of 2005, I developed several expository exercises to supplement my classroom reading instruction. Where do these topics come from? I asked my students what they wanted to know about. Many of the students told me they wanted to know about the tallest mountain and the deepest sea. They wanted to know what it is like on the moon or Mars. They were interested in earthquakes, volcanoes, and creatures such as crocodiles, piranhas, and wasps. So I took their suggestions, did some research using science textbooks, encyclopedias, and internet sources, and developed the passages and tests.

In the Fall of 2005, I used these passages in an informal study. (For more information on the Informal Study, refer to Appendix H.) The reading exercises included expository text passages, multiple choice questions, and short essay questions. The readability level of these teacher-prepared passages, as indicated by the Flesch-Kincaid readability formula, was in the sixth-grade range. At the end of each passage, there are ten multiple-choice questions (Selected Response or SR) and one short essay question, also known as a brief constructed response (BCR). Both experimental and comparison groups used the same materials. Eight expository instructional sets were used in the ten-day instructional stage of this study. The titles are as follows: (1) The Mariana Trench, (2) Volcanic Eruptions, (3) Earthquake Resistant Buildings, (4) Is There Life on Mars? (5) What Is It Like on the Moon? (6) Mount Everest, (7) The Unusual Puffer Fish, and (8) Piranhas. Before taking the final posttest, all participating students read one more instructional passage titled “Bees and Wasps.” (Expository passages and questions are presented in Appendix B.)

How Do These Expository Passages Compare with the Science Textbook?

The passages and tests for this study were written on topics that sixth-grade students found interesting and had vocalized their preferences. Each passage contains approximately 500 words. On the other hand, the science textbook that was used for the school system covered a wide curriculum, with objectives that matched the voluntary state curriculum. Since the topics were decided by the curriculum developers, students had no input in what they had to read. The science textbook is divided into 7 units, with an average of 3 chapters each unit, and each unit has 5 sub-sections. The passages used in this study are about the same length as a sub-section, except that the science textbook has plenty of diagrams, pictures, and other graphic aids. In contrast to the science textbook, the passages for this study were not written with the intention of providing graphic aids. With the exception of the first passage, where graphic images were used to prompt students to visualize the Marianna Trench, all the other passages were written with the idea that the students will generate their own mental images. Both the expository passages and the science textbook seem to provide enough concrete words. The expository passages used in this study were written on a sixth-grade readability (using the Flesch-Kincaid formula). However, unlike the passages written for this study, the science textbook is written on a much higher reading level than the grade for which it is assigned. It is, therefore, not surprising that the average student has a difficult time reading the science textbook. The following table shows an analysis of the text for both the expository passages and the science textbook on two topics.

Table 6

An Analysis of Text Based on the First 500 Words of a Selection

	Concrete Words	***Imaginable Scenarios***	***Words in Captions***	***Average Readability Level***
Passage "Mariana Trench"	174	28	0	6
Science Textbook "The Ocean Floor"	167	27	138/500	9.6
Passage "Volcanic Eruptions"	142	28	0	6
Science Textbook "Volcanic Eruptions"	138	15	167/500	10.3

Procedures

Time Allocations

Time Allocations for Assessment

Time allocation for the *Gates-MacGinitie Reading Test* (2000) and three pre-assessments was 150 minutes. After the instruction period, 75 minutes were allocated for the three post-assessments.

The *Gates-MacGinitie Reading Test* (2000) provided information about students' reading achievement. Along with the state assessments, the *Gates* scores helped identify students as low-, middle-, or high-comprehenders. The *Gates* test took 30 minutes for the vocabulary section and 45 minutes for the comprehension section. This test was not used as a posttest.

The *Vividness of Imagery Questionnaire* took approximately 15 minutes to administer, and was given to students as pre- and posttest. The *Motivation to Read Profile* took about 15 minutes to administer, and was also be used as pre- and posttest. The Pretest for Expository Text is titled “Crocodiles and Alligators.” Time allocation for this task was 40 minutes. Similarly, time allocations for the various Posttests for Expository Text were also 40 minutes.

Time Allocation for Instruction

The experimental group received instruction in mental imagery when reading expository texts for ten class periods, 45 minutes each day. This instruction process spanned two weeks to allow for instruction and guided practice at a reasonable rate. The estimated instruction time was approximately 350 total minutes, because it was reasonable to allow 10 minutes each class period for student preparation and transitional time.

Previous researchers in the field used various time schedules for their instruction. For example, Gambrell's study (1981) using representational mental imagery took 30 minutes for instruction. Other researchers (Center et al., 1999) used representational imagery instruction beginning with pictures and then progressing to mental imagery, taking 12 lessons of 20 minutes duration, three times a week, spreading over four weeks, totaling 240 minutes. The time frame used by these researchers (Center et al., 1999) seemed reasonable, but in the middle school context, ten periods in class consecutively taking up a total of two weeks seemed more suitable since middle school students are used to certain units or themes taught in that time frame.

Instructional Method

The five sets of instruction techniques cover the following stages:

1. Representational instruction using visual aids
2. Representational instruction using mental pictures and self-generated drawings
3. Representational instruction using mental pictures and think-along ideas
4. Representational instruction targeting unfamiliar vocabulary in context
5. Representational instruction with devices of students' choice (illustrations, mental picture, or think along)

Each set of instructional techniques took two class periods, each about 45 minutes in duration. The order of the instructional sessions is progressive in nature. The method of instruction has been selected based on knowledge and information presented by other researchers in the field as well as the information gained from an informal study which investigated the effects of mental imagery strategies on students reading expository texts. The instructional concepts from prior studies and the informal study are explained in later sections.

Experimental Group Instructional Stages

Representational instruction using visual aids. The imagery instruction began with reading text and some graphic image because it may be easier for students to first understand how to mentally link text with pictures. Hibbing and Rankin-Erickson (2003) surveyed their students and found that students claim pictures enhance understanding, especially when the pictures are truthful in their representations. Even teacher generated simple illustrations on the board will work to help students understand, as long as these graphic representations are true to the text (Rankin-Erickson, 2003). Other researchers also agree that pictures enhance the text and make it easier for students to understand and make connections (Bishop & Hickman, 1992; Levin et al., 1987).

Representational instruction using mental pictures and self-generated drawings. During this stage the students learned how to create their own picturesque interpretations or mental images. At this point, students were no longer being provided with pictures by the teacher or text, instead they were encouraged to create mental pictures in their minds (Gambrell & Bales, 1986; Pressley, 1976). Students were encouraged to extend the experience to link with any sounds, smells, touch, taste, and feelings they might have when interpreting the text, further extending the mental imagery to more than just visual, but all prior experiences that entered into their coding system (Sadoski & Paivio 2001; Sheveland, 1992). Furthermore, the students were asked to draw some pictures or diagrams of their own to illustrate what they understood from the text they read. Prior studies that engage students with illustrations suggested that students creating drawings can enhance reading comprehension (Hibbing & Rankin-Erickson, 2003; Rose et al., 2000). Researchers Bean, Valerio, and Stevens (1999) suggested that illustrations or drawings should be included as part of content area literacy instruction. In my informal study (2005-2006), many of the students seemed to enjoy drawing about the text they have read.

Representational instruction using mental imagery and think-along ideas. In this part of the instruction, the students learned to use mental images and expressed their thoughts with words. The teachers modeled and demonstrated the mental imagery in their heads as they read parts of a passage aloud and discussed the ideas with the students. When teachers model and tell the students the thought procedures that went through their minds, the process is termed "think-aloud" (Davey, 1983; Farr, 1997). Then the teachers coached the students to generate ideas and pair share orally. After that, the teachers continued the instruction process by guiding the students to read a passage, then generate images of their own and write them down. This process is termed "think-along" since the students are not orally calling out every thought and image (Farr, 1997). For the think-along process, the focus was on mental imagery; however, any response was fine since the scope of mental imagery included the remembering of past experiences and linking them with the current text. Therefore, if a student read about Hutton's geologic processes at school and learned that natural forces would break rocks down to smaller particles (*Earth Science*, p.

134), he might recall that he had smashed a piece of sandstone into smaller rocks before. That concept was a think-along idea which showed that the student was making connections with the text. Although the particular idea might not seem like a picture, it certainly was an experience that was visual, tactile, and linked with the text.

Think-aloud think-along ideas are not new. Olshavsky (1976) used it as a means to study the cognitive process that readers and writers use as they develop meaning. Farr (1997) and other researchers (Baumann, Jones, & Seifert-Kessell, 1993; Davey, 1983; Duffy & Roehler, 1987; Flower & Hayes, 1980; Kucan & Beck, 1997) have researched the concept and used it as a comprehension strategy. It is listed as one of the many reading strategies to use in Tierney and Readence's *Reading Strategies and Practices: A Compendium* (2000) and Pearson and Fielding's *Handbook of Reading Research* (1991). The foundations of think-along think-aloud can be linked to schema (Rumelhart, 1976) and metacognition (Baker, 1984; Frey, 2006). When students think about what they read and try to make sense of it, they make connections with past experiences, drawing upon the schemata related to what they have read, often bringing up mental imagery (Wade, Buxton, & Kelly, 1999). When they express their ideas out loud or write it on paper, they are aware and reflective of their own cognitive processes, which is the basis of metacognition (Baker & Brown, 1984). Using the think-aloud think-along strategy may help students purposefully choose to make connections with the text so that they may share with the class or in small groups.

When the students were taught mental imagery and the think-aloud think-along strategy, they might express their thoughts about the reading as think-alouds.

The teachers would ask students to share their mental imagery with the whole class one at a time, or pair share with a partner. The teacher then guided them to write some of these ideas down. To use written think-alongs may be a manageable strategy in the classroom because the teacher can maintain effective classroom management while students are engaged. Fast thinkers and writers may raise their hands and be selected to share their think-alongs with the whole class. Considering the dynamics of the classroom, the teacher may choose to let students do pair share or group share. The think-along strategy can be very flexible to use. Students may also use graphic organizers that help them organize their mental images in the categories of sight, hearing, touch, smell, taste, or other senses. In the last five years, I have incorporated the mental imagery think-along strategy in my classroom and found it to be one of the most useful strategies to use with classes of all ability levels.

Representational instruction targeting unfamiliar vocabulary in context. Often when students read expository text, they may encounter technical vocabulary that may be difficult for them (Smith & Ellis, 2003). This next stage was designed to help students use mental images to create connections that may help them with the meaning of unfamiliar vocabulary. Students might use context clues to figure out what a difficult word may mean, and then express the meaning through a written linking vocabulary that required an illustration. One method that is linked to mental imagery is the verbal-visual vocabulary square (Bean, Valerio, & Stevens, 1999; Readence, Bean, & Baldwin, 1998). The method includes writing the new vocabulary in the center of a card about half the size of a regular sheet of paper, then on the four corners add the definition, the part of speech, make a sentence, and draw an image.

Another similar vocabulary strategy is the LINCS card strategy (Ellis, 2004). The idea of the LINCS card is as follows: (1) write the vocabulary word, (2) write the definition, (3) find a linking word (also known as the reminding word) that links or reminds one of the vocabulary word, (4) draw a picture that relates to the word, and (5) write a linking sentence that makes sense using the reminding word (It does not matter if the student does not use the original vocabulary in this strategy).

The common factors among these visual vocabulary strategies are the picture and the connection with the vocabulary word. The students may be prompted to do either one of the two visual vocabulary strategies to enhance their vocabulary.

Representational instruction with devices of students' choice (illustrations, mental picture, or think-along). The last stage was for students to learn how to choose any imagery technique they wish to use on their own. The basic structure of the instruction lesson was always divided into three segments. First, the teachers demonstrated the imagery technique. Second, students partnered with another student for imagery practice. Third, students practiced the imagery technique on their own. After reading and interacting with the entire passage, students answered comprehension questions about the passage they read as an assessment for understanding. The teachers then shared the correct answers. The scores for the independent activities were collected for analysis.

Comparison Group

For the comparison group, the students used the same instructional materials and had the same amount of time as the experimental group. Since there were three parts to each set, comparison group students also had a teacher-guided portion, work-with-a-partner portion, and an independent work portion.

During the first part of each set, the teachers told the students to read the passage carefully. For the second part of each set, the students read the passage with a partner. For the third part of each set, the students read silently and then they answered questions independently. After students completed the questions at the end of each passage, the teachers shared the correct answers. In the case of the written response or BCR, the teachers shared what would be an effective answer. All student answers for the five instructional sets were collected.

Post-Assessment

After the five sets of instruction, students took the post-assessment. Students read the passages silently and answered questions, using whatever imagery technique they felt most comfortable. In addition to the test passages and questions, students in the experimental group received blank paper (for drawing), an "Images Chart" (Appendix E), and writing paper. Students in the comparison group received the test passages, questions, and writing paper.

Summary of Instructional Components for the Experimental and Comparison Group

This study provides students with eight different sets of science expository passages as practice materials. During the initial two-week intervention period, students in the experimental group had mental imagery instruction to go along with these passages while students in the comparison group were asked to read carefully and answer the questions. Table 7 illustrates how the experimental group and comparison group vary in mental imagery instruction. Detailed lesson plans are attached in Appendix D.

Table 7

Comparison of the Instructional Components for the Experimental and Comparison Group during the Initial 2-Week Intervention

Instruction Set	***Experimental Group***	***Comparison Group*** *(Note: This group received mental imagery instruction after the 2-week intervention)*
1☐	Representational instruction using visual aids (2 days). Use "Mariana Trench" passage. Students would see graphic illustrations to help them create mental imageries to connect with the text.	No instruction/ Same materials. Students would be asked to read carefully and answer questions. Correct answers were shared.
2☐	Representational instruction using mental pictures and self-generated drawings (2 days). Use "Volcanic Eruptions" passage. Students draw their own illustrations to connect with the text.	No instruction/ Same materials. Students would be asked to read carefully and answer questions. Correct answers were shared.
3☐	Representational instruction using mental pictures and think-along ideas (Day 1: "Earthquake Resistant Buildings," Day 2: "Is There Life on Mars?"). Students use think-along ideas to connect with the text passage.	No instruction/ Same materials. Students would be asked to read carefully and answer questions. Correct answers were shared.

Instruction Set	*Experimental Group*	*Comparison Group* (Note: This group received mental imagery instruction after the 2-week intervention)
4□	Representational instruction targeting unfamiliar vocabulary in context, LINCs vocabulary cards (Day 1: “What Is It Like on the Moon?” Day 2: “Mt. Everest”). Students would use visual-cue vocabulary cards and think-along ideas to connect with difficult vocabulary and text passages.	No instruction/ Same materials. Students would be asked to read carefully and answer questions. Correct answers were shared.
5□	Representational instruction with devices of students' choice--illustrations, mental picture, or think along (Day 1: “Puffer Fish,” Day 2: “Piranhas”). Students would use mental imagery techniques of their own choice to connect with text passages.	No instruction/ Same materials. Students would be asked to read carefully and answer questions. Correct answers were shared.

Follow-up Instruction

Experimental Group

After the two-week instruction, students in the experimental group continued to receive mental imagery prompts about two to three times a week in their regular reading instruction. They were asked to write think-along ideas or create mental images with parts of the text.

Comparison Group

Students in the comparison group were also taught the same mental imagery strategies experimental students had received as outlined in the lesson plans, except that the regular text book and other classroom resources were used for instruction. Mental imagery strategies were targeted all year. At the end of the school year, students in all four classes used one more instructional passage titled “Bees and Wasps” to prepared them for one more task– the second posttest titled “Butterflies and Moths” (Posttest 2).

The instructional methods presented in this study had been tried previously. The two-week instructional period was smooth-flowing and fit in the regular curriculum similar to a thematic unit. During the school year 2005-5006, I conducted an informal study to investigate the effects of mental imagery instruction on science expository texts. Findings suggest that the Honors students made gains in the SR portion of the comprehension task and the Basic students made gains in the BCR portion of the comprehension task. These findings were encouraging and established part of the foundations for this study. (Information on the informal study is presented in Appendix H.)

Data Analysis

The statistical procedures used to analyze the data are presented with the research questions in Table 8.

Table 8

Table of Relations-- Questions, Measures, and Analysis

Questions	***Measures***	***Analysis***
1. What are the effects of mental imagery strategies on students' reading comprehension when they read science expository texts?	Science expository tests: Pretest "Crocodiles and Alligators," Posttest 1A "Octopus and Squid" or 1B "Poisonous and Nonpoisonous Snakes of America," End of the year Posttest 2 "Butterflies and Wasps"	Mixed between-within subjects ANOVA: 2 (groups: experimental and comparison) X 3 (time: Time 1 Pretest, Time 2 Posttest 1, and Time 3 Posttest 2); performed for SR and then BCR portions of the tests
2. How do the low-, middle-, or high-comprehenders compare in their expository reading achievement after mental	State assessment and *Gates-MacGinitie* test, Expository Pretest and Expository Posttests	Mixed between-within subjects ANOVA 3 (levels) X 2 (repeated measures Posttest 1 and Posttest 2); performed for SR and then

Questions	***Measures***	***Analysis***
imagery instruction?		BCR portions of the tests.
3. Are there relations between the variables of reading comprehension, vividness of mental imagery, and motivation to read low- middle- and high-comprehenders?	*Gates-MacGinitie Reading Test* (2000), *Sheveland Vividness of Imagery Questionnaire* (1992), and *Motivation to Read Profile* (Gambrell et al., 1996)	Correlation analysis using Pearson correlation coefficient
4. Is motivation for reading improved after mental imagery strategies?	*Motivation to Read Profile* used as pretest and posttest	Mixed between-within subjects ANOVA 2 (experimental vs. comparison) X 2 (repeated measures using *Motivation to Read Profile* as pre- and posttest)

To answer Question 1, a mixed between-within subjects 2 X 3 ANOVA was conducted to compare groups over time. The between-subjects factors were the groups (experimental group vs. comparison group). The experimental group was comprised of students in Class One (11 low-comprehenders) and Class Three (2 middle-comprehenders and 12 high-comprehenders). The comparison group was comprised of Class Two (6 low-comprehenders, 9 middle-comprehenders, and 4 high-comprehenders) and Class Four (1 middle-comprehender and 11 high-comprehenders). The within-subject factor or repeated factor was the time that the students were tested on expository reading comprehension: Time 1 (prior to the intervention), Time 2 (following the intervention), and Time 3 (end-of-year). Scores for students who were absent at the end of the year or had missing data were not included in the final analyses. The analysis was conducted first on the selected response (SR) portion of the tests and then the brief constructed response (BCR) portion of the tests.

The initial plan of this study was to use the two posttests, Posttest 1 "Octopus and Squid" and Posttest 2 "Butterflies and Moths," developed in the 2007-2008 school year as the evaluative measures. The "Octopus and Squid" test would be used immediately as the posttest after the ten-day instruction, and the "Butterflies and Moths" test would be used at the end of the school year as a final assessment. In the actual study, Class Three and Class Four were accidentally given the posttest developed in 2005-2006, "Poisonous and Nonpoisonous Snakes of America," because it had not been pulled out from the testing information from the year before. I decided to go ahead analyze the data and see how the students performed anyway. I made this decision mainly because the timing is important, and there was no extra time to retest the students if the program were to move forward. In addition, the data from the informal study conducted in the 2005-2006 school year seemed promising enough. Even though I was aware that the "Snakes" passage was longer and organized somewhat differently when compared to the Pretest, I did not think that it would make that much of a difference. Furthermore, these students would have another chance to show their reading competence using the posttest "Butterflies and Moths" at the end of the school year. Therefore, for the first expository posttest, Class One and Two used Posttest 1A, and Class Three and Four, the Honors classes, used Posttest 1B. All classes used the final assessment "Butterflies and Moths" as Posttest 2.

The final assessment (Posttest 2: "Butterflies and Moths") given at the end of the school year measured sustained effects for the experimental group and assessed gains for the comparison group, which had been taught the mental imagery strategies since the third quarter of the school year.

For Question 2, "How do the low-, middle-, or high-comprehenders compare in their reading achievement after mental imagery instruction?" a mixed between-within-subjects 3 X 2 ANOVA was conducted to compare types of comprehenders over time. The between-subjects factor was the level (3 levels of low-, middle-, and high-comprehenders), and the within-subjects factor or repeated factor was the time: Time 1 (Posttest 1 following two-week intervention) and Time 2 (Posttest 2, end-of-year assessment). Analysis was done for both the selected response part of the test (SR) and the essay or brief constructed response (BCR) portion of the test. For this analysis, the time between Posttest 1 and Posttest 2 established a period when all students-- low-, middle-, and high-comprehenders-- have received mental imagery instruction.

Question 3, "Are there relations between the variables of reading comprehension, vividness of mental imagery posttest, and motivation to read for low-, middle- and high-comprehenders?" was answered by data analysis using the

Pearson correlation coefficient. The Pearson correlation coefficient is a parametric technique using continuous data, such as the scores for the various measures (Huck, 1974, p. 31). Data analysis using this method showed the three components of correlations: (1) the *Gates-MacGinitie Reading Test* (2000) scores, (2) the *Sheveland Vividness of Imagery Questionnaire* (1992) pretest, and (3) the *Motivation to Read Profile* (Gambrell et al. 1996) pretest, and how they relate to the three types of readers: low-, middle-, and high-comprehenders.

Question 4, "Is motivation to read improved after mental imagery instruction using science expository texts?" was answered by using a mixed between-within subjects 2 X 2 ANOVA to compare groups over time. The between-subjects factor was the group (experimental vs. comparison), and the within-subject or repeated factor was time (measures on the *Motivation to Read Profile,* Gambrell et al., 1996, used both before intervention and after intervention).

Effect Size Calculations

Where indicated by statistically significant results, effect size was calculated by obtaining partial Eta squared ($\eta_p{}^{2)}$ using the sum of squares of the effect divided by the sum of squares of the effect and sum of squares error. Partial Eta squared is the proportion of the effect and the error variance that is attributed to the effect. Evaluating the effect size was based on the guidelines proposed by Cohen (1988): .01 = small effect, .06 = moderate effect, and .14 = large effect.

Summary

This study employed a quasi-experimental pretest-posttest group design to investigate the effects of mental imagery instruction using science expository texts on middle school student. The sample was comprised of 56 sixth-grade students from a predominantly white middle-class rural-suburban school in a Mid-Atlantic region. Two teachers were involved with this investigation; each had two reading classes. Each teacher randomly assigned one class to be in the experimental group and the other to be in the comparison group. It was decided that the first reading class each teacher taught would be assigned as experimental, and the other class would be assigned as comparison. All classes took the pre-assessments. Students in the experimental group were taught mental imagery techniques as comprehension strategies for two weeks (10 sessions), using eight different on-grade-level science expository passages with practice questions. Students in the comparison group had the same time for the expository text unit, but were told mainly to read carefully and answer the questions carefully. Data were collected following the intervention. The comparison students then received mental imagery instruction. Throughout the rest of the school year, all students were prompted at least two to three times a week to use mental imagery strategies. A follow-up expository reading comprehension test was given at the end of the school year, and data were collected for analysis.

