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CERTIFICATION OF PROJECT WORK

We, the undersigned, certify that this project entitled WILL COLLBORATIVE STRATEGIC READING PROMOTE CONCEPTUAL UNDERSTANDING IN 6TH GRADE SCIENCE VOCABULARY by Michael Cole, Candidate for the Degree of Master of Science in Education, Curriculum and Instruction Inclusive Education, is acceptable in form and content and demonstrates a satisfactory knowledge of the field covered by this project.

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WILL COLLABORATIVE STRATEGIC READING PROMOTE CONCEPTUAL UNDERSTANDING IN 6TH GRADE SCIENCE VOCABULARY

by

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A Master's Project
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Abstract

This study researches whether a Collaborative Strategic Reading (CSR) strategy promoted conceptual understanding of vocabulary in a sixth grade science classroom. Eighty 6th grade middle school students, ages 11 – 12 and split fairly even by gender participated in this study. These students were 51% Caucasian, 38 % Hispanic / Latino, and 10% of African American descent. The CSR strategy was implemented as a supplement to the traditional teacher-designed lesson plans, in order to compare two chapters with the traditional approach to instruction and two using the CSR to lead instruction. Each of the four chapters was assessed with an eight-question multiple-choice vocabulary quiz including two short answer questions and a chapter test. The mean score of the quiz and tests of each class were calculated. Using this data for each class, the study determined that the CSR strategy did not produce overall higher achievement on the chapters in which the CSR was implemented compared to the chapters using the teachers' traditional approach. During the four chapters covered, the quiz and test grade average for three out of four classes ranged from 71% - 88%. The remaining class did much worse as their scores ranged from 51% - 65%. The CSR strategy produced better average test scores for most classes, while the teachers traditional approach demonstrated better average quiz scores for most of the classes. In this study the CSR strategy did not produce results that indicated the CSR promoted conceptual understanding in the sixth grade science vocabulary.

Table of Contents

Introduction

The struggles in science education are no secret to society since as a whole the United States science scores are less than impressive. An international study of achievement in math and science called *Trends in Mathematics and Science Study* (TIMMS) produces data on academic progress (Pratt, 2005). The most recent TIMMS administered in 2007 produced discouraging results for the United States. American fourth graders came in ranked eighth with Singapore leading the way, while the U.S. eighth graders dropped to eleventh with Singapore once again leading the way. Scores on both the eighth grade and fourth grade assessments declined from 2003, further exemplifying that the United States struggles as a whole in the area of science (U.S. Dept. of Education, 2007). There has since been another TIMMS administered in 2011, however these results still have not yet been revealed. Perhaps due to the political spotlight of international competition, education has built our science lessons around a core set of facts and principles. Tushie (2009) suggests that since the implementation of No Child Left Behind (NCLB), the focus of teachers has shifted to the adequate yearly progress that students must meet in English language arts and math, often leaving the instruction of science lessons behind. The lack of funding, resources, content preparation, and even inadequate professional development have led to decreasing amounts of science content taught and essentially less conceptual understanding (Tushie, 2009). In science classrooms, it becomes obvious that students possess, at best a superficial understanding of science concepts (Flanigan & Greenword, 2007). Further, learning science vocabulary helps students understand what science means as a discipline (Glen & Dotger, 2009). This background information and data suggests that there is a need to improve science vocabulary and conceptual understanding at all levels. According to Kinniburgh and Shaw (2007) in order to become skilled readers of content material, students need to learn the meanings of the academic science vocabulary. If every educator taught science lessons using effective vocabulary strategies, perhaps more students would conceptually understand the material and have more background knowledge to bring to successive grades.

This research is important to me due to my experiences through science. In high school, the thought of becoming a teacher never crossed my mind. It was my senior year where I truly realized that I was interested in biology and life science. I signed up to take a course labeled field biology and thoroughly enjoyed it. The teacher was very passionate about the content, which made it exciting to learn. After that class, I first envisioned that science education might be a career path I wished to pursue. The second half of my senior year the teacher allowed three other students and me to take an independent study with him where we developed a recycling program. During that independent study we wrote many grants and received one from New York State to enable us to assist him with research. After high school I started my undergraduate work at SUNY Fredonia, where I was fortunate to encounter some great professors who like my high school teacher were thrilled about what they did for a profession. I started to realize that I wanted the same thing. Between all of the science courses I have taken, there have been more positive feelings towards my professors then there have been negative, and this is a huge reason why I have developed that same passion my teachers had for science.

I currently hold a bachelor's degree in childhood education, with an additional biology certification. In the near future, I will be able to teach general science at the middle school level or teach high school biology. This certification allows me to teach science from grades 7-12, but only biology at the high school level. I'm excited to land my first teaching job, however some of my science experiences as an educator were not as pleasant as when I was a student. In my first student teaching placement, I worked with a sixth grade science class for eight weeks and witnessed the difficulty the students had with science vocabulary. It became evident on the first quiz that the students did not conceptually understand most of the vocabulary terms being presented to them. The lack of understanding became clearer to me during the instruction of many of my lessons, as very few of the students were able to use background knowledge from their science experiences from earlier grades. Through substitute teaching in the past two years I have unfortunately seen many teachers skip science lessons during the day in favor of math and reading. Science lessons have continued to be unpleasant as many teachers hand out packets or have students write the definitions from the text. As someone who really enjoys science it is upsetting for me to see such an interesting subject be put on the back burner and not really taught. I have seen to many occurrences where a teacher directly reads from the textbook and then expects the class to memorize information that most of the time is brand new to the students. Memorization is an ineffective approach to vocabulary development. Educators are supposed to instruct students and lead them to understand the material so they can carry it with them to the next grade levels.

The idea of researching an effective vocabulary intervention that would help promote conceptual understanding, struck me right away as something that would be purposeful to myself and valuable to the field while allowing me to work in the science content area. My thought was that if I could have evidence to prove that one intervention worked effectively with a class, than it would be worth using in classrooms later as a teacher. I have found a lot of interactive vocabulary interventions that seem to work to help students conceptually understand the material. I looked forward to determining if I could provide evidence that would help improve understanding of commonly difficult vocabulary terms in science.

The research conducted is a step in providing feedback as to whether an effective vocabulary intervention will indeed lead to improved conceptual understanding in a science classroom. Instruction of vocabulary needs to go beyond writing the word and its definition. Glossary definitions are not enough, some students might learn them short term, but they don't remember them six weeks or even six hours later (Flanigan & Greenwood, 2007). Further, Rupley & Slough (2010) state that science vocabulary is more restrictive and carries the concepts represented in the text, stating,

> We do not implement what we know as effective in science education, let alone the unknown reading strategies. Instead, we continue to employ traditional instructional techniques such as lecturing, reading the textbook, answering the questions at the end of the chapter, and defining the vocabulary terms (p. 100).

Young (2005) states that without a clear understanding of the language of the science content, students will certainly experience difficulty and develop lack of interest with the material.

This research study implemented a Collaborative Strategic Reading (CSR) strategy that will add to the science education field that lacks specific research concerning vocabulary development and building conceptual understanding. As an educator, the importance of having students conceptually understand material is a main objective. With the way schools are structured now the elementary schools have science take the back seat, to the middle school and high school where standards are set to measure learning, it is important to take advantage of the instruction time spent on science. If the CSR strategy is an effective vocabulary intervention that can help build the desired conceptual understanding in science or any other content, than it should be a strategy that more teachers are taught to implement. By helping more students get away from the memorization of difficult science vocabulary and instead connect the information with the concepts, the students will be able to bring this new knowledge that was taught to them into future science classes.