To investigate whether mental imagery instruction using science expository texts had helped students improve reading comprehension, a mixed between-within subjects 2 (experimental vs. comparison) X 3 (Time 1, Time 2, Time 3) ANOVA was performed for data analysis for both the SR and BCR portions of the expository comprehension tests. To compare the expository reading comprehension performance of the three levels of comprehenders (low-, middle-, and high-), a mixed between-within-subjects 3 (levels) X 2 (Time 1 & Time 2) ANOVA was conducted to analyze any differences in performance for the three types of comprehenders over time. Additionally, effect sizes using partial Eta squared were calculated to support the interpretation of the statistical analysis conducted on the expository comprehension posttest measures. To investigate the relationship between the variables of reading achievement, vividness of imagery, and motivation to read for the three levels of comprehenders, the Pearson correlation analysis was conducted. Measures used for this analysis were the *Gates-MacGinitie Reading Test*, *Sheveland Vividness of Imagery Questionnaire* (1992), and *Motivation to Read Profile* (Gambrell et al. 1996). To investigate whether students improved in their motivation for reading after mental imagery strategies with expository text, a mixed between-within subjects 2 (experimental vs. comparison) X 2 (repeated measures) analysis of variance was used.

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to investigate the effects of mental imagery as a comprehension strategy for middle school students using science expository texts. This chapter presents data and analysis, with statistical analysis corresponding to the research questions: (a) What are the effects of mental imagery strategies on students' reading comprehension achievement when they read science expository texts? (b) How do the low-, middle-, or high- comprehenders compare in their reading achievement after mental imagery instruction? (c) Are there relations between the variables of reading comprehension, vividness of mental imagery, and motivation to read for low-, middle- and high-comprehenders? (d) Is motivation to read improved after mental imagery instruction using science expository texts?

In each section, tables and graphs reporting the results supplement the explanation of the analysis. For each measure, statistical significance was set at an alpha level of .05. This chapter begins with a description of the initial levels of the students in the various classes. Then the results of each research question are presented. This chapter concludes with a summary.

The Initial Performance of the Students

The students' initial performance was assessed with two measures: *The Gates-MacGinitie Reading Test* (2000) and the expository pretest, "Crocodiles and Alligators." The scores indicated that three of the classes were quite different. Class One, experimental group, was a below-grade-level class. This class was set up to be a

Basic class with a small class size (only 14 students). Class Two, comparison group, was an on-grade-level class with a total number of 23 students. Class Three was an Honors class of 24 students. Class Four was an Honors class of 20 students. Some students and their parents chose not to participate in this study. The students who did not have a signed participation form received the same treatment; however, their scores were not included in the analyses. All data reporting on these classes reflected only the scores of students who agreed to participate and whose parents agreed for them to participate. Participation in this study means to allow the scores to be used for analysis. The "Expository Unit" was designed as a classroom unit as a supplement to the sixth-grade reading program since the textbooks contained so little expository texts. As a result, the student numbers reported on the analyses were smaller than the actual class size.

The number of participants and average reading performance by class based on participating students were as follows:

Class One, Experimental Group One (n = 11): Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for Class One was 3.4. The selected response (SR) mean score for Class One using the science expository pretest was 47.27% (SD = 16.79), and the brief constructed response (BCR) mean score was 40.91% (SD = 30.15).

Class Two, Comparison Group One (n = 19): Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for Class Two was 6.35. The SR mean score for Class Two using the science expository pretest was 70.00% (SD = 15.28), and the BCR mean score was 69.74% (SD = 34.94).

Class Three, Experimental Group Two (n = 14): Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for Class Three was 11.5. The SR mean score for Class Three using the science expository pretest was 83.57% (SD = 14.99), and the BCR mean score was 89.29% (SD = 16.16).

Class Four, Comparison Group Two (n = 12): Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for Class Four was 9.46. The SR mean score for Class Four using the science expository pretest was 80.00% (SD = 10.44), and the BCR mean score was 95.83% (SD = 9.73).

In some cases, a few students were absent and did not make up certain tests, or they did not come to school during the last three days of school and missed the last assessment. The scores of those missing students were not used as part of the analysis.

Students' Performance on Reading Comprehension for Expository Text

Four comprehension tests using science expository passages written on sixth-grade reading level were used in this study. Prior to the intervention, all students took the pretest “Crocodiles and Alligators.” Following the intervention, Class One and Two used Posttest 1A, “Octopus and Squid,” while Class Three and Four used Posttest 1B, “Poisonous and Nonpoisonous Snakes of America.” At the end of the school year, all students took the Posttest 2, “Butterflies and Moths.” These comprehension tests are furthermore divided into two portions: Selected Response (SR) and Brief Constructed Response (BCR) or short essay.

Results for Question 1

What are the effects of mental imagery strategies on students' reading comprehension when they read science expository texts? To answer this question, a mixed between-within subjects 2 X 3 analysis of variance (ANOVA) was conducted to compare groups over time. The between-subjects factor was the group (experimental group vs. comparison group): the experimental group was comprised of students in Class One (a class with low-comprehenders) and Class Three (a class with mostly high-comprehenders); the comparison group was comprised of students in Class Two (a class with mostly middle-comprehenders) and Class Four (a class with mostly high-comprehenders). The within-subject or repeated factor was the time that the students were tested on expository reading comprehension: Time 1 (prior to the intervention), Time 2 (following the intervention), and Time 3 (end-of-year). The analysis was conducted first for the selected response (SR) portion of the test, and then the brief constructed response (BCR) portion of the test.

Expository Reading Comprehension Results for Selected Response

The means and standard deviations for the SR portion of the expository comprehension tests are presented in Table 9. Results indicated that there was a statistically significant interaction for time and group [Wilks' Lambda = .863, F (2, 53) = 4.210, *p* =.020, partial Eta squared = .137]. Using the commonly used guidelines for interpreting the effect size indicated by partial Eta squared proposed by Cohen (1988)– .01 = small, .06 = moderate, .14 = large effect – this result suggests a moderate effect size. The statistically significant interaction of time and group on the mental imagery strategies using expository test indicated differential change in the two groups' application of strategies over the three time periods, from the Pretest to Posttest 1, and to Posttest 2 at the end of the year.

Figure 1 shows a graph of the interaction. The experimental group was comprised of 11 low-comprehenders, 2 middle-comprehenders, and 12 high-comprehenders. This group did not appear to have made any gains immediately after the mental imagery instruction, but appeared to have made gains by the end of the school year. The comparison group was comprised of 6 low-comprehenders, 10 middle-comprehenders, and 15 high-comprehenders. This group also did not appear to make much gain immediately after the two-week of practice in which they received no mental imagery instruction. However, the comparison group was taught the mental imagery strategies during the third quarter and made gains by the end of the school year. Thus, both groups appeared to make gains between Posttest 1 and Posttest 2, once both had received mental imagery instruction. The comparison group, which by chance consisted of stronger readers, appeared to outperform the experimental group at all testing times.

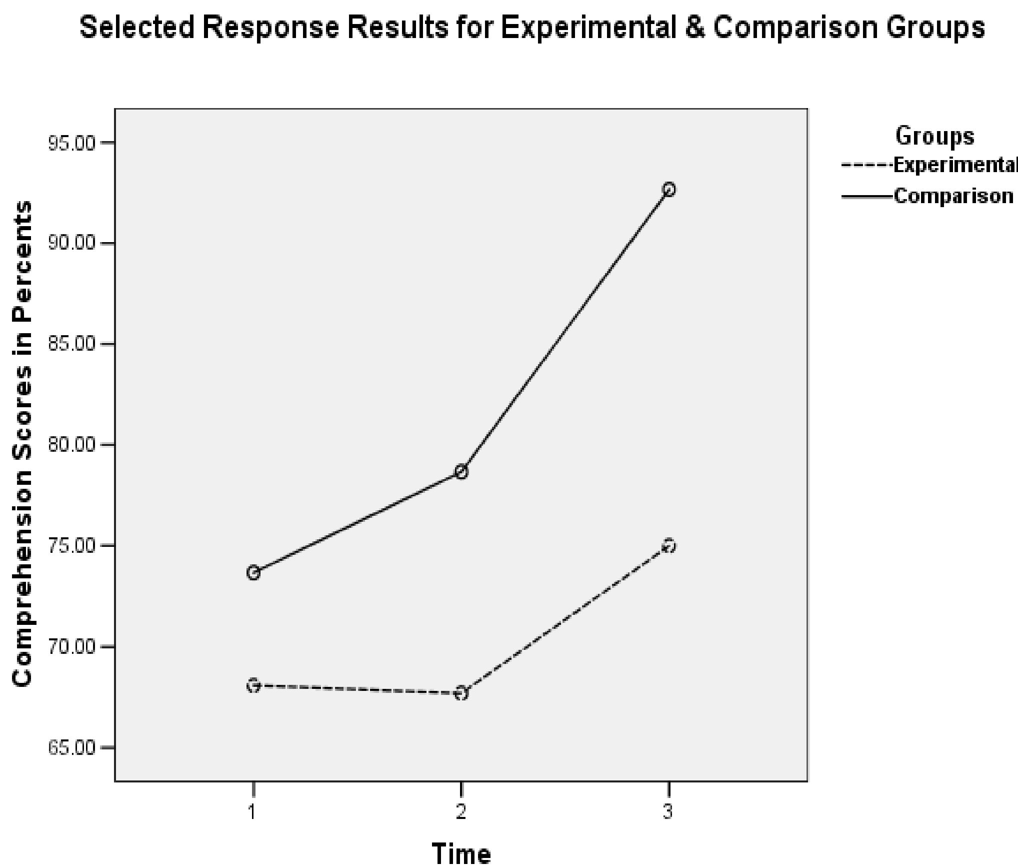
Table 9

Expository Reading Comprehension Selected Response Results

Time	Experimental Group n = 25		Comparison Group n = 31	
	Score	SD	Score	SD
Pretest SR	67.60	24.03	73.87	14.30
Posttest 1SR	68.40	24.61	77.74	20.12
Posttest 2 SR	74.00	30.14	92.90	10.39

Figure 1

Expository Reading Comprehension Selected Response Results



Expository Reading Comprehension Results for Brief Constructed Response

Results indicated that there were no significant changes in scores over time for either group (Experimental and Comparison) for the Brief Constructed Response (BCR) portion of the expository tests. The means and standard deviations for the BCR portion of the expository comprehension tests are presented in Table 10. Figure 2 presents graphic information for this analysis.

Data analysis for the BCR portion of the comprehension task indicated no statistically significant interaction for time and group [Wilks' Lambda = .954, F (2, 53) = 1.291, *p* = .283, partial Eta squared = .046]. There was also no statistically significant main effect on BCR scores for time [Wilks' Lambda = .918, F (2, 53) = 2.369, *p* = .103 partial Eta squared = .082], nor was there a statistically significant main effect for group [F (1, 54) = 1.053, *p* = .310, partial Eta squared = .019]. The mean BCR scores of the Experimental Group went from 68.00% to 81.00%; however, the change over time was not statistically significant. The comparison group's BCR mean score dropped a bit immediately after the two-week practice, during which time they had no mental imagery instruction, but their BCR mean score went back up on Posttest 2 at the end of the year. Again, the changes in scores were not statistically significant.

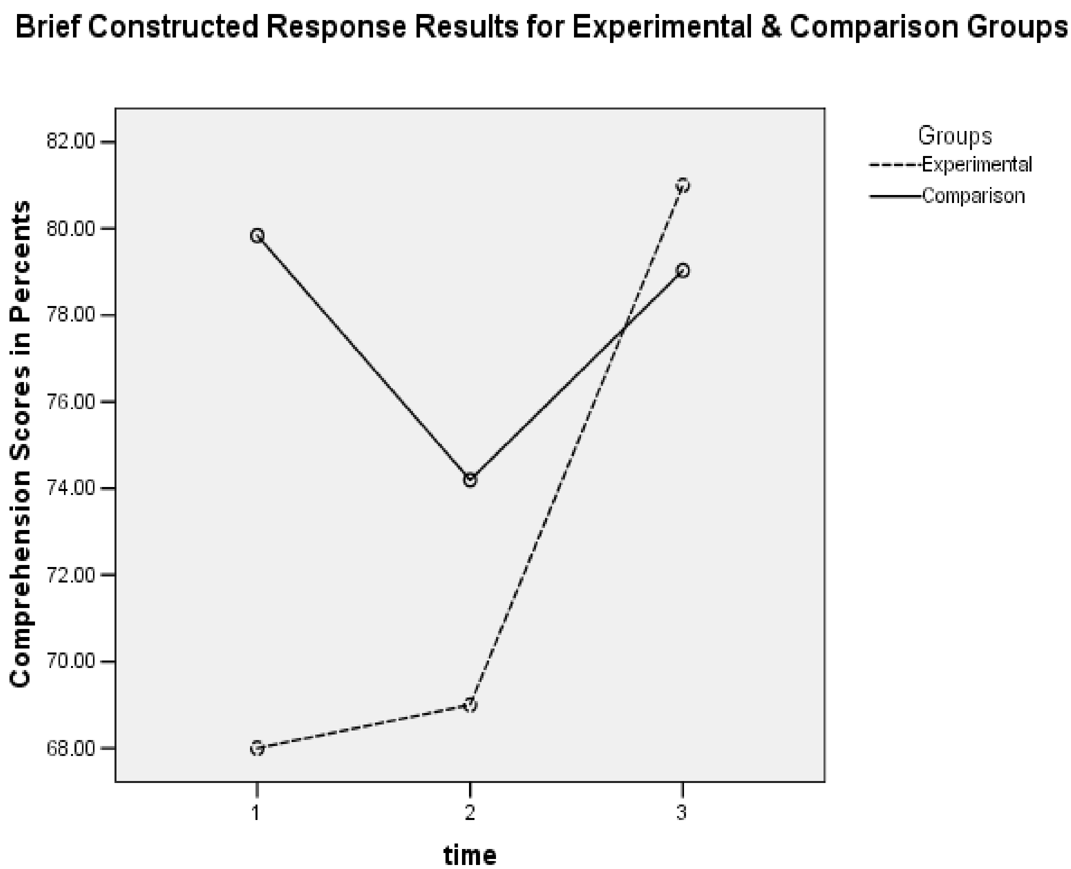
Table 10

Expository Reading Comprehension Brief Constructed Response Results

Time	***Experimental Group*** n = 25		***Comparison Group*** n = 31	
	Score	SD	Score	SD
Pretest BCR	68.00	33.48	79.84	30.55
Posttest 1 BCR	69.00	24.24	74.19	19.88
Posttest 2 BCR	81.00	25.29	79.03	23.36

Figure 2

Expository Reading Comprehension Brief Constructed Response Results



Results for Question 2

How do the low-, middle-, or high-comprehenders compare in their expository reading achievement after mental imagery instruction? A mixed between-within subjects 3 X 2 ANOVA was conducted to investigate differences in performance for the three types of comprehenders over time. The between-subjects factor was the three types of comprehenders (low-, middle-, and high-comprehenders). The within-subjects or repeated factor was the time that the students were tested on expository reading comprehension: Time 1 (Posttest 1), Time 2 (Posttest 2 at the end of the school year). The time between Posttest 1 and Posttest 2 was the period when all students (low-, middle-, and high-comprehenders) had received mental imagery instruction. The analysis was conducted first for the selected response (SR) portion of the test, and then for the brief constructed response (BCR) portion of the test.

Selected Response Results for the Type of Comprehenders

The SR mean scores and standard deviations for the type of comprehenders are presented in Table 11. Figure 3 shows a graph of the results. Results indicated that there was no statistically significant interaction for time and type of comprehenders [Wilks' Lambda = .972, F (2, 53) = .755, p = .475, partial Eta squared = .028]. Data analysis for the SR portion of the comprehension tests indicated that there was a statistically significant main effect for time [Wilks' Lambda = .717, F (1, 53) = 20.887, p =.000, partial Eta squared = .283]. This result suggests a large effect size. The statistically significant result for time indicated that the three levels of comprehenders scored differently from Posttest 1 to Posttest 2. After Posttest 1, all participants had received mental imagery instruction. The students appeared to have made gains at Posttest 2. Tests of between-subjects effects indicated that the three types of comprehenders performed differently [F(2, 53) = 63.733, *p* = .000, partial Eta squared = .706]. This result suggests a large effect size. This indicated that the level of comprehenders was a factor that affected student performance on the SR task. The high- and middle-comprehenders consistently outperformed the low-comprehenders.

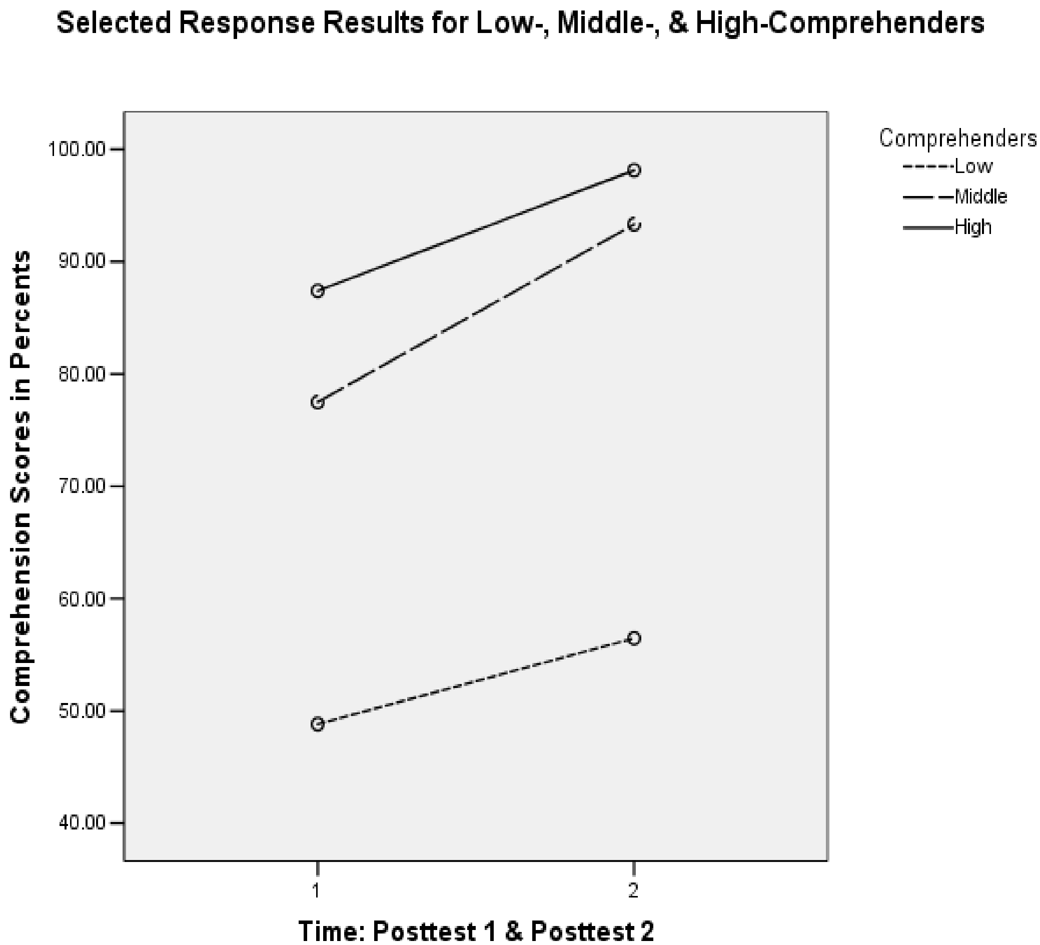
Table 11

Descriptive Data: Selected Response Results for Low-, Middle-, and High-Comprehenders

Time	***Low-Comprehenders*** *n = 17*		***Middle-Comprehenders*** *n = 12*		***High-Comprehenders*** *n = 27*	
	Score	SD	Score	SD	Score	SD
Posttest 1 SR	48.82	21.76	77.50	13.57	87.41	9.84
Posttest 2 SR	56.47	23.96	93.33	8.88	98.15	4.83

Figure 3

Selected Response Results for Low-, Middle-, and High-Comprehenders



Brief Constructed Response Results for the Type of Comprehenders

The BCR mean scores and standard deviations for the type of comprehenders are presented in Table 12. Figure 4 shows a graph of the results. Results indicated that there was no statistically significant interaction for time and type of comprehenders [Wilks' Lambda = .956, F (2, 53) = 1.221, *p* = .303, partial Eta squared = .044]. Data analysis for the BCR portion of the comprehension tests indicated that there was also no statistically significant main effect for time [Wilks' Lambda = .942, F (1, 53) = 3.284, *p* =.076, partial Eta squared = .058]. The lack of statistically significant results for time suggests that the use of mental imagery did not affect the students' performance between Posttest 1 and Posttest 2 on the brief constructed responses. Mental imagery strategies did not appear to help improve the comprehension performance of students when they expressed their understanding on a short essay question (BCR). Tests of between-subjects effects indicated that the students of the three levels of comprehension performed differently [F (2, 53) = 10.705, *p* = .000, partial Eta squared = .288]. This result suggests a large effect size, indicating the level of comprehenders was a factor for students’ performance on the BCR comprehension task. The stronger readers consistently outperformed the weaker readers in the BCR portion of the comprehension task. Indeed, Figure 4 suggests that low-comprehenders made no progress over time, perhaps cancelling out any progress made by middle-and high-comprehenders.

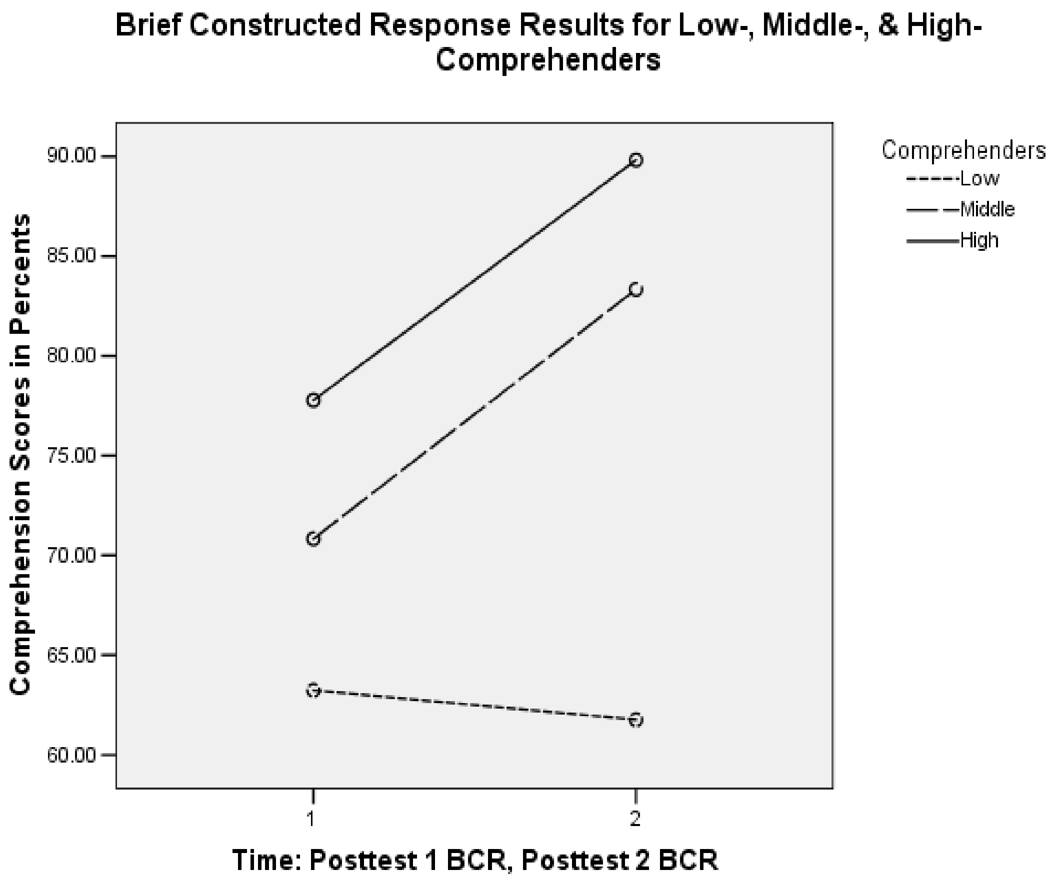
Table 12

Descriptive Data: Brief Constructed Response Results for Low-, Middle-, and High-Comprehenders

Time	***Low-Comprehenders*** *n = 17*		***Middle-Comprehenders*** *n = 12*		***High-Comprehenders*** *n = 27*	
	Score	SD	Score	SD	Score	SD
Posttest 1 BCR	63.24	25.18	70.83	20.87	77.78	18.78
Posttest 2 BCR	61.76	30.77	83.33	19.46	89.82	12.51

Figure 4

Brief Constructed Response Results for Low-, Middle, and High-Comprehenders



Results for Question 3

Are there relationships between the variables of comprehension achievement, vividness of mental imagery, motivation to read, and type of comprehenders? To investigate the relationships between the variables of comprehension achievement, vividness of mental imagery, and motivation to read for each type of comprehender, the Pearson product-moment correlation coefficient was used. The variable selected for reading comprehension at the beginning of the study was the *Gates-MacGinitie Reading Test* (2000) since it is recognized as a reliable and valid measure for overall reading achievement. The second variable selected for this analysis was the *Sheveland Vividness of Mental Imagery Questionnaire* (1992) pretest because the scores represented students' self-reported ratings of the vividness of the images they formed in their minds prior to the investigation. The third variable selected for this analysis was the *Motivation to Read Profile* (Gambrell et al., 1996) pretest as it reported students' value of reading and motivations for reading before this study. The variables were correlated with the three levels of comprehenders. Preliminary analyses were performed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity. Descriptive data are presented in Table 13. The numbers for this analysis were smaller than the numbers of students who participated due to missing *Gates-MacGinitie Reading Test* data on several students.

Table 13

Descriptive Data for Reading Achievement, Imagery, and Motivation for Levels of Comprehenders

Measures	***Low-Comprehenders*** n = 11		***Middle-Comprehenders*** n = 11		***High-Comprehenders*** n = 24	
	Mean	SD	Mean	SD	Mean	SD
Gates-MacGinitie Reading Test	48.75	6.71	77.27	7.20	96.88	5.28
Vividness of Imagery	76.99	19.32	84.79	11.96	87.78	9.03
Motivation to Read	64.22	11.02	60.84	14.39	76.58	10.12

A multiple comparison test Tukey HSD (Pallant, 2005, pp. 199-228) was used to determine the means between which statistically significant differences existed. Table 14 presents the comparison results for the variables reading achievement, vividness of mental imagery, and motivation to read for three levels of comprehenders.

Table 14

Post Hoc Analysis: Comparison of Variables for Three Levels of Comprehenders

Dependent Variable	***Comprehenders***	***Compared with Comprehenders***	***Mean Difference***	***Std. Error***	***Sig.***
Reading Achieve-ment	Low-	Middle-	-28.52(*)	2.42	.000
		High-	-48.13(*)	1.99	.000
	Middle-	Low-	28.52(*)	2.42	.000
		High-	-19.60(*)	2.25	.000
	High-	Low-	48.13(*)	1.99	.000
		Middle-	19.60(*)	2.25	.000
Vividness of Mental Imagery	Low-	Middle-	-7.80	5.33	.318
		High-	-10.79(*)	4.40	.046
	Middle-	Low-	7.80	5.33	.318
		High-	-2.99	4.96	.819
	High-	Low-	10.79(*)	4.40	.046
		Middle-	2.99	4.96	.819
Motivation to Read	Low-	Middle-	3.38	4.47	.731
		High-	-12.36(*)	3.68	.004
	Middle-	Low-	-3.38	4.47	.731
		High-	-15.74(*)	4.15	.001
	High-	Low-	12.36(*)	3.68	.004
		Middle-	15.74(*)	4.15	.001

* The mean difference is significant at the .05 level.

Results indicated that the differences in reading achievement mean scores for the three levels of comprehenders based on the *Gates-MacGinitie Reading Test* were statistically significant. Furthermore, low-comprehenders had statistically significant lower mean scores on the *Motivation to Read Profile* and the *Sheveland Vividness of Imagery Questionnaire* when compared to the mean scores of the high-comprehenders. However, their mean scores on the *Motivation to Read Profile* and the *Sheveland Vividness of Imagery Questionnaire* did not show statistically significant differences when compared to the mean scores of the middle-comprehenders. The difference in mean scores on the *Sheveland Vividness of Imagery Questionnaire* between middle-comprehenders and the other two types of comprehenders was not statistically significantly; however, the difference in mean scores on the *Motivation to Read Profile* when comparing scores of the middle-comprehenders to the scores of the high-comprehenders was statistically significant. High-comprehenders' mean scores on the *Gates-MacGinitie Reading Test* and *Motivation to Read* were higher when compared to the mean scores of the other two types of comprehenders and the differences were statistically significant.

Table 15 shows the correlations results between measures for the low-comprehenders' group [n = 11]. There were no statistically significant correlations between reading achievement, vividness of mental imagery, and motivation to read [$r = .381$, $p = .146$; $r = .279$, $p = .295$]. There was also no statistically significant correlation between students' scores on vividness of imagery and motivation to read for the low-comprehenders [$r = .419$, $p = .106$].

Table 15

Pearson Product-Moment Correlations between Measures for Low-Comprehenders (n = 11)

Measures	1	2
(1) Gates-MacGinitie Reading	—	
(2) Vividness of Imagery	.381	—
(3) Motivation to Read	.279	.419

Table 16 shows the correlations results between measures for the middle-comprehenders' group [n = 11]. There were no statistically significant correlations between reading achievement, vividness of mental imagery, and motivation to read [*r* = -.098, *p* = .775; *r* = .424, *p* = .194]. However, for this group of students, there was a statistically significant, positive correlation between the two variables vividness of imagery and motivation to read [*r* = .675, *p* = .023], with more vividness of mental imagery associated with more motivation to read.

Table 16

Pearson Product-Moment Correlations between Measures for Middle-Comprehenders (n = 11)

Measures	1	2
(1) Gates-MacGinitie Reading	__	
(2) Vividness of Imagery	-.098	__
(3) Motivation to Read	.424	.675*

* p < .05

Table 17 shows the correlations results between measures for the high-comprehenders' group [n = 24]. There was a statistically significant, negative correlation between reading achievement and vividness of mental imagery [*r* = -.535, *p* = .007], with higher scores on reading achievement associated with lower levels of mental imagery. There was no statistically significant correlation between reading achievement and motivation to read [*r* = .173, *p* = .419]. For the high-comprehenders, there was also no statistically significant correlation between the two variables--vividness of imagery and motivation to read [*r* = .061, *p* = .776].

Table 17

Pearson Product-Moment Correlations between Measures for High-Comprehenders (n = 24)

Measures	1	2
(1) Gates-MacGinitie Reading	—	
(2) Vividness of Imagery	-.535**	—
(3) Motivation to Read	.173	.061

** p <.01

Results for Question 4

Is motivation to read improved after mental imagery instruction using science expository texts? To answer this question, a mixed between-within subjects 2 X 2 analysis of variance (ANOVA) was conducted to compare groups over time. The between-subjects factor was the group (experimental group vs. comparison group): the experimental group had 25 students, comprised of students in Class One (a class with low-comprehenders) and Class Three (a class with mostly high-comprehenders); the comparison group had 31 students, comprised of students in Class Two (a class with mostly middle-comprehenders) and Class Four (a class with mostly high-comprehenders). The within-subject or repeated factor was time-- the students were measured using the *Motivation to Read Profile* (Gambrell et al., 1996) at two different intervals: Time 1 (prior to the intervention) and Time 2 (following the intervention).

The means and standard deviations for students' scores on the *Motivation to Read Profile* are reported on Table 18. Results indicated that there was no statistically significant interaction for time and group [Wilks' Lambda = 1.000, F (1, 53) = .003, p =.957, partial Eta squared = .000]. In addition, the main effect result for time did not reach statistical significance [Wilks' Lambda = .996, F (1, 53) = .003, p =.648, partial Eta squared = .004], nor was the main effect for group statistically significant [F (1, 53) = 1.599, p =.212, partial Eta squared = .029].

Figure 5 shows a graph of the non-statistically significant interaction for time and group on motivation to read. The experimental group was comprised of 11 low-comprehenders, 2 middle-comprehenders, and 12 high-comprehenders. The comparison group was comprised of 6 low-comprehenders, 10 middle-comprehenders, and 15 high-comprehenders.

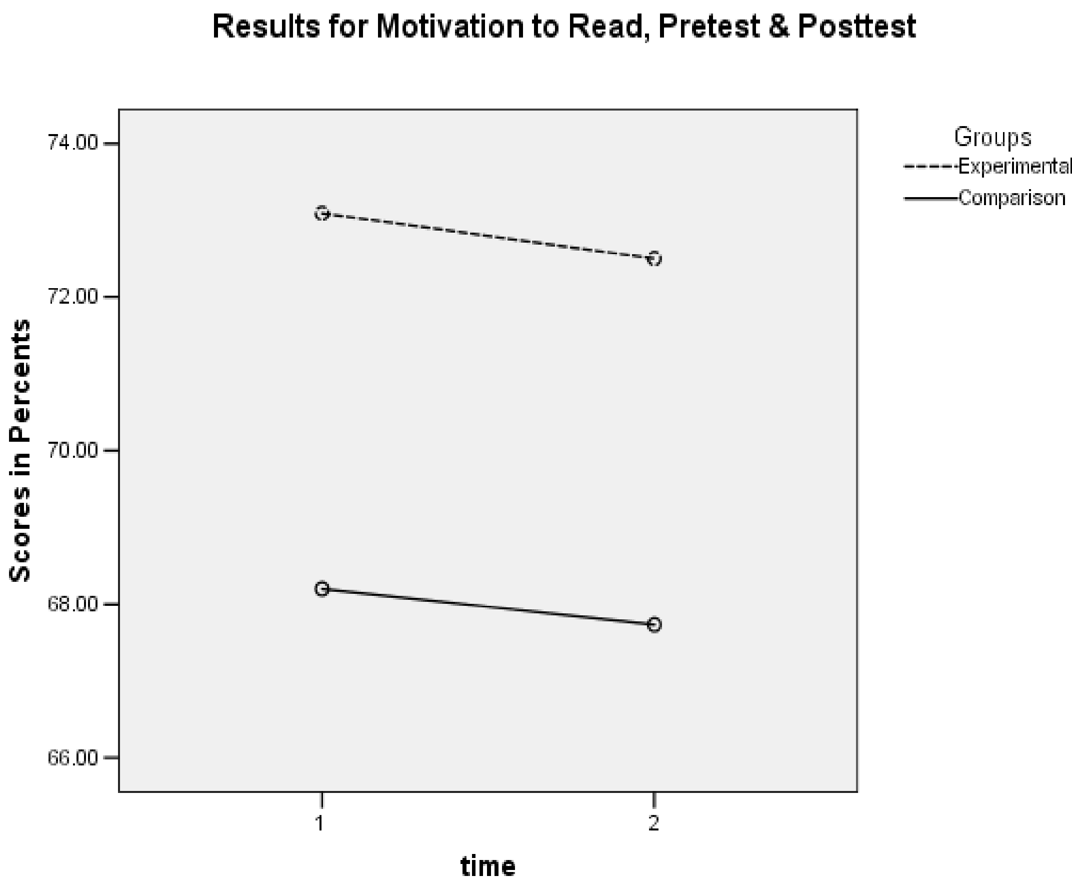
Table 18

Motivation to Read Profile Pre-& Posttest Results

Time	***Experimental Group*** n = 25		***Comparison Group*** n = 31	
	Mean Score	SD	Mean Score	SD
Pretest	73.09	12.47	68.20	13.91
Posttest	72.50	14.73	67.73	17.05

Figure 5

Motivation to Read Profile Pre- and Posttest Results



Summary

This chapter presents data and analysis of the results regarding using mental imagery instruction with middle school students reading expository texts. Data analyses revealed a statistically significant interaction for time and group on the selected response (SR) portion of the comprehension task. Both experimental and comparison groups appeared to make gains between Posttest 1 and Posttest 2, once both had received mental imagery instruction. Although both groups improved, the comparison group, which by chance consisted of stronger readers, appeared to outperform the experimental group. There were no statistically significant effects for the brief constructed response (BCR) portion of the comprehension task.

Data analysis on the performance of low-, middle-, and high-comprehenders revealed statistically significant main effects for time and for type of comprehender on the SR portion of the comprehension task, but no interaction. While all students appeared to make gains between Posttest 1 and 2, the high- and middle-comprehenders consistently outperformed the low-comprehenders. For the BCR portion of the task, there was no statistically significant effect for the interaction or for the main effect of time. However, the tests of between-subjects effects indicated that the three levels of comprehenders performed differently. Thus, level of comprehension was a factor affecting students' SR and BCR performance.

Correlation analysis revealed that there were no statistically significant relations between reading achievement, vividness of mental imagery, and motivation to read for low-comprehenders, who scored significantly lower on all three measures when their scores were compared to the scores of the high-comprehenders. There was a statistically significant correlation between the vividness of mental imagery scores and the motivation to read scores for the middle-comprehenders, with higher vividness of metal imagery scores associated with higher motivation to read scores. For the high-comprehenders, the only statistically significant correlation was their reading achievement and vividness of mental imagery, which was negatively related–with higher reading achievement associated with lower vividness of mental imagery scores. Results also indicated that there was no statistical significance when comparing motivation to read scores before and after mental imagery instruction using science expository texts.

CHAPTER V

DISCUSSION

Introduction

This chapter is organized into five sections. The first section summarizes the study rationale, purpose, questions, and methodology. The second section reviews the results and information regarding the statistical findings and interpretations of these findings. The third section presents study conclusions and implications. Section four follows with an analysis of the limitations of the investigation. The last section, section five, presents recommendations for future research.

Study Summary

Past studies of mental imagery have provided information about its importance as well as the possibilities of using it in various ways to enhance comprehension and memory. Mental imagery has been mainly used with narrative texts, as the major studies show. Mental imagery has also been studied more in the elementary grades than middle school or high school. Several past studies provided limited mental imagery instruction for students, and few studies have extended instruction beyond one session. Even more limited are the mental imagery studies that engage middle school students reading science expository texts. For instruction, some researchers simply mentioned to the participants to create pictures in their minds and did not provide instruction on how to actually create such images. The purpose of this study was to investigate the effects of mental imagery instruction using expository texts with middle school students. This study provided two weeks of instruction for the students, one class period each day (45 minutes), with a total of 450 minutes.

Using a quasi-experimental design, four intact classes were randomly assigned to be in either a treatment or comparison group. During the course of this study, four main research questions were investigated: (a) What are the effects of mental imagery strategies on students' reading comprehension when they read science expository texts? (b) How do the low-, middle-, and high-comprehenders compare in their reading achievement after mental imagery instruction? (c) Are there relations between the variables of reading comprehension, vividness of mental imagery, and motivation to read for low-, middle- and high-comprehenders? (d) Is motivation to read improved after mental imagery instruction using science expository texts?

Seven measures were used to obtain data on students' performance on reading comprehension, motivation to read, and ability to create mental imageries. These measures were the *Gates-MacGinitie Reading Test* (2000), the *Motivation to Read Profile* (Gambrell et al., 1996), the *Sheveland Vividness of Imagery Questionnaire* (1992), the Expository Pretest “Crocodiles and Alligators,” Posttest 1A “Octopus and Squid,” Posttest 1B “Poisonous and Nonpoisonous Snakes of America,” and Posttest 2 “Butterflies and Moths.”

Statistical analyses of the data varied according to the questions, the measures, and the group of students being analyzed. A mixed between-within subjects 2 (group: experimental vs. comparison) X 3 (time: Time 1 before intervention, Time 2 following intervention, and Time 3 at the end of the year) ANOVA was used to compare reading comprehension scores using expository texts on the groups of students over time. A mixed between-within subjects 3 (three levels of comprehenders) X 2 (Time 1 at Posttest 1, and Time 2 at Posttest 2) ANOVA was used to analyze the effects of treatment and the three reading competency levels. Effect sizes were calculated to support the interpretation of the statistical results. Pearson's correlations were calculated to find the relations between reading achievement, vividness of mental imagery, and motivation to read for low-, middle-, and high-comprehenders. To compare the effects of mental imagery instruction on motivation to read for the three levels of comprehenders, a mixed between-within subjects, 2 (group) X 2 (time), analysis of variance was used.

Review of Results

Initial testing using the *Gates-MacGinitie Reading Test* (2000) indicated that the reading performance of the students varied by classes. Class One, experimental group, was a Below-grade-level class. This class was set up to be a Basic class with a small class size (only 14 students). Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for Class One was 3.4. Of the class, 11 students participated in this study. Class Two, comparison group, was an On-grade-level class with a total number of 23 students. Of the group, 19 students participated in the study. Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for participants in Class Two was 6.35. Class Three was an Honors class of 24 students. Of this group, 14 students participated. Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for participants in Class Three was 11.5. Class Four was an Honors class of 20 students. Of this group, 12 students participated in the study. Based on the *Gates-MacGinitie Reading Test* (2000), the mean reading grade level equivalence for participants in Class Four was 9.46.

Some students chose not to participate or their parents did not sign a permission form for them to participate. These students' scores were not included in the analyses even though these students received the same treatment in the classroom. All data reporting on these classes reflected only the scores of students who agreed to participate and whose parents agreed for them to participate. Participation in this study meant allowing the scores to be used for analysis. The total number of participating students was 56 students.

Students' Performance on Comprehension for Expository Text

The Effects of Mental Imagery Instruction

Four comprehension tests using science expository texts provided pretest and posttest data for this group of middle school students. These comprehension tests were furthermore divided into two portions: Selected Response (SR) and Brief Constructed Response (BCR) or short essay. To investigate the effects of mental imagery instruction on middle school students, a mixed between-within subjects 2 (experimental vs. comparison) X 3 (Time 1, Time 2, Time 3) ANOVA was conducted. Results for the SR portion of the expository reading comprehension test indicated that there was a statistically significant interaction for group and time. The mean scores for the experimental group went from 67.60% on the Pretest to 68.40% on Posttest 1, and then to 74% by Posttest 2. The experimental group received mental imagery instruction between the Pretest and Posttest 1. The mean scores for the comparison group, which received mental imagery instruction after Posttest 1 in the third quarter of the school year, went from 73.87% on the Pretest to 77.74% on Posttest 1, and then to 92.90% by Posttest 2.

It is important to note that the two groups were quite different since intact classes were randomly assigned to be in these groups. As noted in Chapter IV, the experimental group had 11 low-, 2 middle-, and 12 high-comprehenders. The comparison group had no low-comprehenders at all, but had 10 middle- and 15 high-comprehenders. Indeed, as can be seen in Figure 1, the graph of the interaction of time and group for SR, the comparison group scored higher than the experimental group initially and for both posttests. The comparison group-- with stronger readers--appeared to have responded well to imagery instruction once they received it after Posttest 1. Between Posttest 1 and Posttest 2, both groups improved on SR, with the comparison group showing more improvement, as reflected in the statistically significant interaction.

Since the posttests were written on sixth-grade level, the low-comprehenders, who were reading on a third-grade reading level (based on the *Gates-MacGinitie Reading Test*, 2000), probably had difficulties understanding the passages and responding to the comprehension questions. These low-comprehenders, all in the experimental group, may have needed a longer time to learn how to effectively use mental imagery strategies with expository texts that were challenging to them. Hence, there was little change on SR from the Pretest to Posttest 1 for the experimental group. Nevertheless, by Posttest 2, both groups of students appeared to have made gains in the SR portion of the test. Other factors such as maturity may also have influenced higher comprehension scores by the end of the school year; however, mental imagery strategies were the target for these classes from the time following the intervention to the end of the school year, and the moderate effect size– very close to large (η_p^2 = .137) as indicated by the analysis– showed that the gain was probably not due to chance alone. While other studies in the field may find mental imagery to be a "quick-fix," this study revealed that using mental imagery with science expository text may take more than two weeks to be effective.

In contrast to the SR score results, results for the short essay or BCR portion of the test showed no statistically significant gain for either group. For the experimental group, the BCR mean scores over the three measured times were 68.00%, 69.00%, and 81.00%. Even though the scores appeared to have risen 13 percentage points, the result was not statistically significant. The standard deviation varied from 33.48, 24.24, to 25.29. This indicated that students were scoring in a wide range and were not scoring consistently as a group. While some students improved greatly, there were those who scored low.

The BCR results for the comparison group also showed no statistically significant gains. The BCR scores for the three measured times were 79.84%, 74.19%, and 79.03%. It appears that mental imagery strategies did not help students improve their reading comprehension score when asked to express their understanding in essay format.

The Effects of Mental Imagery Instruction on Low-, Middle-, and High-Comprehenders

Past research has indicated that mental imagery may benefit the low readers in particular. This study provided some data and insight regarding the effects of mental imagery instruction for low-, middle-, and high-comprehenders using expository texts. A mixed between-within subjects 3 (three levels of comprehenders– low-, middle-, and high-) X 2 (time– Time 1, Time 2) ANOVA was conducted to analyze the data.