The CSR strategy was implemented in a 6^{th} grade middle school classroom of about eighty students, which were split between four different science classes. The CSR strategy was implemented in an ABAB design, in which the teachers traditional approach to teaching was compared to the use of the CSR strategy leading the instruction. For the comparison between the different instructional approaches this research study covered four different science chapters, and calculated for each a quiz and test score of the average of the four classes. The data was found to show no immediate frontrunner in terms of which instructional approach worked best. The study was conducted to see if the CSR intervention would promote conceptual understanding in sixth grade science vocabulary, however, the data that was collected didn't indicate that the use of the CSR improved student' conceptual understanding. The teacher's traditional approach produced better quiz results for the majority of the classes for the two chapters, in comparison to the CSR's two chapters. However, the CSR intervention produced better average test results for the majority of the classes in comparison to the teacher's traditional approach.

The study did not produce the expected results. Many things leading up the implementation of the study could have been changed, the introduction of the CSR strategy, allowing incentives, the age of the participants, and removing certain participants as one class contained English Language Learners (ELL's). However, the CSR strategy could still be effective and work with better implementation. It may also be dependent on the content material that is being taught. In this case the study didn't necessarily promote the conceptual understanding of the sixth grade vocabulary, but it did have its bright spots of showing that it could be an effective strategy in the classroom.

Literature Review

Teaching science to students is not an easy task. Due to the difficult academic vocabulary and ambiguous explanations of many concepts, science and everything it represents can be hard for students to understand (Kinniburgh & Shaw, 2007). The students' level of understanding science vocabulary is an excellent predictor of their ability to understand science as a whole (Young, 2005). Yager and Ackay (2010), state that inquiry can be a highly effective teaching method by helping students in terms of concept mastery and in their use of process skills. Teaching complex concepts in science requires multidimensional teaching techniques (Stahl, 1999). The relationship of inquiry, conceptual development, and vocabulary within science are presented below.

Best Practice in Science

Inquiry based learning or inquiry, are umbrella terms that encompass a range of teaching approaches in which learning is stimulated by a question or issue that is based on constructing new knowledge and understanding (Spronken-Smith, Walker, Batchelor, O'Steen, & Angelo, 2011). Inquiry is an integral part of teaching and learning science (Sampson & Gliem, 2009). The TIMMS of 2007 demonstrated that only 17% of the United States lessons developed science content though inquiry based instruction (Tosa, 2011). Inquiry can be a highly effective teaching method that helps students in terms of concept mastery and the use of process skills (Yager and Akcay, 2010). Clidas (2010), states that during an inquiry lesson, questions and summaries allow students many opportunities to revisit and compare ideas presented by the new information. Additionally inquiry is strongly recommended by state and national science standards. Providing students with inquiry oriented vocabulary strategies can significantly support their understanding and interest concerning the language of science (Young, 2005). An inquiry approach has great potential and can enable more students to develop a sophisticated understanding of both the concepts and the process of scientific knowledge (Sampson & Gleim, 2009).

Many science teachers are unsure of how to promote and support inquiry in the classroom or how to design lessons that engage student inquiry in a way that improves understanding of important science concepts (Sampson & Gliem, 2009). According to Tosa (2011) literature suggests that little inquiry-based learning is taking place in the classroom, despite being strongly advocated for in the United States (NESE, National Research Council, 2010). Tosa (2011) performed a study between the United States and

Japan on what critical elements might be missing in each county's implementation of inquiry based teaching. In this particular study, student learning of science through inquiry was defined as their active development of understanding of scientific concepts (NRC, 1996). A total of 24 teachers participated in the study and taught science lesson that were observed, and then coded according to a rubric that described the five essential features of inquiry based teaching (Tosa, 2011). Tosa (2011) visited each of the participant's schools once for an observation of their science lesson, followed by an interview. The results displayed that students formulated much deeper links to the concepts in the U.S. science lessons than Japanese lessons (Tosa, 2011). Despite the initially stronger conceptual links of U.S. lessons, further results demonstrated that when students had to make connections to their explanations of the science content the conceptual links were lower in U.S. lessons (Tosa, 2011). Tosa (2011) reported that some of the concepts in the U.S. lessons were hard to identify. Most of the findings indicate that students in U.S. lessons were exposed to the discussion of why and what they would do in the lesson, but had few chances to connect their results and explanations with scientific concepts that they needed to understand (Tosa, 2011). In summary Tosa (2011) explains that teacher-directed structured inquiry can generate student engagement and a solid understanding of concepts through teacher's guidance.