For this analysis, the between-subject factor was the type of comprehender (low-, middle, and high-comprehenders). To categorize students into the three levels of comprehenders, students' reading achievement levels on the *Gates-MacGinitie Reading Test* (2000) and state reading assessment scores were reviewed. Students who scored in the grade equivalence range of 4.9 and below on the *Gates* test and in the “Basic” range on the state reading assessment were considered low-comprehenders. Students who scored in the grade equivalence range of 5.0 to 7.5 on the *Gates* test and in the “Proficient” range on the state assessment were considered middle-comprehenders. Students who scored in the grade equivalence range of 7.5 and above on the *Gates* test and in the “Advanced” range on the state assessment were considered high-comprehenders. Students whose scores vary greatly between the two measures were considered on an individual basis, where classroom performance and teacher input would also be considered when placing a student in a category. For example, a student who scored “Advanced” on the state test but scored at a 4.6 grade equivalence on the *Gates-MacGinitie* test may be categorized as a middle-comprehender when this student’s overall performance in the classroom was also considered. In addition, the information was cross-referenced with students' state testing scores from the previous school year as well as teacher input when current state test scores were not available. The following were numbers of low-, middle-, and high-comprehenders in each class who participated in the study: Class One experimental group-- 11 low-comprehenders (n = 11); Class Two comparison group--

6 low-, 9 middle-, and 4 high-comprehenders (n = 19); Class Three experimental group-- 2 middle- and 12 high-comprehenders (n = 14); Class Four comparison group-- 1 middle- and 11 high-comprehender (n = 12). The total numbers for the three types of comprehenders are as follows: low-comprehenders, n = 17; middle-comprehenders, n = 12; and high-comprehenders, n = 27. Based on the Gates-MacGinitie Reading test (2000), the average reading grade equivalency for these students were 3.24 for the low-comprehenders, 6.45 for the middle-comprehenders, and 10.55 for the high-comprehenders.

The within-subject factor for this analysis was time. Time 1 refers to the time students took Posttest 1. At that time, only students in the experimental group had received mental imagery instruction. After Posttest 1, students in the comparison group also received mental imagery instruction. Throughout the rest of the school year, all students were prompted at least two to three times a week to use mental imagery strategies. Time 2 refers to the time when students took Posttest 2, which was at the end of the school year.

Statistical analysis of the SR data indicated no significant interaction effect; however, there was a statistically significant main effect for time as well as a statistically significant main effect for type of comprehender. An inspection of the SR data suggests that while all students appeared to make gains by Posttest 2, the high-comprehenders outperformed the middle-comprehenders on both tests (high-comprehenders Posttest 1 M = 87.41%, Posttest 2 M = 98.15%; middle-comprehenders Posttest 1 M = 77.5%, Posttest 2 M = 93.33%), and the middle-comprehenders outperformed the low-comprehenders on both tests (middle-comprehenders Posttest 1 *M* = 77.5%, Posttest 2 *M* = 93.33%; low-comprehenders Posttest 1 *M* = 48.82%, Posttest 2 *M* = 56.47%). (For details, refer to data Table 11 and the graph in Figure 3). Mental imagery instruction using science expository texts appeared to work for the different levels of comprehenders, and the large effect size (η_p^2 = .283) suggests that the gains were probably not due to chance. In addition, it is noteworthy that after mental imagery instruction, the middle-comprehenders performed better than high-comprehenders before mental imagery instruction (the SR mean score for Posttest 2 for middle-comprehenders was 93.33%, while the SR mean score for Posttest 1 for high-comprehenders was 87.41%). The middle-comprehenders' Posttest 2 SR mean score was also close in range to the high-comprehenders' Posttest 2 SR mean score (middle-comprehenders 93.33% and high-comprehenders 98.15%). Although the low-comprehenders seemed to have made some gains after mental imagery instruction, their mean score for Posttest 2 was at 56.47%. When that score is compared to the 93.33% for middle-comprehenders and 98.15% for high-comprehenders, it suggests that they probably needed more support. These readers would most likely have benefitted from texts on their own reading level, additional instruction in areas such as vocabulary, and perhaps even word analysis.

The analysis for the BCR portion of the reading task showed no statistically significant effects for interaction and time; however, tests of between-subjects effects indicated a statistically significant effect for type of comprehender. For example, the Posttest 2 BCR mean scores for low-, middle, and high-comprehenders were 61.76%, 83.33%, and 89.82% respectively. It may be concluded that students with different levels of comprehension performed differently on their short essay answers. (For more details, refer to data Table 12 and the graph in Figure 4.) The findings suggest that mental imagery strategies alone may not be sufficient to help students improve their brief constructed responses. In addition to comprehension strategies, students may need more support to help them write proficient short essay answers.

Relations between Variables

Past studies noted that students who scored high on comprehension tests also reported more vivid mental imagery and more frequent use of mental imagery. Other studies have noted that students who had more vivid imagery had better attitude and more motivation to read. This study also explored the relationships between the variables of comprehension achievement, vividness of mental imagery, and motivation to read. Data collection for this part of the study included scores from the *Gates-MacGinitie Reading Test* (2000), the *Sheveland Vividness of Imagery Questionnaire* (1992) pretest, and *Motivation to Read Profile* (Gambrell et al., 1996) pretest. The Pearson product-moment correlation coefficient was used to investigate the relationship between the variables and the three types of comprehenders (low-, middle-, and high-).

Results indicated that for the low-comprehenders, there were no statistically significant correlations between reading achievement, vividness of mental imagery, and motivation to read. These students scored significantly lower on all three measures when compared to the high-comprehenders. Results of this study also show that poor readers have less vivid mental imagery than good readers. The findings of this study echoed the findings of prior research (Gambrell et al., 1980), which noted that below-average readers were less capable of inducing mental imagery when compared to the above-average readers.

For the middle-comprehenders, there were no statistically significant correlations between reading achievement, vividness of mental imagery, and motivation to read; however, there was a statistically significant, positive correlation between vividness of mental imagery and motivation to read [$r = .675$, $p = .023$]. This indicated that more vividness of mental imagery is associated with more motivation to read. This finding is consistent with Gunston-Park's study (1985) as well as Macomber's study (2001). Both studies reported that vividness of imagery is associated with better attitudes and motivation towards reading.

For the high-comprehenders, there was no statistically significant correlation between reading achievement and motivation to read. There also was no statistically significant correlation between vividness of mental imagery and motivation to read. However, there was a statistically significant, negative correlation between reading achievement and vividness of mental imagery, with higher reading achievement scores related to lower vividness of mental imagery scores [$r = -.535$, $p = .007$]. The high-comprehenders' mean score for vividness of mental imagery was 87.78%, which was significantly higher than the scores for the low-comprehenders [mean score 76.99%], but it was not significantly different than the scores of the middle-comprehenders [mean score 84.79%]. It is likely that the high-comprehenders have other reading strategies they call upon and they do not completely rely on vividness of mental imagery to make sense of the text and answer questions. This condition was discussed in Oakhill and Patel's study (1991). Oakhill and Patel suggested that good readers might have other efficient strategies for putting what they have read into meaningful context and remembering information from text.

The findings of this study are somewhat similar to part of the conclusions of Cramer's study (1982), which indicated that students who used lots of imagery scored best on comprehension and also had the best attitude towards reading. The correlation analyses of this study supported the findings of previous studies that good readers perform better on expository tests and have more vivid imagery. Good readers are also more motivated to read (Macomber, 2000).

Mental Imagery Instruction and Motivation

Prior studies in the field indicated that some students had more motivation to read after mental imagery instruction (Hibbing & Rankin-Erickson, 2003). This study employed a mixed between-within subjects 2 (groups: experimental vs. comparison) X 2 (time: Time 1, Time 2) analysis of variance to compare groups over time. Time 1 refers to the time when students took all the Pretests, including the *Motivation to Read Profile* (Gambrell, Palmer, Codling, & Mazzoni, 1996). After a two-week intervention period for the experimental group (in which students received mental imagery instruction) and a practice period for the comparison group (in which no mental imagery instruction was given), students took the *Motivation to Read Profile* again as a Posttest. Results indicated that there was no statistical significance for any variance between the *Motivation to Read Profile* pretest and posttest scores. In this study, the students did not show more motivation to read on this measure after mental imagery instruction using science expository texts. The reasons for this were not understood. Could it be that students did not find expository texts interesting and therefore they were not more motivated to read after the intervention? If they used narrative texts, would the results be similar? Could it be that the task was perceived as just another classroom reading unit, and not very motivating at all? Were there other values that affected this particular group of students? These questions could not be answered based on the results of this study, but may be possible ideas for future investigations.

Study Conclusions and Implications

In recent years, educators have been clamoring for “balanced instruction” (Rasinski & Padak, 2004) in which students are expected to both learn to read and read to learn. However, this type of knowledge acquisition necessitates attention to expository texts (Dreher, 2000). The mental imagery strategies used in this study appeared to be effective for middle school students reading science expository texts answering selected response questions. Results also indicated that mental imagery appeared to be more effective for the average and above-grade-level middle school students when they read science expository texts and answered selected response questions. The below-grade-level students appeared to have made some improvements, but they were consistently outperformed by the other two groups. This conclusion is different from Oakhill and Patel's study (1991), in which students with low reading achievement benefitted the most from imagery instruction. A major difference between the two studies is that this study investigated middle school students reading science expository texts whereas Oakhill and Patel's study involved elementary students reading narrative texts.

The students in the experimental group also performed better on Posttest 2 (given at the end of the year) when compared to Posttest 1 (following the two-week intervention). While these students appeared to have made some small improvements after two weeks of mental imagery instruction, it was by the end of the school year when they demonstrated the most gain. These findings imply that the use of mental imagery strategies with science expository texts should be a long-term process and not a “quick-fix.”

To contextualize the use of mental imagery for students while reading expository texts, the following instructional strategies appeared to be effective in the classroom:

1. *Prompting students to use visualization with the text:*

   Many students respond to sight, and generally will respond when prompted to create a picture in the mind's eye. This recommendation is consistent with the instructional method used in several prior studies (Finch, 1982; Gambrell, Koskinen, & Cole, 1980; Pressley 1975).

2. *Guiding students to draw diagrams and pictures may help them with the understanding of the text:*

   Self-generated pictures and diagrams have been useful in many classrooms. This method was used partly by Rose, Parks, Androes, and McMahon (2000) and Hibbing and Rankin-Erickson (2003).

3. *Guiding students to make metacognitive connections with the text by activating all the sensory modalities:*

Students can make connections with the text when prompted to link the text to something they have experienced. The recall of personal images and events activates all of their sensory modalities. This strategy was also used by Douville and Algozzine (2004) in a model they termed as SAM, or sensory activated model.

4. *Asking students to use think-along ideas (oral or written) while using imagery:*

   Also known as think-aloud think-along, this strategy is effective because it helps students use the strategies of predicting, questioning, clarifying, summarizing, and making personal connections. This strategy was used by researchers such as Davey (1983), Farr (1997), and Olshavsky (1976). In addition to responding aloud, having students write down their think-along ideas was found to be a very effective classroom practice that engages all students.

5. *Creating a sensory chart:*

   A sensory chart or some form of graphic organizer is useful as an alternate way to let students select information from the text that may be linked to specific images. Charts and organizers have been known to be effective ways to organize concepts from text, especially for content fields such as science and social studies (Bean, Valerio, & Stevens, 1999). The use of sensory charts may be useful to help students comprehend specific elements and make connections with the text. (A sample sensory chart titled “Images Chart” is included in Appendix E.)

6. *Using visual-cue vocabulary cards to enhance vocabulary:*

   Whether called LINCs (Ellis, 2004) or visual-cue cards (Bean, Valerio, & Stevens, 1999; Readence, Bean, & Baldwin, 1998), this strategy helps students learn and remember important vocabulary words. To create a visual-cue vocabulary card, students have to write the vocabulary word, copy definitions, create their own reminding words, draw their own pictures, and write their own sentences using the vocabulary words. Furthermore, having students share with the class makes the vocabulary words more memorable because of the repetition as well as the presentation of other imaginable scenarios that students share using the same word.

Analysis of the Limitations

One limitation of this study was that the sample size was relatively small, not large enough to analyze data for all the subgroups. In addition, the way these students disperse ability-wise did not follow the normal curve. When these 56 students were examined by ability groupings, 11 students were categorized as low-comprehenders (30.36%), 12 students as middle-comprehenders (21.43%), and 27 students (48.21%) as high-comprehenders. It would have been more ideal to have a larger number of middle-comprehenders, but those classes with many middle-comprehenders were taught by two other teachers in the school not involved in this study.

Furthermore, this study adopted a quasi-experimental design, with the sampling population from one school only, which further limits the variability of the population. The students were from a suburban middle school, with students in the free and reduced lunch program at 20%; therefore, it was most likely that the results may not be generalized to a different population with higher or lower free and reduced lunch status. However, the school, as a microcosm, did resemble the state where it was located. For example, in reading achievement, the school also scored similar to other schools across the nation. Using the 8^{th} grade NAEP scores in Reading, the mean score of this school was around 32% at or above the proficient level, which was similar to the state and nation in which it is located. Therefore, it is possible that successful intervention methods for this school may also be successful elsewhere.

Recommendations for Future Research

The field of reading comprehension research using mental imagery for expository text is open for new ideas. There is still much that we do not know. For example, how much scaffolding would students need if they were in the low-comprehenders group and they needed to be brought up to on-grade-level performance? What type of imagery instruction would best suit them? This study used passages that were written on 6^{th} grade readability level, but the students reading below-grade-level had a difficult time with them. It would be beneficial to know how low-comprehenders would perform if they had text passages that matched their reading ability. It would also be interesting to know if they would perform well if the passages progressively increased in difficulty (based on readability). Future research may include dividing students into subgroups and have varying levels of reading materials for them to use, with the target of using imagery to improve their comprehension so that they may be reading on the level of their grade placement as soon as possible.

Another investigation could involve imaginable text and dealing with texts that may be considered unfriendly for imagery. For example, an analysis of students' basal readers as well as science and social studies textbooks for imaginable features may shed light into the materials they are currently reading in school. Research can also bring this one step further and devise ways to help students create imagery and make connections even with texts that are typically unfriendly for imagery.

Many questions remain unanswered. Do students use more vivid mental imagery with narrative text than with expository texts? Are there relations between age and gender and the use of mental imagery with science expository text? Young readers seem to delight in books that are scientific. For example, many children are curious about the world, the planets, the animals, computers, and other technological items. When and why do some students perceive science texts to be difficult? Do students change their interests over time or are the science textbooks too boring? These are questions that require new investigations. Case studies of students using mental imagery as a comprehension strategy would also be enlightening.

This study also revealed that good readers do not totally rely on mental imagery as a comprehension strategy; so what are some other strategies these students use? Furthermore, it would be interesting to find out whether students could create more images with narrative or expository texts if the passages were matched for imagery-evoking words. Would students be more motivated to read after mental imagery instruction with one type of text versus another? Does gender play a part in the preference? Future research involving a larger, more diverse sample could allow for analysis involving subgroups with more students.

In this study, students did not show more motivation to read after they were taught mental imagery strategies. Could this result be due to the fact that the students read expository texts for this study? Do more students prefer narratives and find science expository texts less engaging? If they had read narratives instead of expository texts, would there be an increase in motivation to read? What about ways to improve the brief constructed response? These questions are beyond the scope of this study, and may be good topics to explore in future research.

Although this study provides a bit more information to the vast field of reading research, it is my hope that more research will be conducted using strategies that may be classroom friendly for expository text, giving more students a boost in reading achievement, perhaps equipping these students with something extra when they face expository texts in science class, in reading class, on county benchmark tests, on the state tests, and one day, in real life or work situations.

Appendix A

Model for Imagery Instruction

<table>
<tr><td colspan="2" align="center">Parent & Subject Consent Forms</td></tr>
<tr><td colspan="2" align="center">Gates-MacGinitie Reading Test (2000)</td></tr>
<tr><td colspan="2" align="center">Motivation to Read Profile (Gambrell et al., 1996)</td></tr>
<tr><td colspan="2" align="center">Sheveland Vividness of Imagery Questionnaire (1992)</td></tr>
<tr><td colspan="2" align="center">Expository Text Pretest: “Crocodiles and Alligators”</td></tr>
<tr><td>Experimental Group: Two Classes
● 5 sets of expository passages with imagery instruction (10 days)</td><td>Comparison Group: Two Classes
● 5 sets of expository passages with NO imagery instruction (10 days)</td></tr>
<tr><td colspan="2" align="center">Expository Text Posttest 1: “Octopus and Squid” or “Poisonous and Nonpoisonous Snakes of America”</td></tr>
<tr><td colspan="2" align="center">Motivation to Read Profile (Gambrell et al., 1996)</td></tr>
<tr><td colspan="2" align="center">Sheveland Vividness of Imagery Questionnaire (1992)</td></tr>
<tr><td>Experimental Group would continue to use strategy in the regular classroom</td><td>Comparison Group would be instructed in imagery strategies.
● Imagery instruction (10 days) and ongoing practice in classrooms</td></tr>
<tr><td>Sequential Sampling: Expository Posttest 2: “Butterflies and Moths”</td><td>Sequential Sampling: Expository Posttest 2: “Butterflies and Moths”</td></tr>
</table>

Appendix B

Passage 1

The Mariana Trench

Have you wondered what is the deepest point in the oceans? It is known as the Mariana Trench. It is located in the Pacific Ocean near the Mariana Islands east of Japan. It is 11,033 meters (36,201 feet) below sea level. To picture how deep this is, imagine setting Mount Everest (8850 meters), the tallest point in the world, into the Mariana Trench, and there would still be 2183 meters of water left above it.

Scientists believe that the earth's surface can be divided into several sections or plates called **tectonic plates**. When one tectonic plate is **subducted** or sank beneath another, a deep valley called a trench forms at the boundary. The scientists believe that the Mariana trench is formed that way.

The Mariana Trench was discovered in 1951. A British research ship was charting the Pacific ocean floor using echo sounders. These instruments bounce signals off the ocean floor. For a while, they were showing depths between two to three miles. Then all of a sudden, they showed a depth of almost seven miles. This surprised the scientists. Even the Grand Canyon is only one mile deep. The scientist named this deep underwater valley the Mariana Trench. The scientists found that the Mariana Trench is really made up of a long **chain** of trenches. All the trenches are very narrow, dark, and deep. The water is very cold there. Because it is so deep, the water pressure is very heavy, about eight tons of pressure per square inch.

Since the Mariana Trench is so cold, dark, and has such heavy water pressure, can anything live there? In 1960, the US Navy sent two people to find the answer to this question. They went down to explore the Mariana Trench in a special underwater vessel called a **submersible**. It was designed to take the heavy water pressure at those depths. After they went down to the bottom of the trench floor, they turned on a high power search light. They looked through a port hole and saw fish swimming by. The fish in the deep trench did not look exactly like regular fish. Some of them have glowing parts. Others have very large mouths. Some were angler fish that used a glowing lure to catch other fish as food. Most of them were less than one foot long. There were also bacteria and other micro organisms that lived there. Their trip took nine hours, but it showed that life does exist down in the deepest trench.

In 1995, a Japanese unmanned submersible went down the Mariana Trench to study more. The vessel had bright flood lights and was guided by a computer positioning system. Cameras took videos of life in the dark trenches. Scientists found that the ocean floor had **hydrothermal** (hot water) **vents** formed by the cracks of the tectonic plates. These vents were like chimneys on the ocean floor. Smoke came out, releasing hydrogen sulfide and other minerals. The vents may be as hot as 300 degrees Celsius (572 degrees Fahrenheit). The heat of these vents warms the surrounding water. A special kind of deep sea crab called the Vent Crab likes to live near the vents. There are also tube worms. The water gets colder further away from these vents. Different types of plant and animal life live in different temperatures. Nearly 5000 new species of sea creatures were discovered.

Part A: Questions

Select the correct answer for each question.

1. The passage is mainly about _______________.
   A. what the Marian Trench looks like
   B. what the Mariana Trench is, how it was discovered, and what is there
   C. why the Mariana Trench is the deepest part of the world
   D. when it was discovered

2. The Mariana Trench was formed by ________________.
   A. one tectonic plate subducted beneath another
   B. tectonic plates pushed against each other
   C. volcanic action of the sea floor
   D. explosion under the sea

3. The trenches in the Pacific Ocean are **not** _________.
   A. cold B. shallow C. deep D. dark

4. The Mariana Trench was first discovered __________________.
   A. by a Japanese submersible
   B. by the US Navy
   C. by two famous scientists who had a theory it was there
   D. by people in a research ship who were charting the ocean floor

5. **Chain** can have several meanings. Choose the meaning used in paragraph 3.
   A. a group of stores or business under the same ownership
   B. a rope of metal links or chains
   C. a series of connected things
   D. a unit of length equal to 66 feet

6.We can decide that the hydrothermal vents _________________.
   A. did not make a difference at all in the trench
   B. made it too hot for sea life to live in the trench
   C. made it possible for some unusual sea life to live in the deep trench
   D. was giving out toxic smoke that hurt sea life

7. In paragraph 2, subducted means ___________.

A. to crush
B. to go under
C. to go over
D. to crack

8.We can decide that the fish looked different in the deep trench because they have to adapt to the living conditions. Which of the following may describe one type of fish found in the trench?

A. Some fish have large eyes
B. Some fish have long teeth
C. Some fish have glowing parts
D. Some fish are very large, more than 8 feet

9.We can decide that ____________________.

A. Vent Crabs like heat.
B. Angler fish is large and dangerous.
C. People can swim in the Mariana trench.
D. Scientists found everything they needed to know about the Mariana Trench.

10. A submersible is ___________________.

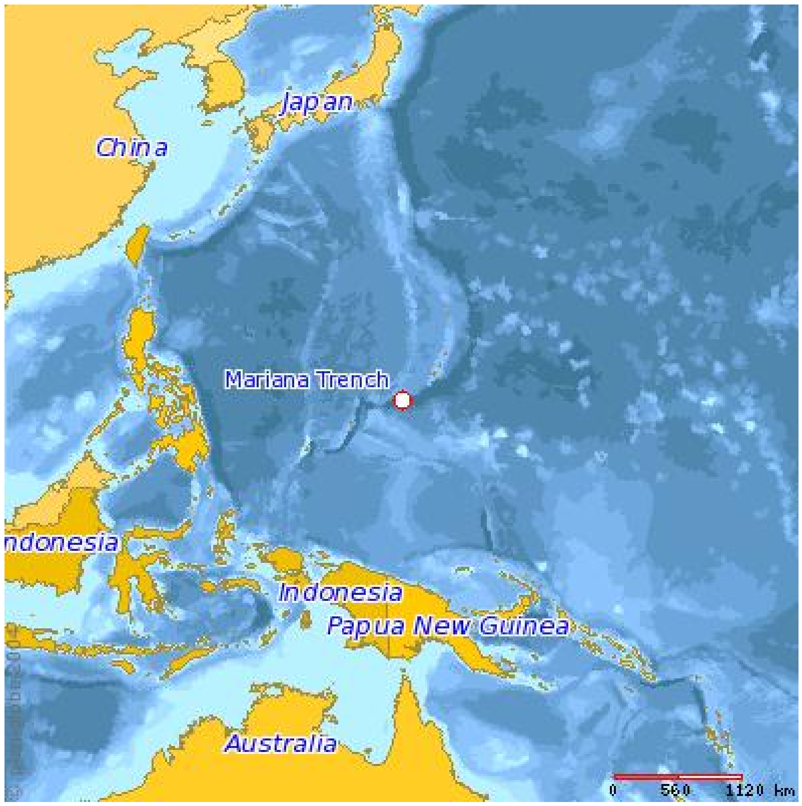
A. a vessel that is very large and must be manned
B. a ship that charts the depths of the ocean
C. a vessel that goes down into the depths of the ocean
D. a vessel that is operated by remote control

Part B: BCR. Answer by writing a paragraph with supports from the text.

Would you like to explore the ocean floor? Why or why not? What would you want to learn about? Explain your choice by using information from the passage.

Figure 6

Location of the Mariana Trench



(The image is copied from the "English Wikipedia," which is generated by {{User|Dcfleck}} at [http://www.planiglobe.com www.planiglobe.com] with the licensing, according to the original source, as follows. == Licensing == {{cc-by-2.5}})

A diagram of the Mariana Trench showing the abyssal region and the deep trench is accessible from the following website: http://www.marianatrench.com/mariana_trench-oceanography.htm

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Appendix B

Passage 2

Volcanic Eruptions

You probably already know a lot about volcanoes. Volcanoes are mountains that form when **magma** is forced to the earth's surface. Magma is hot, molten rock formed under the earth's surface. Are volcanoes always explosive? The answer is no. Scientists classified volcanic eruptions into two kinds: explosive and nonexplosive.

The explosive type of eruption can be very destructive. Think about the force of the explosion produced by the first atomic bomb used in World War II. Now imagine an explosion 10,000 times stronger. That can be compared to the power of an explosive eruption. When Krakatau in Indonesia erupted, it blew half the island away. In 1902, Mount Pelee erupted. It was on a small volcanic island in the Caribbean Sea known as Martinique. The hot steam, toxic gas, and volcanic debris killed all but one person on the island. The survivor was a prisoner held in a dungeon.

In an explosive eruption, clouds of hot debris and gas can shoot out at supersonic speeds. Dust particles from molten rock are blown into the air. Sometimes the dust circles the earth for years in the upper atmosphere. An explosive eruption can blast a million tons of solid rock. In 1980, Mt. St. Helens erupted. It blasted away a whole side of a mountain.

Explosive eruptions are usually caused by magma that contains two substances-- water or **silica.** When a volcano has magma with high water content, it is likely to explode. This can be compared to a bottle of soda. When you shake up a bottle of soda, the gas that was dissolved in the soda is released. If you open the shaken bottle, soda will come shooting out. The same thing happened with water in the magma. The heat caused the water to turn into steam. As the steam pressure builds up, it will burst with great force. Another substance that can cause a volcano to erupt explosively is silica. Silica is a nonmetallic substance. Magma with a large amount of silica is usually very thick. Silica hardens quickly. This can plug up the vent. If enough pressure builds up, an explosive eruption results. Explosive eruptions are usually very destructive. For example, Mount Vesuvius erupted in A.D. 79 and destroyed the city of Pompeii.

On the other hand, the nonexplosive eruptions are relatively calm. These are just outpourings of **lava**. Lava is magma that flows onto the earth's surface. Imagine rivers of red-hot lava flowing out of a volcano. That scene shows a typical nonexplosive eruption. An example of this is Mount Kilauea in Hawaii. As lava oozes out, it flows many kilometers. The lava then cools and hardens. Tourists go there to see the sight at a safe distance.

Some of the largest mountains on earth grew from repeated lava flows. They grow over hundreds of thousands of years. An example is Hawaii's Mauna Kea. It is the largest mountain on earth. Measured from its base on the sea floor, Mauna Kea is taller than Mount Everest, the tallest mountain on land.

Once in a while, even nonexplosive eruptions can spray lava into the air. These sprays rarely exceed a few hundred meters in height. Lava flow from the nonexplosive eruptions is slow. This type of eruption is more of a threat to property than to human life.

Part A: Questions

Select the correct answer for each question.

1. The passage is mainly about __________________.
   A. the damage volcanic eruptions can cause
   B. the presence of water and silica cause volcanoes to be explosive
   C. how tourists can visit nonexplosive volcanoes
   D. comparing two types of volcanic eruptions, explosive and nonexplosive

2. Debris from a volcano probably contains __________________.
   A. magma, gas
   B. steam, froth
   C. rocks, ashes
   D. trash, rocks

3. The explosive volcanic eruption was comparable to ____________________.
   A. the power of an atom bomb
   B. ten thousand times the power of an atom bomb
   C. the power of the sun
   D. the destruction of tidal waves

4. Why was there one man who survived in the eruption of Mount Pelee at St. Martinique?
   A. He escaped on a boat.
   B. He predicted the eruption and hid in a cellar.
   C. He was a prisoner held in an underground cell.
   D. He was rescued on a beach.

5. Which of these is **not** an example of the destruction of an explosive eruption?
   A. hot steam, toxic gas, and debris killed people
   B. half an island was blown off
   C. lava oozed out on the slope
   D. a million tons of solid rock was blasted

6. What caused some eruptions to be explosive?
   A. steam and ash in the magma
   B. water and silica in the magma
   C. chemical change in the magma
   D. presence of toxic gases

7. Why is Mauna Kea so tall?
   A. It was formed by volcanic action, and layers of lava were added on over the years.
   B. It was formed by a large explosive eruption.
   C. It was formed by plate tectonics, and the earth folded up very high.
   D. It was taller than Mount Everest.

8. Comparing the two kinds of eruptions, ______________________.
   A. the explosive eruptions are definitely more studied by scientists
   B. the nonexplosive eruptions are more dangerous
   C. the explosive eruptions are not as much a threat to property
   D. the nonexplosive eruptions are less of a threat to life

9. The nonexplosive eruptions are ________________________.
   A. probably very dangerous because it can burn people up
   B. probably not dangerous to human life because we can run away from it
   C. probably not dangerous because of tourists
   D. probably dangerous because they can quickly turn into explosive eruptions

10. The author compared the presence water in the magma to _________________.
   A. gas in a bottle of soda
   B. rocks that plug up a vent
   C. a steam engine
   D. a dust cloud

Part B: BCR. Answer by writing a paragraph with supports from the text.

Explain the causes of an explosive eruption. Use information from the text to support your answer.

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Appendix B

Passage 3

Earthquake Resistant Buildings

There are parts of the world today that are frequently disturbed by earthquakes. Some earthquakes damage entire cities. You may have seen scenes like that in a movie. The ground splits, everything shakes, and tall buildings topple over. These quakes have happened in many places. For example, the San Francisco Bay area, Kobe in Japan, the West coast of Mexico, and Western Turkey all had earthquakes. Sometimes, earthquakes cause many lives to be lost. In Tangshan, China, the earthquake of 1976 caused 255,000 deaths.

Why do so many people die in an earthquake? The main reason is that buildings are shaken badly in an earthquake. They crumble and fall, crushing the people. In order for the people to live more safely, architects and engineers have invented some earthquake resistant buildings. These buildings can keep standing even in a **major** earthquake. In fact, some of these buildings have been made so that they feel hardly any shaking at all.

What is the secret behind these buildings? The truth is that they actually move. They are designed to move in the opposite way of the shake. There are several ways to make this work. One of the most frequently used methods is shifting weights. **Base isolators** are placed on the base of the building. They act as shock absorbers during an earthquake. They are made of layers of rubber and steel. On the bottom part of the building, engineers place a special system called the "active tendon system." Sensors notify a computer when the building is moving. Then the computer activates devices to shift a large weight to counteract the movement. The roof also has one of the sensors to show building movement in an earthquake. That sensor may also add information to activate the shifting of the weight to balance the building.

Another method uses strong ropes or braces to pull the building back in place. Even jets of water or air may be used to push the building back in place. All the methods use computer controls. In addition, all the buildings use flexible pipes. This means that the rubbery joints will not have to break during an earthquake. To make the floors and sides sturdy, the engineers use steel cross-braces. The braces are like X-shaped crosses. They can counteract pressure that pushes and pulls at the sides of buildings during an earthquake.

Scientists hope that more earthquake resistant buildings are built in areas with frequent earthquakes. With these buildings, people are more prepared for such an event.

Part A: Questions

Select the correct answer for each question.

1. The passage does not tell _________________.
   A. how earthquake resistant buildings are built
   B. when the first earthquake resistant building was built
   C. why earthquake resistant building don't fall
   D. different ways to build earthquake resistant buildings

2. The word **major** can mean different things. Mark the meaning used in paragraph 2.
   A. an officer in the army
   B. greater in amount or importance
   C. very serious
   D. main field of study

3. The author's purpose for writing this passage is __________________.
   A. to inform the reader about how earthquakes are dangerous
   B. to entertain the reader with interesting facts about earthquakes and buildings
   C. to persuade the reader to build an earthquake resistant building
   D. to explain how earthquake resistant buildings work

4. Which of the following is a fact?
   A. It would be nice to have earthquake resistant buildings in our town.
   B. Earthquake resistant buildings use a system of shifting weights to balance the building.
   C. Scientists hope that more earthquake resistant buildings are built in areas with frequent earthquakes.
   D. It is very sad that so many people died in earthquakes because the buildings fell and crushed them.

5. What is the main reason for so many people dying in an earthquake?
   A. They had no food or water.
   B. They fell in the earth's cracks.
   C. The buildings crumble and crush people.
   D. They were frightened to death.

6. Flexible pipes are used in the earthquake resistant buildings because ______________.
   A. they are cheaper than fixed pipes
   B. they have rubber joints
   C. they look better on the earthquake resistant buildings
   D. they will not break in an earthquake

7. What best explains the "active tendon system"?

A. Sensors activate a computer system, which shifts weights to balance the building.
B. Sensors inform the computer of what part of the building is shaking.
C. The building moves like tendons and muscles in an earthquake.
D. The building has an active tendon system, which makes it earthquake resistant.

8. The information in the article suggests that _______________.
A. Some earthquake resistant buildings have been built and are operational.
B. The engineers and architects are planning to build the first earthquake resistant building.
C. People all over the country are requesting to build earthquake resistant buildings.
D. Most people think that earthquake resistant buildings are not necessary.

9. Why do these buildings have **base isolators**?
A. They are made of rubber and steel.
B. They make a firm foundation that does not move in an earthquake.
C. They help shift weights to balance the building.
D. They act as shock absorbers.

10. Which of these is the best summary of the article?
A. Earthquake resistant buildings are wonderful to have.
B. Earthquake resistant buildings use cross braces to strengthen the walls.
C. Earthquake resistant buildings use a computerized system to balance the building during an earthquake.
D. Earthquake resistant buildings have saved many lives since they are able to withstand earthquakes.

Part B: BCR. Answer by writing a paragraph with supports from the text.

Explain the "secret" or principles behind the earthquake resistant buildings. Use information from the text to support your answer.

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Appendix B

Passage 4

Is There Life on Mars?

Mars is also known as the Red Planet. It is the fourth planet from the sun, and is reddish in color. The rust-like color comes from the large amount of iron in the planet's soil. Its atmosphere has much less oxygen than earth. Only 13% of the air on Mars is oxygen. The earth, in comparison, has 21% oxygen in the air. Carbon dioxide makes up 95.3% of Mars' atmosphere.

People have been observing Mars from ancient times, but its exploration was fairly recent. Different space crafts brought back information about Mars. In 1976, Viking 1 and Viking 2 landed on Mars. In 1997, the space craft Pathfinder landed on Mars for more study. All these space crafts were unmanned. This is because the condition of Mars is unsuitable for humans to live. The observations of these spacecraft showed no signs of life.

What is the climate of Mars like? Why is it unsuitable for humans? Like earth, Mars has a layer of gases around it. The layer of gases is very thin. Because of its thin atmosphere and its great distance from the sun, Mars is very cold. Mid-summer temperatures range from -13 degrees Celsius to -77 degrees Celsius. Mars is also very windy. When Viking 1 landed, it placed a seismograph on Mars' surface. Instead of measuring quakes, it was just blown by the wind. It was acting like a wind gauge. It recorded quaking action only once during that time. Because Mars is so cold, Mars is unsuitable for humans to live there.

The air pressure on Mars is very low because of the thin **atmosphere**. If you boil water on Mars, it will boil away very quickly. The only water you will find on Mars is in the form of ice. Mars has two polar ice caps that contain both frozen water and frozen carbon dioxide. There are no rainstorms, snowstorms, or hurricanes on Mars. Mars is like a cold desert. Even though there is no water on the surface on Mars today, scientists found evidence that it did exist in the past. The land forms of Mars show dry river beds, mud flows and other landscape eroded by water. Where did this “lost water” go? Scientists think that it is frozen beneath the soil.

Since there was water on the surface of Mars, did it support some form of life? Scientists believe that water is one of the three necessary ingredients for life. The planet has two other ingredients that are necessary for life: chemical elements such as carbon, oxygen, hydrogen, nitrogen that form the basis of life, and a source of **energy**. The sun is possibly a form of energy for Mars. The sun is farther away on Mars than on earth and not as warming. The energy could also come from its core. Like the earth, the inner core of Mars is very hot. Many scientists believe that life did exist on Mars. The evidence came in 1996. A team of scientists from NASA discovered a meteorite from Mars. On the meteorite were strands that looked like fossilized bacteria and microbes. Although this team of scientists believe strongly that Mars had life, some other scientists still disagree.

Another group of scientists are actually planning how to use Mars as a colony or outpost for earth. They think that interplanetary traveling is not that far away. Although there is no apparent life on Mars at this time, these scientists hope that one day, it will support human life.

Part A: Questions

Select the correct answer for each question.

1. The main idea of this passage is _________________________.
   A. some scientists found evidence of Martians
   B. all scientists claim that there is no life on Mars
   C. Some scientists found evidence of life on Mars
   D. Mars will be a colony of earth

2. Why are there no rainstorms or snowstorms on Mars?
   A. Mars has a cold climate.
   B. Mars has no surface water.
   C. Mars is too cold.
   D. Mars has no atmosphere.

3. Water on Mars is ____________________.
   A. not present in any form
   B. frozen as ice caps
   C. running in underground streams
   D. present as thick clouds

4. Why is Mars not suitable for humans to live on?
   A. It is too cold.
   B. It is too hot.
   C. It is too windy.
   D. It has no oxygen for breathing.

5. The word **atmosphere** in this passage is used to mean ______________.
   A. the water on a planet
   B. the gases surrounding a planet
   C. the weather
   D. the surrounding feelings

6. The passage did not mention the ______________ of Mars.
   A. air pressure
   B. atmosphere

C. temperature
D. gravity

7. Why would water boil away quickly on Mars?
   A. The air pressure is high.
   B. The air pressure is low.
   C. There is only ice there.
   D. It is very cold.

8. The life forms discovered from a meteor from Mars were ________________.
   A. fossils of animals
   B. seeds of plants
   C. bacteria and microbes
   D. worms

9. Which of the following may be a source of **energy** for life to exist?
   A. Water makes life grow.
   B. Some life forms can use carbon dioxide to grow.
   C. Energy from the poles can help life grow.
   D. The heat of the core can help life grow.

10. According to the scientists, Mars had all the necessary ingredients for life. Which of the following is not a necessary ingredient for life:
   A. water
   B. minerals like iron
   C. chemicals like hydrogen, carbon, oxygen, nitrogen
   D. a source of energy

Part B: BCR. Answer by writing a paragraph with supports from the text.

If earth people were to settle on Mars, what would they need in order to survive there? Use information from the text to support your answer.

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Appendix B

Passage 5

What It Is Like on the Moon

People have long been fascinated by the moon since ancient days. Poets have written poems about it, songs were sung about it, artists drew pictures of it, and different cultures have stories about the moon. For example, the ancient Romans worshiped Diana as goddess of the moon. Because of the Apollo mission sent to the moon in 1969, we know much more about the moon today. For example, rock samples from the moon show that it is about 4.6 billion years old.

The moon is our Earth's **satellite**. This means that it goes around the earth. It takes 27 days, 8 hours for the moon to **revolve** around the earth. It is smaller than the earth. Its diameter is 3,475 km (2,160 miles).

It may be very hot or very cold on the moon. Where the sunlight shines, the surface is very hot. Where the sunlight does not reach, it gets very cold. If you are on the bright side of the moon, the surface temperature may be 134 degrees Celsius. That is hotter than what it takes to boil water! If you are on the dark side of the moon, it may be as cold as -170 degrees Celsius. Since freezing point is 0 degrees Celsius, this is way below freezing! If you were an astronaut on the moon, you need to wear a special suit that can protect you from extreme temperatures. In addition, the moon has no atmosphere. You will need an oxygen tank to help you breathe there. Since there is no air, sound cannot travel on the moon. You will need a walkie-talkie to communicate with another astronaut on the moon.

What will you see on the moon? You will probably see rocks and dust covered landscape that is like a grayish desert. You will see many **craters**. Craters are large circular depressions on the land. Scientists believe that most of these craters are formed over the years when meteors and asteroids crashed into the moon. There are no plants, trees, or animals on the moon because there is no surface water. The water there is frozen either below ground or at the poles of the moon.

You may have seen movies showing how people can jump really high and far on the moon. This is because the moon only has 1/6 or 17% of Earth's surface gravity. Here you weigh only one-sixth of your weight on earth. This makes walking a bit of a challenge. You are so light you have to thrust yourself forward to walk. Once you get going, it is like bouncing on a trampoline. Stopping is also a challenge. You have to dig your heels in the ground and lean back. Even if you fall, it can be fun because it is like falling in slow motion. You will land so gently that you won't be hurt. You will get covered in powdery, gray moondust.

Part A: Questions

Select the correct answer for each question.

1.This passage is mainly about ______________________.
   A. how you can't hurt yourself if you fall on the moon
   B. how the moon looks bare, with nothing but craters and dust
   C. how long it takes for the moon to revolve around the earth
   D. what it is like to be on the moon

2. One opinion about the moon is _____________________.
   A. ancient Romans worshiped a goddess of the moon
   B. poets wrote poems about the moon, and artists drew pictures of it
   C. it is fun to fall on the moon since you won't be hurt
   D. sound cannot travel on the moon

3. The passage does not say, but we can decide that ______________________.
   A. astronauts use walkie-talkies on the moon just because it is fun to use
   B. a walkie-talkie does not depend on air to send signals
   C. a walkie-talkie uses sound waves for communicating
   D. a walkie-talkie is not needed for communication on the moon

4. The word **satellite** in paragraph 2 means _________________________.
   A. a man-made device launched into orbit
   B. a small heavenly body that revolves around a planet
   C. a form of TV based on signals sent from space
   D. a follower of someone of importance

5. A **simile** compares two things that may be alike in some way. A **simile** used in the passage is _______________________.
   A. you will be covered in powdery, gray moondust
   B. jumping on the moon is like bouncing on a trampoline
   C. you are so light you have to thrust yourself forward to walk
   D. craters are large circular depressions on the land

6. The moon has less gravity than the earth. The proportion of the gravity moon compared to that of the earth can be expressed as ________________.
   A. 1: 17
   B. 1: 6
   C. 1: 27
   D. 1: 4.6

7. According to rock samples, the moon is ______________ years old.
   A. 100 billion
   B. 4.6 million

C. 10 million
D. 4.6 billion

8. How did we find out more information about the moon?
   A. A communication device set up on the surface of the moon sends pictures and other information.
   B. The Apollo space mission brought back rock samples and pictures.
   C. There were many landings on the moon so scientists were able to study it.
   D. The space station monitored the moon since 1969.

9. You won't get hurt falling on the moon because ____________________.
   A. there is no gravity on the moon
   B. there is less gravity so you fall slowly
   C. you are like a feather on the moon
   D. you are one-tenth lighter

10. The moon's surface looks like it is __________________________.
   A. covered with dust and has lots of craters
   B. hot with sand dunes like a tropical desert
   C. cold and bare like the polar regions
   D. full of volcanic craters and has lava oozing out of the craters

Part B: BCR. Answer by writing a paragraph with supports from the text.

Explain the challenges you will face on the moon and what you would do to overcome those challenges.

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Appendix B

Passage 6

Mount Everest

It's the tallest mountain in the world! Everyone has probably heard about Mount Everest. However, few people can tell where it is located, how it is formed, how tall it is, or what it takes to climb this mountain.

Mount Everest is the tallest mountain in a group of mountain ranges called the Himalayan Mountains. It is located southwest of China and northeast of India. It covers parts of the countries of Nepal and Tibet.

How is Mount Everest formed? Scientist believed that it was formed by **plate tectonics**. They studied the earth and noted that the earth's crust has weak fault lines that divide the continents into large plates. These continental plates move, especially when there is movement from the inner core of the earth. Examples of inner movement are earthquakes and volcanic eruptions. Scientists think that millions of years ago, the continental plate that India is on crashed against the Asian continental plate. The crash caused the land to buckle up real high, forming a range of very large and tall mountains. These tall mountains are the Himalayan Mountains. The tallest is Mount Everest.

Mount Everest is 8,848 meters (29,000 feet) high. A network of satellites called the **Global Positioning System** (GPS) monitors the mountain. In monitoring the GPS data, scientists found that Mount Everest is actually moving and growing! The mountain is still being pushed by the two continental plates, causing it to buckle up even more. Over a year's time, the mountain moves northeast about 27 mm, and grows from 3 to 5 mm taller.

It takes a lot to climb Mount Everest. A person must have physical endurance as well as money! It is a grueling climb to the top of Mount Everest. It is a steep climb in many places. In some places, there are no footholds. A climber will have to hammer in nails for climbing. They also have to rely on ropes they set up as guides or holds. The temperature is below freezing, and there is blinding snow that falls frequently. There are dangers such as avalanches and falling rocks.

In addition, above 25,000 feet, the air is very thin. It has only one-third of the oxygen of the regular air we breathe. The air is so thin that it is hard to do any physical activity. People usually feel weaker up there. Most people bring an oxygen tank to help them in the final ascent. The price it would cost for a person to climb Mount Everest is estimated to be US $65,000 based on the price listed during the summer of 2005. This package will include guides, food, drinks, oxygen tank, warm clothes, climbing boots, and other mountain climbing equipment. It also includes some medical equipment in case a person gets sick while climbing. It does not include a plane trip to Nepal, where the foothills are located.

Why do people still want to climb Mount Everest? It represents nature's challenge. There are people who would like to climb it just “because it's there.”

Part A: Questions

Select the correct answer for each question.