A study conducted by Yager and Akcay (2010) supported this notion that inquiry will help promote more conceptual understanding in a science lesson. The purpose of this study was to determine the effectiveness of the Iowa Chautauqua Project as a model staff development program for middle school teachers in Iowa (Yager & Akcay, 2010). The program's participants were from middle grades and worked together in cooperative teaching groups to perform hands-on science inquiry activities that arose from one another's questions, curiosities, and experiences (Yager & Akcay, 2010). The study involved 12 teachers who "agreed to collect pre-test and post-test assessment information for all six assessment domains: 1.) Concept Domain, 2.) Process Domain, 3.) Creativity Domain, 4.) Attitude Domain, 5.) Application Domain, and 6) Worldview Domain (Yager & Akcay, 2010, p. 7). For each of the six domains, Yager and Akcay (2010) prepared the study so that one section of each domain was taught with a traditional approach and another section using inquiry teaching. Yager and Akcay (2012) were able to enroll a total of 724 students to participate, from twelve different school districts. The inquiry package model included instruments, test features, scoring directions and wide array of assessment tools. The given instruments were applied for the pre and post-tests and from the pre-test results the teacher designed the inquiry lesson based on the issues identified, while traditional approaches simply followed the textbook (Yager and Akcay, 2010). The most interesting results that Yager and Ackay (2010) uncovered were the pre-test and post-test scores under the concept domain. The students under the concept domain scored significantly higher with respect to concept mastery while studying in an inquiry environment (Yager & Akcay, 2010). One other end product of the study was that Yager and Akcay (2010) found that student ability to apply concepts was enhanced substantially when the science was experienced in an inquiry format. Students who studied science with an inquiry approach also developed better understanding concerning the nature and history of science (Yager & Akcay, 2010). Lastly, Yager and Akcay (2011) identified more positive student and teacher attitudes by inquiry teaching in the classroom. From these studies it can be determined that using an inquiry approach can help to lead to conceptual understanding in the classroom.

Conceptual Understanding

Definition.

Conceptual understanding as defined by the National Assessment of Educational Progress (NAEP, 2005) means understanding principles of science used to explain and predict observations of the natural world and knowing how to apply this understanding efficiently in the design and execution of scientific investigations and in practical reasoning. Brunsell and Marcks (2007) state that one goal of science education is to move students' naïve understandings of the world toward those that are more scientific.

Importance of conceptual understanding.

Resnick (1982) has attributed students' learning difficulties to conceptual learning, and explained that difficulties in learning are often a result of failure to understand the concepts on which procedures are based. Undoubtedly, it is necessary to promote conceptual understanding in science. A survey by Duit (2007) indicated there are over 8,000 studies in science education literature that reported the existence of misconceptions or alternative conceptions. Conceptual development is a major goal of content area instruction (Young, 2005). As Duit (2007) explains, conceptual change has potential to provide useful resources because teachers need to be knowledgeable about students' pre-instructional ideas to tailor their lessons specifically to student needs. Research by Brunsell and Marcks (2007) suggests that teaching for conceptual change in students involves starting with their own ideas about how the natural world works based on a rich tapestry of prior experiences and understandings. Students must first become dissatisfied with their initial ideas in science, when dissatisfied three conditions are necessary in order for conceptual change (Brunsell & Marcks, 2007). The three conditions Brunsell and Marcks (2007) state are students must be able to understand the new idea, then understand how it can be used to resolve the dissatisfaction, and lastly see how the new idea can be used in other situations.