1. This passage is mainly about ______________.
   A. how tall and famous Mount Everest is
   B. how Mount Everest is formed by tectonic plates crushing against each other
   C. where Mount Everest is located, how it was formed, its height, and what it takes to climb it
   D. It takes about US $65,000 to climb Mount Everest

2. Where is Mt. Everest located?
   A. Southwest of India
   B. South of Nepal
   C. Northeast of Tibet
   D. Southwest of China

3. How is Mount Everest formed?
   A. The continent plates crashed against each other, causing the land to buckle up.
   B. It is formed by volcanic action.
   C. It is the result of an earthquake.
   D. It is divided from a large range of tall mountains.

4. Why do people usually feel weak up on Mount Everest?
   A. They have little food and water.
   B. The air is thin.
   C. There are no footholds on some parts.
   D. They were sick and needed medical treatment.

5. Why does Mt. Everest grow every year?
   A. The mountain grows 3 to 5 mm taller every year.
   B. It grows because more snow and ice fall on it.
   C. Plate tectonics are continually pushing the land together.
   D. The wind causes erosion and the rocks on the peak were exposed.

6. Which of the following statements about Mount Everest is an opinion?
   A. It's the tallest mountain in the world!
   B. Mount Everest is actually moving and growing!
   C. The temperature is below freezing.

D. It represents nature's challenge.

7. The passage does not say, but we can decide that _____________.
   A. A Global Positioning System is used for directing traffic to Mt. Everest.
   B. Scientists have a special interest in Mt. Everest, and developed a Global Positioning System for Mt. Everest only.
   C. Scientists use a Global Positioning System to monitor major changes about the earth’s surface.
   D. Scientists believe that a Global Positioning System is better without a network of satellites.

8. Dangers on a climb up Mt. Everest would **not** include:
   A. falling off the mountain
   B. a poor guide
   C. avalanche
   D. lack of air

9. Why is the climb so difficult?
   A. There is blinding snow.
   B. There are earthquakes.
   C. The sun is too hot.
   D. The rocks are too sharp.

10. According to the passage, why do some people climb Mt. Everest?
   A. People wanted to see how the mountain grows.
   B. Because it’s there.
   C. It is the most challenging thing any person can do.
   D. Some people wanted to show that they are rich enough to afford it.

Part B: BCR. Answer by writing a paragraph with supports from the text.

Explain what a person needs to do to climb Mount Everest and what to expect climbing this mountain.

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Appendix B

Passage 7

The Unusual Puffer Fish

Many of you have seen pictures of puffer fish, or have seen Mrs. Puff on SpongeBob Squarepants. The puffer fish is a special type of fish that will inflate when it feels threatened. By swelling, the puffer becomes too large to eat for most fish. In addition, many puffers also have spikes all over their bodies. Some puffers have smooth leathery skin, and the spikes only show on the belly when they blow up. When a puffer is removed from the water, it will inflate itself with air. If it is returned to the water, it will float upside down on the surface for several minutes until it releases the air.

There are 120 kinds of puffers. They are also known as blow fish, globefish, or fugu (Japanese term). Puffers can be found all over the world in warm oceans, brackish waters, and even in some rivers. They have a beak-like mouth used for tearing coral. They also use this “beak” for crushing shells of crabs, clams, shellfish, and shrimps. They may grow anywhere from 2 inches (5 cm) to 2 feet (60 cm) in size.

Recently, the puffer fish aroused great interest among **geneticists**. Geneticists are scientists who study genes and **genomics**-- the study of how genes are organized. These geneticists found that the puffer fish has a minimum set of genes needed to make up a vertebrate animal. The puffer has low genomes, or less “filler” DNA. It is worth studying as it is simpler than many other creatures.

Another interesting fact about the puffer is that most of them are poisonous. The inner organs and skin contain a toxin known as **tetrodotoxin**. It is a neurotoxin that can cause death to 60% of the people who ingest it. The toxin is not produced by the fish, but by bacteria related to the fish. The fish in turn, develops resistance to the toxin.

Are puffers eaten as food then? Yes, it is. In Japan, the puffer, or fugu is considered a delicacy. When properly cleaned and prepared, the fugu is a delicious food. By Japanese standards, only a specially trained and licensed chef can handle the cleaning and cooking of the fugu. A person may pay as much as US$400 for a meal of fugu. If a person eats an improperly cleaned piece of fugu, he may feel a tingling in the mouth and lips, then dizziness, headache, weakness, paralysis, maybe even death. If rushed to the hospital in time, many patients can be saved. Despite quality control and other life-saving measures, eating fugu still caused about 50 deaths annually. The puffer fish is certainly not a fish to blow off.

Part A: Questions

Select the correct answer for each question.

1. The passage mainly is about__________________.
   A. what the puffer fish eats and who eats the puffer
   B. what puffer fish does when it is threatened
   C. what the puffer fish is like and what is important about them
   D. how the puffer is poisonous

2. The puffer "blows up" because ________________________________.
   A. it wants to fight other puffer fish
   B. it wants to release tetrodotoxin
   C. it feels like floating
   D. it feels threatened

3. Geneticist are interested in puffers because __________________________.
   A. it has a minimum set of genes and is a good sample to study because it is simpler
   B. it has a maximum set of genes for fish and is worth studying because it is complex
   C. it has tetrodotoxin and therefore worth geneticists' attention
   D. it is a vertebrate animal

4. "Low genomes" means ____________________________.
   A. it has less well-organized genes
   B. it has less "filler" DNA
   C. it has poisonous substances like tetrodotoxin
   D. it is a low calorie but high risk food

5. What is **not** another name for the puffer fish?
   A. Balloon fish
   B. Blow fish
   C. Globe fish
   D. Fugu

6. Knowing that the puffer fish is poisonous, why do some people eat it?
   A. They think the poison is not so bad.
   B. It is considered to be a delicious "delicacy" in Japan.
   C. Americans like to try Japanese foods.
   D. Some people want to take risks.

7. The tetrodotoxin is produced by _______________________.
   A. bacteria in the inner organs and on the skin
   B. neurotoxin in the spikes

C. poisonous glands under the skin
D. bacteria in the meat of the puffer

8. Which of the following is an opinion?
A. The fugu is a delicious food that is worth trying at least once in a lifetime.
B. The fugu meal may cost as much as US$400.
C. The fugu is considered a delicacy in Japan.
D. The fugu has neurotoxin that can cause death when ingested.

9. Why do Japanese standards insist on having a licensed and trained chef to prepare the puffer fish meal?
A. A licensed and trained chef will be able to charge top dollar since he or she is l licensed to prepare the puffer fish meal.
B. A licensed and trained chef will be able to spice the puffer fish up to make a most delicious meal.
C. A licensed and trained chef has insurance in case the restaurant gets sued for poisoning the food.
D. A licensed and trained chef will ensure all organs and skin of the puffer fish are removed properly without allowing bacteria to go on the meat.

10.What are some of the symptoms of puffer fish poisoning?
A. Death
B. Headache, coughing and sneezing
C. Tingling in the mouth, dizziness, paralysis
D. Dizziness, weakness, throwing up

Part B: BCR. Answer by writing a paragraph with supports from the text.

Explain why the puffer is such an unusual fish. Use information from the text to support your answer.

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Appendix B

Passage 8

Piranhas

Most people heard of the vicious, blood-thirsty piranha. They may also have seen movies that show how piranhas could eat a large animal up. They leave nothing but bones in just minutes. Scientists who study this tropical fish claim that usually they don't even attack humans. Most of the movies and drama are just misunderstood facts and **hype**.

So what are some real facts about this fish? The piranha is a sharp toothed fish that lives in lakes and rivers throughout South America. There are over 25 species of piranhas. The body color range from olive green to blue-black. They all have orange or red bellies and razor-sharp teeth. They may grow up to 1 foot (30 cm) long.

What do piranhas eat? Usually, they eat smaller fish, seeds, and other fruits in the water. Most piranhas swim alone. They are not known to attack humans. Occasionally, they swim together in schools. Like a pack of wild dogs, a school of piranhas will attack an animal much larger. There were no confirmed human fatalities resulting from piranha attacks.

Piranhas may prey on other fish, but it also is prey of other creatures. For example, larger fish will eat the piranha. Water snakes, turtles, birds, otters, and even people will eat piranhas. Some fishing enthusiasts claim that they like catching piranhas. Piranhas are fierce fighters when hooked, and they are very tasty as well.

Have people been attacked by piranhas then? Yes. Some people who wade by in waters near a piranha nest may have been bitten. Single bites are never fatal. The piranha will take out a chunk of meat when it bites though. In Brazil, in the summer of 2002, there were 38 piranha attacks reported. Fortunately, none were fatal. Scientists studied the river where the attacks took place. They found that the building of a new river dam had caused piranhas to increase in numbers. How did that happen? Piranhas lay **larvae**, or their young ones, in submerged or floating waterweeds. When rivers flood, they are partly swept away. Much of the waterweeds with larvae are washed up on shore. These dry up, and the population of the piranha is kept under control. When Brazil built the river dam, the larvae and waterweeds were kept in the river. The piranha larvae then grew into full sized fish. They increased in numbers greatly. Scientists there are trying to get the piranha numbers under control.

Even more deadly than the attacks, piranhas, if released to a new river or lake, may cause serious ecological damage. Piranhas are predators that will eat up other fish, frogs, and water creatures. After awhile, people may find no regular fish to catch. That is why China has banned the import of Piranhas in 2002. Today, many Americans are still buying these fish as pets. Many people like them because of their fierce reputation. Some people may enjoy them in their aquariums for awhile, and then they get tired of the expense of feeding them live fish. Some people had released their unwanted piranha pets into the lakes and rivers of the US. Some flush them down the toilets which had sewers leading to lakes and rivers. As a result, wild piranhas have been introduced in some rivers and lakes in the US, particularly the Southeast. Scientists do not know what the impact will be yet, but they urge pet owners to be more responsible and not to release them into our environment.

Part A: Questions

Select the correct answer for each question.

1. In real life situations, piranhas will usually ____________________.
   A. attack humans
   B. attack and eat up a large animals in a few minutes
   C. eat small fish, seeds, and fruits
   D. eat their own young ones

2. There are different species of piranhas. Things they all have in common are: _________________.
   A. olive green color and sharp teeth
   B. orange or red bellies and sharp teeth
   C. eating their own young and attacking humans
   D. attacking humans and razor-sharp teeth

3. Which country has banned the import of piranhas?
   A. United States
   B. China
   C. Brazil
   D. South America

4. The word "**hype**" in paragraph 1 means _______________.
   A. being overactive
   B. to promote
   C. an attention-getter
   D. advertising

5. From the passage, we can imply that
   A. people find piranhas interesting and deadly
   B. people frequently eat piranhas as food
   C. people are not worried about piranhas
   D. piranhas are important to have in our rivers and lakes

6. Why do some people buy piranhas as pets, and then release them later?
   A. They don't like the way piranhas look any more.

B. They want to pollute the rivers and streams with piranhas.
C. They want the piranhas to clean-up the lakes and streams by eating insects.
D. Feeding piranhas live fish all the time gets expensive.

7. This passage is mainly about ______________________.
A. what piranhas look like and how they attack
B. what piranhas are like, what they eat, and how they can be damaging
C. how myths about the piranhas are not true
D. how America should ban piranhas into this country

8. In Brazil, 2002, there were 38 incidents of piranha attacks on humans. Scientists claim that it was because ___________________.
A. much of the waterweeds containing piranha larvae remained in the river due to a new river dam, and the number of piranhas increased
B. the piranhas increased in numbers when the river flooded
C. the piranhas were dangerous and vicious creatures and attacked because they were hungry
D. the waterweeds containing piranha eggs were flooded to new areas and help them increase in numbers

9. An opinion about the piranhas is _____________________.
A. they eat smaller fish, seeds, and other fruits in the water
B. they are vicious, bloodthirsty, and dangerous to humans
C. they may cause serious ecological damage if released into streams where they were not there before
D. some people will fish and eat piranhas

10. We can assume that ____________________.
A. piranhas are now present in some American rivers and lakes
B. piranhas are not found in any American rivers and lakes
C. piranhas are peaceful and safe to be around
D. piranhas have caused fatalities and should be banned in America

Part B: BCR. Answer by writing a paragraph with supports from the text.

Explain why releasing piranhas into the streams and lakes of America is not a good idea.

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Appendix B: Extra Practice Passage

Name_________________________

Date__________________________

Bees and Wasps

When you open a can of soda in summer, have you ever been bothered by buzzing insects that fly around your sweet drink? These insects are larger than flies and look like they could sting. Are these bees or wasps? After all, they do look similar. Both bees and wasps are flying insects that can sting. Scientists classify them in the Hymenoptera order. The term Hymenoptera means “membraned-wings.” Bees and wasps have four thin wings, with the top two being bigger than the bottom two. Although some species of bees and wasps are solitary, most bees and wasps live in colonies, or a group that works together. The bees and wasps have queens. The life of a colony revolves around the queen, whose main function is to lay eggs. Workers do work such as gather food, build the nest, clean the nest, and raise the young. So how are bees and wasps different and how can you tell them apart?

First of all, look at their bodies. The shapes of their bodies are different. The bees' bodies look plumper and are often fuzzy while the wasps have slim, smooth bodies and a tiny waist. The second thing you can look at is their legs. Many species of bees have developed special “pollen baskets,” which are formed from part of their tibia on the hind legs to carry pollen grains. Pollen grains are the yellowish powder on flowers that fertilize flowers to form fruits. On the other hand, wasps do not carry pollen grains on their legs.

You can also observe where these insects fly and what they hover around. Most bees are only interested in flowers. Bees make honey from the nectar of flowers and they carry pollen in the “pollen baskets” on their legs. Bees feed honey and pollen to the young ones, and they store honey as food for the winter. Although wasps also drink nectar and plant juices, they frequently visit picnic grounds. They may come to get sweet drinks from soda cans and eat leftover foods such as luncheon meats from the garbage. Most wasps are predators or parasites. Wasps often prey on other insects and capture them for their young ones to eat. Wasps may even use their venom to paralyze other insects, such as caterpillars, and lay eggs in them. The young wasps can then eat the other insects once they are hatched.

If you bother their nests or try to hurt them, bees and wasps may sting you. Honey bees have barbs on their stingers. When the stinger is lodged into the flesh of the victim, tearing away will cause the death of the bee. That led to the saying that a honey bee only stings once. On the other hand, wasps can sting multiple times. Both bees and wasps can inject venom into the victim with their stingers. On the bright side, both bees and wasps are helpful to the environment because they help plants pollinate. Wasps also eat up other bugs that harm our crops. So next time you see a bee or a wasp, stay away and just let it do its work.

Part A: Questions

Select the correct answer for each question.

1. The article mainly is about ________________.
   A. where bees and wasps live
   B. the many differences between wasps and other insects
   C. similarities and differences between bees and wasps
   D. what bees and wasps eat

2. Which of the following statement is true about the colonies of bees and wasps?
   A. The workers do many chores such as building nests and gathering food.
   B. The queen rules the colony and orders the workers to do jobs.
   C. The workers lay eggs and raise the young.
   D. The workers fight among each other, so the strongest one becomes queen.

3. The article suggests that in order to tell the difference between bees and wasps, the first thing is to ____________________.
   A. see where they fly
   B. compare the wings
   C. see if they can sting multiple times
   D. look at the shape of their bodies

4. Why are many wasps described as parasites?
   A. Wasps come around people's trash and garbage.
   B. Wasps drink nectar and plant juices.
   C. Wasps have four thin membraned wings.
   D. Wasps lay eggs in other insects so their young ones may eat them.

5. Which of these tells how the body of a bee is different from the body of a wasp?
   A. The bee has a fuzzy body and a stinger at the end, but the wasp has a smooth body and no stinger.
   B. The bee has a plumper body while the wasp has a narrow waist.
   C. The bee has two wings on its body while the wasp has four wings.
   D. The bee folds its wings up against the body while the wasp keeps its wings flat.

6. Predict what would happen to the bees and wasps if winter comes.
   A. Almost all the bees will die off because they are small.
   B. Almost all the wasps will live because they are tough.
   C. Most bees will survive the winter because they have stored honey.
   D. Most wasps will survive the winter because they stored honey.

7. In the article, the words “pollen grains” refer to ______________.
A. bits of honey
B. yellowish powder from flowers
C. yellowish parts of the bee's body
D. what wasps eat and carry home

8. The information in the article suggests that _________________.
A. bees are important because of their honey but wasps are pests
B. bees and wasps are important parts of nature's balance
C. bees and wasps are insects that we can live without and we should stay away from them
D. a honey bee's sting may hurt more than a wasp's sting since it can only sting once

9. Which of these is an opinion?
A. Bees make honey from nectar of flowers.
B. Many wasps are parasites.
C. Honey bees are better than wasps.
D. Wasps help the environment.

10. The author wrote this article mainly to ________________.
A. explain how to determine if a flying insect is a bee or a wasp
B. explain why bees and wasps are classified as Hymenoptera
C. entertain readers with interesting facts about bees and wasps
D. convince readers to keep a safe distance from dangerous insects

Part B: BCR. Answer by writing a paragraph with supports from the text.

In your own words, explain how to tell bees apart from wasps. Use information from the text to support your answer.

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Appendix C: Pretest and Posttests

Pretest

Crocodiles and Alligators

You have probably seen a crocodile and an alligator either in zoos, pictures, or movies. Can you tell them apart? For most people, it is really hard to tell them apart because they belong to the same family. Scientists group them in an order called Crocodilian. They are both cold blooded reptiles. They are believed to be of an ancient lineage more than 200 million years old and have changed little since the dinosaur days. Crocodiles and alligators both love to be warm. They bask in the warmth of the sun every day. Like other reptiles, their bodies are the same temperature as the surroundings. That is why they both live in warm regions. Crocodiles live in the swamps and rivers of warm regions in the Americas. They also live in parts of Africa, Asia, and Australia. Alligators are commonly found along warm coastal areas of the United States and China.

Finding differences between the crocodile and the alligator may be difficult. The first thing you need to look at is their jaws. The crocodile has lower teeth that stick out even when its jaws are closed. On the other hand, the alligator does not show its teeth when its jaws are closed.

Another way to distinguish between the two animals is their size. The crocodile is bigger. It can grow as long as 20 feet. The alligator is smaller, usually only growing up to 12 feet. Just because the crocodile is bigger than the alligator, it does not mean that all its body parts is bigger. The crocodile's snout is actually smaller than the alligator's snout. It is thin and pointed like a sharp pencil. In contrast, the alligator's snout is large and rounded like a worn crayon tip.

One final way to tell a crocodile apart from an alligator is by their skin. A crocodile has hard, tough, rough and bumpy looking skin. An alligator has hard but smooth looking skin.

Questions

Part A: Select the correct answer for each question.

1. The article mainly is about _______________.
   - A. the habitat of crocodiles and alligators
   - B. similarities and differences between crocodiles and alligators
   - C. the many differences between crocodiles and other reptiles
   - D. the many reptiles related to crocodiles and alligators

2. Where are alligators commonly found?
   - A. along the coast in warm areas of the United States and in China

B. in the swamps and rivers of China and the Americas
C. throughout coastal areas of America and Australia
D. on all continents wherever there is water

3. What can you do first to tell the difference between a crocodile and an alligator?
A. determine each reptile's body temperature
B. compare the jaws of each reptile
C. estimate the length of each reptile's
D. examine the skin of each reptile

4. Why is a reptile's body temperature always the same as that of its surroundings?
A. because reptiles bask in the sun for hours
B. because reptiles prefer warm climates
C. because reptiles are warm-blooded
D. because reptiles are cold-blooded

5. Which of these tells how the jaws of an alligator are different from the jaws of a crocodile?
A. The alligator does not have a jaw, but the crocodile does.
B. The alligator has a round jaw, but the crocodile has a pointed jaw.
C. The alligator doesn't show teeth when its jaw is closed, but the crocodile does.
D. The alligator has a small jaw, but the crocodile has a large jaw.

6. Predict what would happen if the temperature suddenly turned very cold where an alligator lives.
A. The alligator would dwell on only the water instead of on both land and water.
B. The alligator would maintain a lower body temperature.
C. The alligator would not be able to tolerate the change and would die.
D. The alligator would adapt to the cooler temperature.

7. In the article, the word “distinguish” means _______________.
A. examine the similarities
B. determine the differences
C. compare the lengths
D. maintain a safe distance

8. The information in the article suggests that __________________.
A. a crocodile spends most of its time in the water
B. a crocodile prefers warmer temperatures than an alligator
C. an alligator's body temperature can vary
D. an alligator is considered more dangerous than a crocodile

9. Which of these is an opinion?
A. Crocodiles live in Africa.
B. Crocodiles have a pointed snout.
C. Crocodiles like to bask in the sun.

D. Crocodiles are interesting reptiles.

10. The author wrote this article mainly to ________________.
   A. explain how to determine if a reptile is a crocodile or an alligator
   B. explain why crocodiles and alligators are classified as reptiles
   C. entertain readers with interesting facts about crocodiles and alligators
   D. convince readers to keep a safe distance from dangerous reptiles

Part B: BCR. Answer by writing a paragraph with supports from the text.

In your own words, explain how crocodiles and alligators are different. Use information from the text to support your answer.

____

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Appendix C

Posttest 1 A

Name__________________________

Date___________________________

Octopus and Squid

Have you seen an octopus before? What about a squid? You probably remembered that they were both sea creatures and that they both have lots of tentacles, or long arms with suction cups. You are right, of course. They use their tentacles to move as well as to capture fish, crabs, and other sea creatures for food. They belong to the family of invertebrates, which means that they do not have skeletal backbones. Instead, these creatures have a mantle or skin cover that protects their body. Both can live in shallow waters or the deep oceans. Many species of the octopus and squid can change color to blend with their backgrounds and even squirt out ink to confuse their enemies, such as the sperm whale. While these two creatures have a lot in common, they also have differences.

One main difference between the octopus and the squid is that they do look different. First, count their arms. An octopus has eight arms or tentacles. On the other hand, the squid has ten arms. Some scientists say that eight of the squid's arms are arms with suction cups, and the other two are tentacles because they are longer than the other eight arms. Next, look at their body shapes. The octopus is more rounded, with the tentacles attached to a bulb-like head. There is hardly any body at all. In contrast, the squid has a tube-like body and the arms are all attached to a small head on one end.

Another major difference between the two creatures is the size. Some octopuses only grow to be 2 inches, but larger species of octopus can have arms that are 16 feet long. Similarly, some squids only grow to be 2 inches; however, the giant squid can grow 20 to 50 feet. From observing suction cup scars that squids left on whales, some scientists decided that some squids may be as large as 200 feet! The squid is the largest of all invertebrates.