Additional research confirmed this notion as Calik, Kolomuc, & Karagogle (2010) investigated the effect of conceptual change pedagogy on student's conceptions of rate and reaction, using animations in a chemistry lesson. The research was conducted on 72 Turkish grade eleven students and used a pre-test/post-test equaling a total of 19 items in a non-equivalent comparison group design approach (Calik, Kolomuc, & Karagolge, 2010). The study consisted of one control group and one experimental group, both having similar educational and socio-economic backgrounds (Calik, Kolomuc, & Karagolge, 2010). The study groups were split up between two teachers, with the control group using the traditional instructional approach (Calik, Kolomuc, & Karagolge, 2010). The experimental group used animations to make abstract concepts more clear, created an active learning environment, fostered individual learning, boosted overall class engagement, and lastly made connections at the different levels of the science content taught (Calik, Kolomuc, & Karagolge, 2010). Through the study, students showed they were able to store their new knowledge in their long-term memory banks; however, utilizing more than one intervention model was deemed needed to effectively eliminate student alternate conceptions (Calik, Kolomuc, & Karagogle, 2010). Further, Rupley and Slough (2010) state much of the students vocabulary and ideas brought to their science learning frequently have non-scientific, general language meanings that conflict with their scientific meanings. Both studies help signify the importance of conceptual understanding and the issue of student misconceptions in classrooms currently.

Conceptual change instruction recognizes that students bring personal, or naïve, conceptions to the classroom, which they use to explain their world, interpret situations, and create meaning (Driver, 2007). One way to fix the lack of conceptual understanding is to use Khourey-Bowers (2011) conceptual change instruction, which creates opportunities to replace student's naïve conceptions with scientific concepts, which ends with student understanding. Bowers study four years later came to similar conclusions as Brunsell and Marcks in that Bowers found students must be dissatisfied with their existing conceptions, and then be provided new concepts they find to be intelligible, plausible, and fruitful (Khourey-Bowers, 2011). In a study on teaching for conceptual understanding entitled *Elementary Teachers' Teaching for Conceptual Understanding*: *Learning from Action Research*, Kang (2007) examined teachers' views about science teaching and learning, teachers learning about teaching practices, and conditions that supported the teachers learning through action research. Kang (2007) points out that research on student's misconceptions has been one of the most important areas of science education. In the study teachers conducted action research on their students' conceptual learning in science. As Kang (2007) suggested, students were expected to abandon these prior ideas or modify in a way to make them consistent with scientific ideas.

A total of fourteen teachers with similar class populations from urban school districts in the US participated in the study (Kang, 2007). The project had three phases: planning, instruction, and reflection. The project lasted eight weeks, with four of the weeks dedicated to planning. The teachers planned a series of lessons to assist their students' conceptual understanding and tightly linked the material to the pre-test and intended learning outcomes (Kang, 2007). During the instruction the teachers were asked to focus on one or two students, and share their lesson activities through discussion and microteaching so adjustments could be made to their instruction if needed (Kang, 2007). In the midst of the instruction and reflection period Kang's (2007) study required one videotaped instructional period in order to review and assess their teaching practices. Each teacher wrote a reflection paper guided by specific questions after reviewing their own videotaped instruction and shared their responses with the other teachers. Lastly, after all the lessons were completed and the post-tests were analyzed, the results were reported and turned in (Kang, 2007).

Most results pointed towards more teacher development, the struggles in attempting to displace conceptual ideas with new and accurate ones, and gaining insights of effective and ineffective teaching practices (Kang, 2007). Thus, it is often difficult to change student's misconceptions from current ones during formal schooling (Li & Li). The most interesting finding was that all the teachers came to a consensus on the importance of identifying student's prior ideas in planning lessons, implying that they readily recognize the role of student's prior ideas in learning and teaching (Kang, 2007). If we want students to develop understanding, we must teach directly to their existing conceptions and help guide them into more scientific ways of thinking (Khourey-Bowers, 2011). Khourey-Bowers (2011) also notes that multiple definitions of common words, affect students' understanding of fundamental scientific concepts. It is up to the teachers, to help students distinguish scientific meanings from the everyday meanings of words their accustomed too (Khourey-Bowers, 2011). Conceptual learning is a key aspect for students to gain full understanding of any topic being taught. The studies show that due to the naïve understandings that are brought to the classroom, it is always a challenge to change students' initial understanding. Trying to displace these prior understandings of students can be tough, but if teachers can teach the vocabulary that coincides with the concepts, then these prior ideas can be corrected.