One other difference between the octopus and the squid is their behavior and habits. The octopus often crawls on its tentacles. The squid only swims. Since the octopus has no bones, it can crawl through small holes. On the other hand, the squid has a shell called a “pen” under its mantle, so it cannot squeeze through small spaces like the octopus. The octopus also likes to stay in its territory. In contrast, the squid swims all over the place and migrates.

The octopus and the squid may be different in many ways, but one thing is common-- they are eaten as food by many people, particularly those from

Mediterranean Countries and Asian countries around the Pacific ocean. Scientists also like to study them because they are smart creatures and useful for research.

Part A: Questions

Select the correct answer for each question.

1. The article is mainly about ______________________.
   A. the habits and behaviors of the octopus and the squid
   B. the many differences between the octopus and the squid
   C. the similarities and differences between the octopus and the squid
   D. the many invertebrates related to the octopus and the squid

2. According to the article, what is the first thing you can do to tell the difference between an octopus and a squid?
   A. Look at their body shapes.
   B. Watch how they behave.
   C. See if the creature can crawl through a small hole.
   D. Count their arms.

3. Why is it that an octopus can squeeze through a small hole?
   A. The squid has a "pen" in the mantle.
   B. The octopus has a "pen" in the mantle.
   C. The octopus has no bones or shell in its body.
   D. Compared to the squid, the octopus is more skilled and clever.

4. Which of the following tells how the behavior of the octopus is different than that of the squid?
   A. The octopus may walk or crawl on the bottom of the sea.
   B. The octopus can squirt out ink to confuse its enemy.
   C. The octopus may be small and only grow to be 2 inches.
   D. Many people eat the octopus.

5. Predict what may happen if a squid encounters a large enemy such as the sperm whale.
   A. The squid may shoot poison into the whale and then immobilize it.
   B. The squid may wrap its tentacles around the whale and eat it by pulling it into its mouth.
   C. The squid may squirt out ink, but if it can't get away then it will wrap its tentacles around the whale and fight.
   D. The squid may be frightened and becomes still, then sperm whale swallows it.

6. In the article, the word "invertebrates" means __________________.
   A. covered by skin
   B. covered with a mantle

C. no backbone
D. sea creature

7. According to the passage, who eats squids and octopus?
   A. people in some African countries
   B. people from Mediterranean countries and East Europe
   C. people who go to special fancy restaurants
   D. people from Mediterranean Countries and some Asian countries

8. The information in the article suggests that ____________________.
   A. the octopus and the squid are an important food resource
   B. the octopus and the squid are endangered species
   C. the octopus and the squid are dangerous creatures
   D. the octopus and the squid are friendly to humans

9. Which of the following is an opinion?
   A. Some species of the octopus can squirt out ink to confuse its enemies.
   B. The octopus is more interesting than the squid because it can swim, crawl, and squeeze through small holes.
   C. The giant squid is the largest invertebrate in the world.
   D. The giant squid has a "pen" under its mantle and therefore cannot squeeze through small holes.

10. The author mainly wrote this article to ______________________.
   A. explain how the octopus and the squid belong to the same scientific family, yet they have their differences
   B. entertain readers with interesting facts about the octopus and the squid
   C. explain why the octopus and the squid have ways to escape from their natural enemies. For example, they may squirt ink
   D. convince readers to try and eat some octopus and squid

Part B: BCR. Answer by writing a paragraph with supports from the text.

In your own words, explain how the octopus is different than the squid. Use information from the text to support your answer.

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Posttest 2

Name________________________

Date_________________________

Butterflies and Moths

You may have seen colorful butterflies fluttering in the breeze before, or seen pictures of butterflies. Some poets describe them as flowers that fly. Sometimes what people think is a butterfly may be a moth. Although many people think that butterflies are colorful and moths are dull, that is not always true. Some butterflies can be plain and some moths colorful. Butterflies and moths look similar and belong to the same winged insect family called Lepidoptera. The word "Lepidoptera" is derived from a Greek word meaning "scale wing." There are 165,000 species of Lepidoptera worldwide, of which 24,000 are butterflies and the others are moths. Butterflies and moths range in size from a tiny 1/8 inch to a huge almost 12 inches. They both go through a life cycle that takes them through different stages called metamorphosis. They hatch from eggs and live as larvae known as caterpillars. Then the caterpillars change into pupae, and finally emerge as full grown adults. The adults lay eggs and die soon after. Then the life cycle starts over for a new generation. So how can you tell the difference between a butterfly and a moth?

Although the butterfly and moth look similar, there are ways to tell them apart. First, look at their feelers or antennae on top of their heads. The butterflies have thin antennae. At the end of each antenna is a little knob. The moths, on the other hand, have feathery looking antennae and they appear thicker. Second, look at their bodies. The butterflies have thin bodies while the moths have thicker, plump bodies.

Another way you can tell butterflies apart from moths is by observing how they fold their wings when they rest. Butterflies fold their wings up or they spread them out at an angle. Moths fold their wings flat over their bodies. Many moths end up looking like a triangular shape when they are at rest.

One last way to tell butterflies apart from moths is by their habits. Butterflies usually fly in the day while moths tend to fly out at night. Some butterflies even use poison as a defense system. For example, the monarch butterfly feeds on poisonous plants such as the milkweed so that few birds would want to eat them. Moths are not known to use poison as a defense system.

Both butterflies and moths help plants grow. They bring pollen from flower to flower, pollinating them so that new fruits can be formed. They are also beautiful to look at. Some people even collect them as specimens!

Questions

Part A: Questions

Select the correct answer for each question.

1. The article is mainly about ________________________.
   A. the habits and behaviors of butterflies and moths
   B. the importance of butterflies and moths in the plant world
   C. the similarities and differences between butterflies and moths
   D. how butterflies and moths are related and belong to the same family

2. According to the article, what is the first thing you can do to tell the difference between butterflies and moths?
   A. Observe how they fold their wings.
   B. Watch how they behave.
   C. Look at their antennae.
   D. Check to see whether they feed on milkweed.

3. The stages that butterflies and moths go through can be explained as _________.
   A. eggs, pupae, larvae, adult
   B. eggs, larvae, pupae, adult
   C. eggs, caterpillars, larvae, adult
   D. adult, eggs, pupae, larvae

4. Which of the following tells how the behavior of butterflies is different than that of moths?
   A. Butterflies fly in the day while moths fly at night.
   B. Butterflies are colorful while moths are dull-colored.
   C. Moths may have poisons.
   D. Butterflies have thin antennae while moths have thick feathery antennae.

5. Predict what may happen if a bird eats the monarch butterfly.
   A. The bird will enjoy a good meal.
   B. The bird may not care that the monarch butterfly looks beautiful.
   C. The bird may get sick or it may die.
   D. The bird will try to eat more monarch butterflies after it tried one.

6. In the article, the word “metamorphosis” means ____________________.
   A. growing up
   B. a type of butterflies
   C. a type of winged insect
   D. a cycle of changes

7. Which of the following sentences states a fact?
   A. Butterflies are more colorful and moths are always dull.
   B. Butterflies and moths range in sizes, from a tiny 1/16 inch to 12 inches.
   C. Butterflies belong to a group called Lepidoptera while moths belong to a

different family.

D. Both butterflies and moths go through metamorphosis to become adults.

8. The information in the article suggests that ____________________.

A. butterflies and moths are important because they help plants

B. butterflies and moths are endangered species

C. butterflies and moths should be collected as specimens

D. butterflies and moths use poison as a defense against their enemies

9. Which of the following is an opinion?

A. Many butterflies fold their wings up when they are at rest.

B. Butterflies are more interesting and colorful than moths.

C. Butterflies and moths belong to the Lepidoptera family.

D. Moths usually fly out at night.

10. The author mainly wrote this article to ______________________.

A. explain how butterflies and moths belong to the same scientific family, yet they have their differences

B. entertain readers with interesting facts about butterflies and moths

C. explain why butterflies and moths go through metamorphosis

D. convince readers to save butterflies and moths from extinction

Part B: BCR. Answer by writing a paragraph with supports from the text.

In your own words, explain how to tell butterflies apart from moths. Use information from the text to support your answer.

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Posttest 1B (Alternative)

Poisonous and Nonpoisonous Snakes of America

Many people are afraid of snakes. Most snakes are more afraid of people. One thing that makes people especially cautious about snakes is that some of them are poisonous. There are about 2,700 species of snakes. Only about 250 species are poisonous. How are poisonous snakes different from nonpoisonous snakes? Poisonous snakes have fangs with hollow grooves. The snakes inject venom through their fangs when they bite. Nonpoisonous snakes have no fangs or venom. However, there is no easy way to distinguish all poisonous snakes from nonpoisonous ones. A person must either recognize the special features of specific species, or see whether the snake has fangs.

In America, there are only two main types of poisonous snakes-- the coral snake and the group known as pit vipers. The coral snake is brightly colored. It has orange, white, and black sections. The coral snake has short front fangs that are fixed in place.

The other group of poisonous snakes is the pit viper. It has its name because these snakes have pits or **depressions** around the eyes and nostrils. These pits are infrared-ray detectors that help them find prey in the dark. These snakes have venom that is produced in a large gland behind the eye. When the snake bites its prey, venom is forced down from the venom glands into ducts. The ducts lead to the teeth, which is like a hallow needle. Then the snake venom is shot into the prey. Most of the pit vipers in the United States are rattlesnakes. The largest rattler is the diamondback, which grows up to more than 7 feet (2 meters). These snakes are called rattlers because they have a "rattle" at the end of their tails made of hard skin. They rattle when they are disturbed. Other types of pit vipers include the copperhead and the water moccasin. The copperhead also accounts for most cases of venomous snake bites in the country. However, its venom is rather mild. Unlike copperheads that live on land, the water moccasin lives in shallow waters. It is also a type of viper, but its fangs are short. Its venom is stronger than the copperhead. Pit vipers mainly eat rodents and smaller creatures.

There are many species of nonpoisonous snakes in America. The nonpoisonous snakes include blind snakes, water snakes, bull snakes, rat snakes, black snakes, garter snakes, brown snakes, water snakes, and corn snakes. Scientists classify 75% of all snakes as common harmless snakes. The blind snake looks like a worm and burrows in the ground. They are often small, less than a foot. The water snakes live in edges of lakes and streams. Most of these common harmless snakes eat mice and other small creatures. Of all the nonpoisonous snakes mentioned, the king snake is quite unusual. It will also eat other snakes. It would wrap itself around a snake of a different species and crush it by constricting.

Poisonous or not, most snakes are really not interested in harming humans unless they felt threatened. In fact, snakes help people in many ways. They eat up rodents, insects, and pests that eat up our crops or infest the area. Scientists claim that they form part of the environment and help preserve the balance of nature. Certain species of snakes also make good pets. Some people even make snake products for money. Oddly enough, the most valuable product of a snake is its venom. The price ranges from $40 a gram to $200 a gram!

Part A: Questions

Select the correct answer for each question.

1. How is a poisonous snake different from a nonpoisonous snake?
  A. A poisonous snake is colorful, but a nonpoisonous snake is plain.
  B. A poisonous snake has venom, but a nonpoisonous snake has a rattler on its tail.
  C. A poisonous snake lives in the water, but a nonpoisonous snake lives on land.
  D. A poisonous snake has fangs with hollow grooves, but a nonpoisonous snake does not.

2. The word "depression" in paragraph 3 means __________________.
  A. a sad mood or feeling of dejection
  B. a sunken place that is deeper than the surrounding
  C. a time when people have little money and few jobs
  D. low atmospheric pressure

3. Which of the following expresses an opinion?
  A. Snakes can be dangerous because some are poisonous.
  B. Snakes can be helpful to humans.
  C. It is very easy to identify poisonous snakes from nonpoisonous ones.
  D. The largest rattler is the diamondback.

4. Predict what may happen if there are no snakes (poisonous or nonpoisonous).
  A. There will be more rodents, insects, and pests.
  B. People will lead happier, safer lives.
  C. There will be more fish like eels that look like snakes but are not really snakes.
  D. People will manufacture lots of venom from chemicals instead.

5. The passage does not say, but we can decide that ___________________.
  A. people bitten by the copperhead will all die
  B. people bitten by the copperhead usually will survive
  C. the water moccasin is less dangerous than the bull snake
  D. the king snake is very dangerous to humans because it can constrict

6. According to the passage, ______________________________.
  A. it is easy to distinguish poisonous snakes from the nonpoisonous ones

B. all snakes have fangs
C. snakes are helpful to humans because they eat mice and other pests
D. snakes are dangerous and should be killed

7. The most valuable part of a snake is ___________________.
A. the rattle
B. the leather or skin
C. the fangs
D. the venom

8.How does a poisonous snake put its venom in the prey?
A. Venom is produced in venom glands located under the eyes or pits of the poisonous snake.
B. Venom from the glands goes into ducts that lead to the hollow, needle-like teeth. The venom is then shot into the prey when the snake bites.
C. Venom is spat out by the snake's forked tongue, which paralyzes its prey.
D. Venom is produced by bacterium located under the skin and teeth. When the snake bites its prey, the prey will be infected.

9.One point the author wants the readers to know is that __________________.
A. it is easy to tell a poisonous snake apart from a nonpoisonous snake
B. snakes form part of the environment and help preserve the balance of nature
C. snakes make good pets once their venom glands are removed
D. copperheads account for the most frequent venomous snake bites, and many people died as a result

10. The passage is mainly about ________________________.
A. how to tell poisonous and nonpoisonous snakes of America apart, and how snakes are actually good for the environment
B. why we need to get rid of the two kinds of snakes-- the poisonous and nonpoisonous snakes of America
C. how people can make money off poisonous snakes
D. the poisonous and nonpoisonous snakes of America are alike in many ways, and the king snake is best of all

Part B: BCR. Answer by writing a paragraph with supports from the text.

Explain how to tell poisonous snakes apart from nonpoisonous snakes. Use information from the passage to support your answer.

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Appendix D

LESSON PLANS

EXPERIMENTAL GROUP INSTRUCTION

Set 1: Representational Instruction Using Visual Aids

Time Allotted:

Two class periods (45 minutes each). For day 2, continue where the class left off after repeating "What is Mental Imagery."

Materials:

The passage "Marianna Trench," paper, pencils, picture of the Mariana Trench, pictures of undersea animals such as tube worms, angler fish, under water hydro-thermal vents, submersible, Map of the World

Objective: Students will be able to use visual aids to help create mental imageries connected with the Mariana Trench

Introduction: (5 minutes)

Ask students if they know how deep is the deepest part of the ocean. Show a picture of what it may look like. (Pictures of the ocean trench and various sea creatures can be easily obtained on the Internet.) Generate some discussion.

Warm-up: (7 minutes)

Ask students to locate the Marianna Trench using the Map of the World.

Teacher Directed Instruction:

What is Mental Imagery?

Explain to the students that they will be learning a strategy that will help them understand what they read better and make what they read more interesting, building on the knowledge and experience that they have. The strategy is called mental imagery. Much of the strategy involves making pictures in their minds. It also includes recalling images, sensations, and feelings experienced that relate to what they read-- including smells, feelings, sensations, sounds, and tastes.

Directed Practice:

Read the first paragraph to the students and give examples of images that form in your head as you read (during reading images). Then sum up as a complete package what the text about the "Marianna Trench" makes you see, sense, or feel (after reading image).

Encourage students to share some of their mental images.

Paired Practice:

With a partner, students will read the rest of the passage and discuss with a partner what other mental images they could bring up. (If the class dynamics is one that is uncooperative, have students read independently. At regular interval such as 10 minutes, ask students to share what they have thought about, and share some examples.) When the students have completed their discussion, show them pictures of undersea creatures, etc. Ask students if they noticed a match in their mental imagery and what it really looked like. Discuss how words may not fully describe everything, but they should find that the basic information for forming mental images is there.

Independent Practice:

Students will review the passage on their own and answer comprehension questions independently. Check answers. Discuss how seeing the pictures helped them understand the passage better.

Conclusion:

Tell the students they did a good job, and that next time, they will be drawing their own pictures to help them understand the passage better.

Appendix D

LESSON PLANS

EXPERIMENTAL GROUP INSTRUCTION

Set 2: Representational Instruction Using Mental Pictures and Self-Generated Drawings

Time Allotted:

Two class periods. For Day 2, continue where the class left off after reminding them that their task is to draw diagrams and pictures that come to their minds and that will help them understand the passage better.

Materials: The passage "Volcanic Eruptions," paper, pencils

Objective:

Students will be able to create mental images, pictures and diagrams to help them understand and interpret the passage.

Warm-up: (5 minutes)

Ask students if they know something about volcanoes. Generate some discussion.

Teacher Directed Instruction:

Tell students that when they form mental images in their heads, one way to record it is to draw diagrams and pictures. These pictures and diagrams do not have to be beautiful art pieces. Stick figures will do. The purpose is to draw quick pictures and diagrams that will help them with understanding the passage-- not any random beautiful picture. They need to know that since this is a strategy for comprehension, they cannot take too long, because this is not for art. Usually when they do any reading task like this, such as benchmark tests, they have limited time.

Directed Practice:

Read the first paragraph to the students and give examples of images that form in your head as you read (during reading images). Draw some quick diagrams or pictures on the board to demonstrate this. Then sum up as a complete package what the first paragraph makes you feel or see by drawing another quick drawing (after reading images).

Paired Practice:

With a partner, students will read the rest of the passage. They will draw pictures and diagrams, and discuss with a partner what other mental images they could bring up. (If the class dynamics is one that is uncooperative, have students read independently. At regular interval such as 10 minutes, ask students to share what they have drawn, and share some samples.) Ask if they noticed a match or some differences on their pictures and what someone else had. Tell them how it is all fine as long as the picture relates to the passage and helps them understand the text better. Encourage students to share some of their mental images.

Independent Practice:

Students will review the passage on their own and answer comprehension questions independently. Check answers. Discuss how drawing the pictures helped them understand the passage better.

Conclusion:

Tell the students they did a good job, and that next time they will be using mental pictures and think-along ideas.

Appendix D

LESSON PLANS

EXPERIMENTAL GROUP INSTRUCTION

Set 3: Representational Instruction Using Mental Pictures and Think-along Ideas

Time Allotted:

Two class periods. For Day 1, students will use the passage “Earthquake Resistant Buildings.” For Day 2, continue the same directions except use the passage “Is There Life on Mars?”

Materials:

The passages mentioned above, paper, pencils (overhead projector and transparency is a good option instead of writing on the board), Images Chart (See Appendix E.)

Objective:

Students will be able to create mental images and write think-along ideas that help them understand and interpret the passage.

Warm-up: (5 minutes)

Ask students if they know something about the topic of the day (Day 1, Earthquakes; Day 2, Mars). Generate some discussion.

Teacher Directed Instruction:

Tell students that when they form mental images in their heads, one way to record it is to write down think-along ideas. These ideas may be a description of a picture or sensation, a quick summary, a question, a clarification, a prediction, a personal response, or something recorded on an Images Chart. The purpose is to respond to the text and write down something that will help them understanding and relate to the passage.

Directed Practice:

Read the first paragraph to the students and give examples of images that form in your head as you read (during reading images). Demonstrate what you would write as think-along ideas by either writing on the board or writing on a sheet of transparency using the overhead projector. You may demonstrate how to use the Images Chart. Demonstrate a couple of "during reading" think-along ideas and one conclusive "after reading" think-along idea for the first paragraph.

Paired Practice:

With a partner, students will read the rest of the passage. They will write think-along ideas either using regular writing paper or the Images Chart, and discuss with a partner what other mental images they could bring up. Tell them to generate two think-along ideas per paragraph. (If the class dynamics is one that is uncooperative, have students read independently and write think-along ideas on their own. At regular interval such as 10 minutes, ask students to share what they have written as think-along ideas.) Ask if they noticed a match or have some differences on their think-along ideas compared to other ideas shared. Tell them how it is all fine as long as they think about the passage and that their ideas help them understand and connect with the passage.

Independent Practice:

Students will review the passage on their own and answer comprehension questions independently. Check answers. Discuss how writing the think-along ideas or using the Images Chart helped them understand the passage better.

Conclusion:

Tell the students they did a good job and what to expect next time. After Set 3, Day 1, students will be using the passage for Set 3, Day 2. After Set 3, Day 2, they will be using mental images with vocabulary or using mental imagery to learn unfamiliar words in passages.

Appendix D

LESSON PLANS

EXPERIMENTAL GROUP INSTRUCTION

Set 4: Representational Instruction Targeting Unfamiliar Vocabulary

Time Allotted:

Two class periods. For Day 1, students will use the passage “What It Is Like on the Moon.” For Day 2, continue the same directions except use the passage “Mt. Everest.”

Materials:

The passages mentioned above, paper, pencils (overhead projector and transparency is a good option instead of writing on the board)

Objective:

Students will be able to use mental imagery strategy to target some unfamiliar vocabulary they may encounter in passages (LINCS strategy).

Warm-up: (5 minutes)

Ask students if they know something about the topic of the day (Day 1, the moon; Day 2, Mt. Everest). Generate some discussion.

Teacher Directed Instruction:

Tell students that when they encounter unfamiliar words, they can form mental images using the clues in the passage to figure out the meaning as well as learn the words and remember them better by using mental images. They will be using the LINCS strategy for vocabulary words. There will be five parts or steps to this process.

They may use a sheet of paper and divide it into four parts or use a chart (illustrated below) for this practice. (Other options include index cards-- two parts per side.)

Directed Practice:

Ask the students to skim the passage and find a couple of unfamiliar or difficult words. Write them on the board or use an overhead projector. Then select one as a sample to do with the class. The LINCS strategy procedures are as follows:

1. Find an unfamiliar or difficult word and write it down.
2. Define the word. This may be done either using context clues or a dictionary. Read the sentence that contains the targeted vocabulary word. (If you need more context clues, read a few more sentences near the targeted vocabulary word.) Figure out what it means. Write the definition. If there are no context clues, use a dictionary for the definition.
3. Write a “reminder” word that may help you think of this vocabulary word (mnemonic device). This word may rhyme or be a word part or somehow cause someone to think about the targeted vocabulary word. (A different person may have a different reminding word since people do not think all alike.)
4. Write a sentence using the reminder word and the targeted vocabulary word.
5. Draw an illustration of this word being used.

The following chart (Figure 7) demonstrates two vocabulary words from “Mt. Everest.”

Figure 7

Sample Visual-cue Vocabulary Chart: Words from Mt. Everest

Unfamiliar Word	***Definition***	***Sentence w/ Unfamiliar Word & "Reminder" Word***	***Illustration***
Avalanche ***"Reminder" Word***: launch	a rapid downhill flow of a large mass of snow or ice dislodged from a mountainside, or a similar fall of rocks and earth	The scream launched an **avalanche**.	A diagram showing a person screaming-- ice and snow falls from the top of a mountain.
Endurance ***"Reminder" Word***: endure	the ability or power to bear prolonged exertion, pain, or hardship	The coat helped him **endure** the cold because he didn't have natural **endurance** for freezing weather.	A picture of a person wearing a big coat. Snow flakes falling.