Vocabulary

Definition.

"Vocabulary can be defined as "the words we must know to communicate effectively: words in speaking and words in listening (Neuman & Dwyer, 2009, p. 385)." Vocabulary learning is an ongoing natural and lifelong phenomenon (Bintz, 2011). Bintz (2011) states that many teachers believe defining words before reading the text is an effective instructional technique to support vocabulary growth, however research indicates otherwise. An article by Butler and Nesbit (2008) describes that it takes time to transform new knowledge, but students must be given opportunities in a school environment in order to conceptually understand this knowledge. Strategies that focus on word recognition and word use in meaningful contexts are most likely to positively affect vocabulary growth (Bintz, 2011).

Role of vocabulary.

How does this scientific conceptual understanding tie in with the use of vocabulary? As Rupley & Slough (2010) state experiential and conceptual backgrounds are extremely important in vocabulary development. It is these background experiences that enable students to develop, expand, and refine the concepts that words represent within the context of science (Rupley & Slough, 2010). According to Young (2005) vocabulary is the essential element of comprehending concepts in content areas such as science. "The students' understanding of science concepts are inextricably bound to their understanding of the vocabulary used to define and communicate the concepts and matching those concepts with the appropriate background knowledge" (Rupley & Slough, 2010, p. 100). This is essential as science subjects contain numerous terminology and concepts, and students' level of understanding concerning their science vocabulary is an excellent predictor of their ability to understand science (Young, 2005). Under the language of science, the use of vocabulary helps construct a precise representation of the concepts (Rupley & Slough, 2010). Hitt and Townsend (2007) state that instructors usually tend to focus teaching at the symbolic level that refers to scientific formulas, equations, and definitions. This instruction directed towards the symbolic level of learning, is what often leads to the result of students becoming disinterested with the content and memorizing definitions instead of thinking critically to understand the concepts (Hitt & Townsend, 2007). When learning occurs this way the memorization of vocabulary becomes ineffective because it does not result in connections to the concepts, and the new information is stored only briefly (Bransford & Donovan, 2005).

This is especially significant at the elementary level, as early school experiences leave students with large deficits in their vocabulary as they move up to the middle school (Cunningham & Allington, 2007). During these transitions from grade to grade it is the student's background knowledge that plays a vital role in vocabulary development and content specific learning (Harmon Wood, Hedrick, & Gress, 2008). Rupley & Slough (2010) state instructional strategies in vocabulary should connect word meanings to conceptual learning in a manner that enables and expands student's background knowledge basis specific to science and builds science vocabulary that is accurate to that knowledge base. Using a focus on word meaning within a conceptual framework empowers students to take control of their own learning and that of others (Harmon, et al, 2008). If done correctly misrepresenting science will not happen, and students will no longer be deprived of the opportunities that allow them to truly understand science (Rupley & Slough, 2010). Rupley and Slough (2010) conclude that it is of critical importance that students possess the vocabulary and background knowledge to be actively engaged in science learning.

Effective vocabulary strategies.

Teaching science in middle school is fraught with challenges, as textbooks are dense with unfamiliar concepts, the vocabulary is unique and difficult, and the students are mostly unprepared to talk about the text (Braun, 2010). Teaching these science concepts can be tougher when dealing with students who have learning disabilities, but teachers are accountable for promoting understanding for all students (Shook, Hazelkorn, & Lozano, 2011). It is vital to pre-assess students on their comprehension of science vocabulary, in order to increase literacy in science (Clidas, 2010). In addition, it is critical that students learn how to derive meaning of the unfamiliar words (Shook, et al, 2011).

Clidas (2010) suggests that using quick writes within a notebook can help build the foundation students need to understand scientific concepts, understand vocabulary and correct any misconceptions students may have. "A quick write entails the teacher asking open-ended questions and having the students write all they know in a few minutes (Clidas, 2010, pg. 60)." Clidas (2010) suggests that using quick writes can help record what students already know, document new information that is not thoroughly known, and provide opportunities for the students to go back and revisit their questions and answers as any good scientist should. Clidas (2010) emphasizes the importance of modeling the process of asking open-ended questions, (including composing a quick write to a question) so that students understand the quality of work expected. The first step in using these quick writes is to assess what students already know before each science inquiry. This can be accomplished by asking a simple question or directive for the students to respond to in their notebooks (Clidas, 2010). The quick writes are then shared with a partner so that every student can contribute and encourages class discussion about the questions or responses shared (Clidas, 2010). Quick writes also help direct the teachers' instruction for the future, as the information provides critical pre-assessment data (Clidas, 2010).

Clidas (2010) suggests that quick writes can be used for any subject of science. The Clidas (2010) study focused on rivers and flow of water, and the analyses of data helped suggest the quick writes were successful. Through the process of the quick writes students were able to confirm, challenge, clarify, and extend previous ideas about the movement of water in rivers. The students recorded their thoughts, questions, observations, and processes used to attain their information about the rivers (Clidas, 2010). The quick writes analyzed by Clidas (2010) promoted an engaged learning environment and the new words collected through each topic were added to the student's notebook for them to keep and use (Clidas, 2010). Clidas (2010) found that the intervention studied allowed students to play with their writing skills, which led to improved science vocabulary and development of deeper understandings of the new science concepts. Another strategy that engaged the whole class and proved to be effective for vocabulary was an intervention called "Read-Alouds."

Braun (2010) investigated the use of read-alouds in science classes. A read aloud strategy is one in which a class as a whole or in groups read the given text aloud for everyone to hear. A read aloud strategy will keep the students on task, given every student participates at some point through the readings (Braun, 2010). Braun (2010) found that students were actively engaged in the reading material and teachers were given the opportunity to share their own excitement in the world of science (Braun, 2010). Braun (2010) also reported that student motivation and vocabulary acquisition improved tremendously. A teacher in the study was quoted as saying "The more places students see the vocabulary, the better they understand the vocabulary" (Braun, 2010.)

Adjective Boxes is another intervention that seemed to provide positive results (Rule, Barrera, & Stewart, 2004). Adjective boxes were used for students to build descriptive vocabularies through direct experience with a theme-based assemblage of real objects, each with a corresponding card of descriptive adjectives (Rule, et al, 2004). In this study, six third-grade classrooms were used to determine the effect of descriptive adjective boxes on vocabulary development on the rock cycle, earth processes, and movement of landforms. A total of 115 students from two rural Idaho schools participated (Rule, et al, 2004). The experimental group used the descriptive adjective boxes to build descriptive vocabularies (Rule, et al, 2004). Each group was administered the same pre-test and post-test containing different objects that the students were asked to describe using as many words as possible. Based on test analyses, the students who used the adjective boxes made solid gains, whereas the control group regressed from the pre-test (Rule, et al, 2004).

A technology based vocabulary development was one other intervention used in the classroom as a class wide program (Adiguzel & Vannest, 2008). This web-based vocabulary assessment of science learning monitored two years of development in order to meet certain criteria that was set. The web-based program is called Science Key Vocabulary Assessment (SkeVA), and provides increased exposure for science vocabulary and better understanding of science material (Adiguzel & Vannest, 2008). During both years students were pre-tested and post-tested after a unit of instruction was delivered and assessed with multiple choice items, built in the format of Texas' high stakes end of the year test (Adiguzel & Vannest, 2008). According to Adiguzel and Vannest's (2008) data analyses, during the first year, 77% of the participants showed measureable improvement from pre-test to post-test, whereas this number increased to 85% the following year. Adiguzel and Vannest (2008) report that across all classes in the second year students improved an average of 21%. The improvements have led to the support of teachers and students to accept the use of this web based intervention in the classroom (Adiguzel & Vannest, 2008).