Encourage students to share some of their vocabulary words with "reminder" words, definitions, sentences, and illustrations.

You may ask students to make a chart just like the one above for their vocabulary words.

Paired Practice:

With a partner, students will read the passage. They will target two unfamiliar words from the passage and complete the vocabulary practice using the LINCS strategy. If students are really good readers who know all the vocabulary words well, they should choose two words that may be difficult for other 6th graders. This practice will only familiarize them to a method of learning vocabulary, not to actually increase their vocabulary. Tell them that they may want to try this strategy on some new words they may encounter in the future. For students who really have difficulty with some of the words, this method will help them link related experience with the unfamiliar words and help them learn. (If the class dynamics is one that is uncooperative, have students work independently. At regular interval such as 10 minutes, ask students to share what they have written and illustrated, and share some examples.)

Independent Practice:

Students will review the passage on their own and answer comprehensive questions independently. Check answers. Discuss how using mental links and images with vocabulary may have helped students understand the words and passage better.

Conclusion:

Tell the students they did a good job and what to expect next time. After Set 4, Day 1, students will read and do activities for the Set 4, Day 2 passage. After Set 4, Day 2, students will be using their own choices of mental imaging devices to help them understand and relate to the passage better.

Appendix D

LESSON PLANS

EXPERIMENTAL GROUP INSTRUCTION

Set 5: Representational Instruction Using Devices of Students' Choice

Time Allotted:

Two class periods. For Day 1, use passage “Puffer Fish;” for Day 2, use passage “Piranhas.”

Materials:

The passages listed above, paper, pencils, Images Chart

Objective:

Students will be able to select mental imagery techniques that are most effective for them, such as creating mental images, drawing pictures and diagrams, using think-along ideas, using Images Chart, and linking imagery with vocabulary to help them understand and interpret the passage.

Warm-up: (5 minutes)

Ask students if they know something about the topics of the day (Day 1, puffer fish; Day 2, piranhas.) Generate some discussion.

Teacher Directed Instruction:

Tell students that they have learned a variety of ways to make mental imagery work for them. Now they will choose the ones most useful to them when they read.

Directed Practice:

Read the first paragraph to the students and give examples of different imagery techniques that worked for you.

Paired Practice:

Ask students to pair up and read the passage together. Each student will use some imagery strategy (about two per paragraph). They may use and share ideas within their groups. (For classes that are not cooperative, ask students to read by themselves, and at certain time intervals-- about 10 minutes, do a quick “check” and ask students to share with the class some examples of imagery strategy that worked for them.

Independent Practice:

Ask students to do the comprehension questions on their own. Check answers. Discuss why the answers given are correct.

Conclusion:

Tell students they did a good job and to expect a posttest after the Day 2 passage.

Appendix D

LESSON PLANS

COMPARISON GROUP INSTRUCTION

Materials:

The reading passages, paper, pencils (similar to the experimental group, except that there will be no extra pictures or other aids)

Objective:

Students will be able to read passages carefully and answer comprehensive questions.

Introduction: (3 minutes)

Tell the students that they will have a two-week unit on science-type reading passages and that it will help them understand similar passages in science books, county tests, and state tests. (After Day 1, skip the Introduction part.)

Warm-up: (7 minutes)

For each lesson, the passages are the same as the experimental group. Always ask for some background knowledge about the topic of the day, and generate some discussion.

Teacher Directed Instruction:

Ask students to read carefully. Read the first paragraph out-loud to the students and point out some important facts.

Paired Practice:

Ask students to pair up and read the passage together. (For classes that are not cooperative, ask students to read by themselves, and at certain time intervals (about 10 minutes), do a quick “facts check” and ask students to share with the class some important information that they read.

Independent Practice:

Ask students to do the comprehension questions on their own. Check answers. Discuss why the answers given are correct.

Conclusion: Tell students they did a good job, and what passage to expect the next day.

Appendix E

NAME________________________________

DATE________________________________

IMAGES CHART

ASSIGNMENT:____

What I See	***What I Hear***
What I Taste	***What I Smell***
What I feel (sense of touch)	***What I sense***

Appendix F

Name______________________
Grade______________________
Teacher_____________________
[ ] Boy [ ] Girl

Sheveland Vividness of Imagery Questionnaire

Very Clear: Vivid	Moder-ately Clear & Vivid	Not Clear but Recog-nizable	Vague and Dim	No Image Just Know
4	3	2	1	0

Vision: Your mind's eyes:

1.Your favorite relative's face					
2.The sun setting: sunset					
3.A red apple					

Sound: Your mind's ears:

1.A fire truck siren					
2.The mewing of a cat					
3.The clapping of hands					

Feel: Your mind's hands:

1.Sand					
2.Fur					
3.The prick of a pin					

Action: Your mind's sense of movement:

1.Running upstairs					
2.Drawing a circle on paper					
3.Reaching up to a high shelf					

Taste: Your mind's mouth:

1.Salt					
2.Oranges					
3.Jelly					

Smell: Your mind's nose:

1.Pizza baking					
2.Fresh paint					
3.Freshly mown grass					

Sensations: Your mind's sense of feel:

1.Hunger					
2.A sore throat					
3.Sleepiness					

(Sheveland, 1992)

Appendix G

MENTAL IMAGERY LESSON PLAN FRAMEWORK

AUXILIARY INSTRUCTION

(FOR COMPARISON GROUP AFTER EXPERIMENTAL PROJECT)

BACKGROUND

This lesson plan framework is designed to teach students how to use mental imagery that activates all their senses while reading. The framework can be adjusted to teach any reading text for any class. It is suggested to take two weeks to teach the students using teacher choice of materials. The instructional reading materials may be selections from a basal reader, student magazines such as *Current Science* (Weekly Reader, Delran, NJ), *TIME for Kids* (*TIME*, New York, NY), *Scholastic SCOPE* (Scholastic, Jefferson City, MO), or any other choice. While this method can be used to teach narrative text, the thrust of this study is to teach students how to use mental imagery with expository text, so selecting expository reading materials and providing students with more opportunity with expository text is important. The key points of the Instruction are similar to the main experimental study and contain the following steps.

1. Representational Instruction Using Visual Aids
2. Representational Instruction Using Mental Pictures and Self-Generated Drawings
3. Representational Instruction Using Mental Pictures and Think-along Ideas
4. Representational Instruction Targeting Unfamiliar Vocabulary
5. Representational Instruction Using Devices of Students' Choice

Set 1: Representational Instruction Using Visual Aids

Time Allotted:

Two class periods (45 minutes each). For day 2, continue where the class left off after repeating "What is Mental Imagery."

Materials:

Select reading material that has some visual aids.

Objective: Students will be able to use visual aids to help create mental imageries while reading.

Introduction: (5 minutes)

Ask students if they know anything about the topic. Generate some discussion.

Warm-up: (7 minutes)

Write down three facts you already know about the topic.

Teacher Directed Instruction:

What is Mental Imagery?

Explain to the students that they will be learning a strategy that will help them understand what they read better and make what they read more interesting, building on the knowledge and experience that they have. The strategy is called mental imagery. Much of the strategy involves making pictures in their minds. It also includes recalling images, sensations, and feelings experienced that relate to what they read-- including smells, feelings, sensations, sounds, and tastes.

Directed Practice:

Read the first paragraph to the students and give examples of images that form in your head as you read (during reading images). Then sum up as a complete package what the text about the selected paragraph makes you see, sense, or feel (after reading image).

Encourage students to share some of their mental images.

Paired Practice:

With a partner, students will read the rest of the passage and discuss with a partner what other mental images they could bring up. (If the class dynamics is one that is uncooperative, have students read independently. At regular interval such as 10 minutes, ask students to share what they have thought about, and share some examples.) When the students have completed their discussion, show them more pictures or draw diagrams on the board for other aspects for which the article did not provide visual aid. Ask students if they noticed a match in their mental imagery and what it really looked like. Discuss how words may not fully describe everything, but they should find that the basic information for forming mental images is there.

Independent Practice:

Students will review the passage on their own and answer comprehension questions independently (if provided by the article, otherwise, do summarizing or create some questions). Check answers. Discuss how seeing the pictures helped them understand the passage better.

Conclusion:

Tell the students they did a good job, and that next time, they will be drawing their own pictures to help them understand the passage better.

Appendix G

MENTAL IMAGERY LESSON PLAN FRAMEWORK

AUXILIARY INSTRUCTION

(FOR COMPARISON GROUP AFTER EXPERIMENTAL PROJECT)

Set 2: Representational Instruction Using Mental Pictures and Self-Generated Drawings

Time Allotted:

Two class periods. For Day 2, continue where the class left off after reminding them that their task is to draw diagrams and pictures that come to their minds and that will help them understand the passage better.

Materials: A suitable passage, paper, pencils

Objective:

Students will be able to create mental images, pictures and diagrams to help them understand and interpret the passage.

Warm-up: (5 minutes)

Ask students if they know something about the topic. Generate some discussion.

Teacher Directed Instruction:

Tell students that when they form mental images in their heads, one way to record it is to draw diagrams and pictures. These pictures and diagrams do not have to be beautiful art pieces. Stick figures will do. The purpose is to draw quick pictures and diagrams that will help them with understanding the passage-- not any random beautiful picture. They need to know that since this is a strategy for comprehension, they cannot take too long, because this is not for art. Usually when they do any reading task like this, such as benchmark tests, they have limited time.

Directed Practice:

Read the first paragraph to the students and give examples of images that form in your head as you read (during reading images). Draw some quick diagrams or pictures on the board to demonstrate this. Then sum up as a complete package what the first paragraph makes you feel or see by drawing another quick drawing (after reading images).

Paired Practice:

With a partner, students will read the rest of the passage. They will draw pictures and diagrams, and discuss with a partner what other mental images they could bring up. (If the class dynamics is one that is uncooperative, have students read independently. At regular interval such as 10 minutes, ask students to share what they have drawn, and share some samples.) Ask if they noticed a match or some differences on their pictures and what someone else had. Tell them how it is all fine as long as the picture relates to the passage and helps them understand the text better. Encourage students to share some of their mental images.

Independent Practice:

Students will review the passage on their own and answer comprehension questions independently. Check answers. Discuss how drawing the pictures helped them understand the passage better.

Conclusion:

Tell the students they did a good job, and that next time they will be using mental pictures and think-along ideas.

Appendix G

MENTAL IMAGERY LESSON PLAN FRAMEWORK

AUXILIARY INSTRUCTION

(FOR COMPARISON GROUP AFTER EXPERIMENTAL PROJECT)

Set 3: Representational Instruction Using Mental Pictures and Think-along Ideas

Time Allotted:

Two class periods. (Students can proceed at a faster rate now, and may read passages and form imagery quicker.)

Materials:

Two selected articles or a longer passage, paper, pencils (overhead projector and transparency is a good option instead of writing on the board), Images Chart (See Appendix E.)

Objective:

Students will be able to create mental images and write think-along ideas that help them understand and interpret the passage.

Warm-up: (5 minutes)

Ask students if they know something about the topic of the day. Generate some discussion.

Teacher Directed Instruction:

Tell students that when they form mental images in their heads, one way to record it is to write down think-along ideas. These ideas may be a description of a picture or sensation, a quick summary, a question, a clarification, a prediction, a personal response, or something recorded on an Images Chart. The purpose is to respond to the text and write down something that will help them understanding and relate to the passage.

Directed Practice:

Read the first paragraph to the students and give examples of images that form in your head as you read (during reading images). Demonstrate what you would write as think-along ideas by either writing on the board or writing on a sheet of transparency using the overhead projector. You may demonstrate how to use the Images Chart. Demonstrate a couple of "during reading" think-along ideas and one conclusive "after reading" think-along idea for the first paragraph.

Paired Practice:

With a partner, students will read the rest of the passage. They will write think-along ideas either using regular writing paper or the Images Chart, and discuss with a partner what other mental images they could bring up. Tell them to generate two think-along ideas per paragraph. (If the class dynamics is one that is uncooperative, have students read independently and write think-along ideas on their own. At regular interval such as 10 minutes, ask students to share what they have written as think-along ideas.) Ask if they noticed a match or have some differences on their think-along ideas compared to other ideas shared. Tell them how it is all fine as long as they think about the passage and that their ideas help them understand and connect with the passage.

Independent Practice:

Students will review the passage on their own and answer comprehension questions independently. Check answers. Discuss how writing the think-along ideas or using the Images Chart helped them understand the passage better.

Conclusion:

Tell the students they did a good job and what to expect next time. After Set 3, Day 2, they will be using mental images with vocabulary or using mental imagery to learn unfamiliar words in passages.

Appendix G

MENTAL IMAGERY LESSON PLAN FRAMEWORK

AUXILIARY INSTRUCTION

(FOR COMPARISON GROUP AFTER EXPERIMENTAL PROJECT)

Set 4: Representational Instruction Targeting Unfamiliar Vocabulary

Time Allotted:

Two class periods.

Materials:

Two short articles or a longer passage, paper, pencils (overhead projector and transparency is a good option instead of writing on the board)

Objective:

Students will be able to use mental imagery strategy to target some unfamiliar vocabulary they may encounter in passages (LINCS strategy).

Warm-up: (5 minutes)

Ask students to write down three things they know about the topic of the day. Generate some discussion.

Teacher Directed Instruction:

Tell students that when they encounter unfamiliar words, they can form mental images using the clues in the passage to figure out the meaning as well as learn the words and remember them better by using mental images. They will be using the LINCS strategy for vocabulary words. There will be five parts or steps to this process. They may use a sheet of paper and divide it into four parts or use a chart (illustrated below) for this practice. (Other options include index cards-- two parts per side.)

Directed Practice:

Ask the students to skim the passage and find a couple of unfamiliar or difficult words. Write them on the board or use an overhead projector. Then select one as a sample to do with the class. The LINCS strategy procedures are as follows:

1. Find an unfamiliar or difficult word and write it down.

2. Define the word. This may be done either using context clues or a dictionary. Read the sentence that contains the targeted vocabulary word. (If you need more context clues, read a few more sentences near the targeted vocabulary word.) Figure out what it means. Write the definition. If there are no context clues, use a dictionary for the definition.

3. Write a "reminder" word that may help you think of this vocabulary word (mnemonic device). This word may rhyme or be a word part or somehow cause someone to think about the targeted vocabulary word. (A different person may have a different reminding word since people do not think all alike.)

4. Write a sentence using the reminder word and the targeted vocabulary word.

5. Draw an illustration of this word being used.

Figure 7 demonstrates two vocabulary words from "Mt. Everest."

Figure 7

Sample Visual-cue Vocabulary Chart: Words from Mt. Everest

Unfamiliar Word	***Definition***	***Sentence w/ Unfamiliar Word & "Reminder" Word***	***Illustration***
Avalanche ***"Reminder" Word***: launch	a rapid downhill flow of a large mass of snow or ice dislodged from a mountainside, or a similar fall of rocks and earth	The scream launched an **avalanche**.	A diagram showing a person screaming-- ice and snow falls from the top of a mountain.
Endurance ***"Reminder" Word***: endure	the ability or power to bear prolonged exertion, pain, or hardship	The coat helped him **endure** the cold because he didn't have natural **endurance** for freezing weather.	A picture of a person wearing a big coat. Snow flakes falling.

Encourage students to share some of their vocabulary words with "reminder" words, definitions, sentences, and illustrations.

You may ask students to make a chart just like the one above for their vocabulary words.

Paired Practice:

With a partner, students will read the passage. They will target two unfamiliar words from the passage and complete the vocabulary practice using the LINCS strategy. If students are really good readers who know all the vocabulary words well, they should choose two words that may be difficult for other 6^{th} graders. This practice will familiarize them to a method of learning vocabulary. To actually increase their vocabulary, they need to rehearse the word many times and use the word frequently as part of their vocabulary. Tell them that they may want to try this strategy on some new words they may encounter in the future. For students who really have difficulty with some of the words, this method will help them link related experience with the unfamiliar words and help them learn. (If the class dynamics is one that is uncooperative, have students work independently. At regular interval such as 10 minutes, ask students to share what they have written and illustrated, and share some examples.)

Independent Practice:

Students will review the passage on their own and answer comprehensive questions independently. Check answers. Discuss how using mental links and images with vocabulary may have helped students understand the words and passage better.

Conclusion:

Tell the students they did a good job and what to expect next time. After Set 4, Day 2, students will be using their own choices of mental imaging devices to help them understand and relate to the passage better.

Appendix G

MENTAL IMAGERY LESSON PLAN FRAMEWORK

AUXILIARY INSTRUCTION

(FOR COMPARISON GROUP AFTER EXPERIMENTAL PROJECT)

Set 5: Representational Instruction Using Devices of Students' Choice

Time Allotted:

Two class periods.

Materials:

The “Bees and Wasps” article and another passage, paper, pencils, Images Chart

Objective:

Students will be able to select mental imagery techniques that are most effective for them, such as creating mental images, drawing pictures and diagrams, using think-along ideas, using Images Chart, and linking imagery with vocabulary to help them understand and interpret the passage.

Warm-up: (5 minutes)

Ask students to write down three things they know about the topic (bees and wasps). Generate some discussion.

Teacher Directed Instruction:

Tell students that they have learned a variety of ways to make mental imagery work for them. Now they will choose the ones most useful to them when they read.

Directed Practice:

Read the first paragraph to the students and give examples of different imagery techniques that worked for you.

Paired Practice:

Ask students to pair up and read the passage together. Each student will use some imagery strategy (about two per paragraph). They may use and share ideas within their groups. (For classes that are not cooperative, ask students to read by themselves, and at certain time intervals-- about 10 minutes, do a quick "check" and ask students to share with the class some examples of imagery strategy that worked for them.

Independent Practice:

Ask students to do the comprehension questions on their own. Check answers. Discuss why the answers given are correct.

Conclusion:

Tell students they did a good job and to expect a posttest after the Day 2 passage.

APPENDIX H

Informal Study: The Use of Mental Imagery as a Comprehension Strategy for Middle School Students Reading Science Expository Texts

Introduction

In the school year 2005-06, I conducted an informal study to investigate the effects of mental imagery instruction on sixth-grade students reading expository texts. Part of this project arose from the desire to help out my colleagues who were science teachers. They claimed that the students had a difficult time understanding science texts. Another reason for this informal study was to investigate effective strategies that would make reading expository texts interesting and meaningful, and hopefully, identify strategies that would help create better readers. After some research into the studies of mental imagery, I thought that pursuing mental imagery would be worthwhile.

Summary of Informal Study

At the time, I taught three sixth-grade reading classes: a Basic class, an On-grade-level class, and an Honors class. In the beginning of the school year, all the students took the *Gates-MacGinitie Reading Test* (2000) to identify their reading achievement level. Using a quasi-experimental pretest-posttest comparison group design, I assigned intact classes to experimental or comparison groups-- an Honors class (average reading level 9.0) and a Basic class (average reading level 4.1) were assigned to the experimental group, and the On-grade-level class (average reading level 5.7) was assigned to be the comparison group.

All students took the following pretests: (a) the Pretest for Expository Text: “Crocodiles and Alligators,” (b) the *Vividness of Imagery Questionnaire*, and (c) *Motivation to Read Profile*. Then I used a two-week time frame similar to a thematic unit to teach the students an “Informational Text Unit.” In middle school, students are familiar with such units. For example, in science class, students may have a two-week unit on volcanoes. In reading class, students may have a two-week unit on folk tales. For this “Informational Text Unit,” the experimental group received mental imagery instruction as a reading strategy for the expository texts. The comparison group did not receive any strategies; they were told to read the informational texts carefully and answer questions. After the two-week period, all students took the following posttests: (a) the Posttest for Expository Text: “Poisonous and Nonpoisonous Snakes of America,” (b) the *Vividness of Imagery Questionnaire*, and (c) *Motivation to Read Profile*.

The results were promising even though the sample size was small. Table 19 summarizes the data for the informal study.

Table 19

Informal Study Data by Classes

Class	***Number***	***Gates Test Percentile***	***Pretest Selected Response***	***Posttest Selected Response***	***Pretest BCR (3-pt scale)***	***Posttest BCR (3-pt scale)***
A (Contr.)	23	43.43	73.50%	67.70%	1.75	1.83
B (Exper.)	20	81.65	82.00%	93.00%	2.63	2.45
C (Exper.)	12	15.25	51.00%	62.50%	1.04	2.14

Class A, the comparison group, did not appear to make any gains. Half the students read the passage “Alligators and Crocodiles” as pretest, while the other half read “Poisonous and Nonpoisonous Snakes” as pretest. For the posttest, the students read the passage they did not use before. Students' scores on the pretest and posttest were about the same.

The Honors class, Class B, appeared to make some gain in their Selected Response (SR) portion of the Posttest. Prior studies in the field, such as the studies by Oakhill and Patel (1991) and Pressley's (1976), suggested that good readers already do well, and that mental imagery strategy may not help good readers improve much more. In this instance, the class average for the Pretest was 8.2 (on a 10-point scale) or 82%. The Posttest showed 9.3 (on a 10-point scale) or 93%, which appeared to be a substantial gain. This group did not make any gain on their essay or Brief Constructed Response (BCR) part of the Posttest. The Pre- and Posttest BCR scores looked very similar, being 2.6 and 2.5 (on a 3-point rubric) respectively. Since the highest possible score was 3.0, students in this group were already performing above the mid-range score (2.0) on the Pretest, and it may have been difficult for them to show more gain in this skill area.

For Class C, the Basic class, students appeared to show gains in both the SR and the BCR portions of the test. For the SR portion of the comprehension task, the class average was 51% for the pretest and 62.5% for the posttest. For the BCR portion, the class average on the pretest was 1.04 on a 3-point scale, indicating that the rating was Basic. After instruction, the class average for the posttest BCR score was 2.3 on a 3-point scale, indicating that the rating was Proficient.

Discussion

One major limitation of this informal study was the small sample size. The Honors class had 20 students, the On-grade-level class had 23, and the Basic class had only 12. However, the informal study not only suggested that mental imagery instruction helped the students improve their comprehension when they read expository texts, it also provided information to help refine the formal study. For example, I improved the pretest, posttest, and instructional passages by making sure that all questions covered comprehension skills such as main idea, vocabulary, inference, and drawing conclusion. I also realized that I could involve my co-worker so that more student data could be gathered for this study. In addition, I realized that an additional follow-up assessment at the end of the school year could show sustained effects for the experimental group and possible gains for the comparison group once the comparison group received instruction on the mental imagery strategies.

This informal study provided some basic foundations for the formal study. For example, the pretest, posttest, and science expository instructional materials developed for use in the informal study were also used in the formal study. The only additional materials used in the formal study were two updated posttests and an additional instructional passage. The instructional procedures for using mental imagery with expository text and lesson plans developed for use in the informal study were replicated for the formal study since students appeared to be receptive to those methods and the results were promising.

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