Other effective interventions that were not studied, suggested for possible use for improving the acquisition of science vocabulary in the middle school classroom included: TV visualization, a word-meaning concept strategy that helps students internalize words by creating a mental image and interest, definition map, that helps students brainstorm their ideas and link concepts related to the vocabulary; personal clue cards support long-term retention rate and application of vocabulary; rate your words activity, a pre-reading activity to help students assess their level of understanding of featured vocabulary; and semantic feature analysis, a reflective way of mapping key vocabulary words that helps students examine relationships among the words and concepts (Young, 2005). The interventions Young (2005) explores are all word meaning concept strategies that are equipped to help students better understand, process, and internalize the new material. Another intervention suggested by Jones (2010) is using photographs on science topics to improve student vocabulary by prompting answers about what they see in each picture. He goes on to state that this strategy supports the classroom as a whole as well as *English Language Learners* (ELL). Husty and Jackson (2008) suggested other interventions to support these struggling students including mystery canisters, windowpanes, hardness scale, and bag and tag word wall (Husty and Jackson, 2008). Lastly, students can uncover the meanings of the science vocabulary and elaborate on confusing concepts with the use of the reader's theater (Kinniburgh & Shaw, 2007, p. 18).

All of the interventions briefly discussed have either been found effective or thought to be effective in helping improve students' vocabulary development. However, only some of the interventions touch on vocabulary leading to conceptual understanding. Likewise only some of the strategies discussed the importance of inquiry in the development of vocabulary and conceptual understanding. Bowers (2011) states taking time to ask questions requires students to think, use evidence, and listen to others compelling students to integrate knowledge from others into their own understandings. Concept development and language development are interrelated, so the more students talk about science, the more opportunities they have to refine their understandings of important concepts (Bowers, 2011). One strategy that intertwines vocabulary, conceptual development, and inquiry is known as a Collaborative Strategic Reading, or a CSR.

Collaborative strategic reading (CSR).

Cooperative Strategic Reading (CSR) is a learning intervention that involves groups of students at different ability levels, who work together and use a variety of learning activities to improve their understanding of a subject. Further, CSR was stated as being designed to address three educational problems: 1.) How to adequately include students with disabilities and ELL's, 2.) How to teach text comprehension strategies to facilitate students' learning from expository text, and 3.) How to provide opportunities for students with disabilities to interact effectively with peers (Kligner, Vaughn, Arguelles, Hughes, & Leftwich, 2004). Each group in a CSR lesson follows the same format, using vocabulary cue cards presented by the teacher. The first part of the CSR lesson students *brainstorm* or *discuss* what they already knew and predict what they will learn from reading. The second part of the CSR lesson students use the *click* strategy to refer to content that makes sense and *clunk* or refer to the portions they do not understand. For part three of the CSR lesson students complete *get the gist* strategy (where the groups identify and summarize the most important ideas in various sections of texts). The last part of the CSR is the *wrap up and review* strategy in which students review what they learned about the topic, formulate questions pertaining to the topic, and answer questions about what was learned. In a study conducted by Shook, Hazelkorn, & Lozano (2011), each group contained 6 individuals and each had a specific position that would rotate weekly: 1.) Leader, lead the group in implementing the CSR and gathering needed material 2.) Clunk expert, reminds students the steps to follow when dealing with a difficult word/concept 3.) Announcer, holds the vocabulary card and calls on members of group to share feedback or comments so everyone participates 4.) Encourager, gives positive feedback to members of group and reports how many words students get correct 5.) Reporter, records the words the group knows and doesn't know and 6.) Timekeeper, sets the timer for each portion of the CSR and tells groups when to move on to next part (Shook, et al, 2011)

Shook, Hazelkorn, and Lozano (2011) used a CSR in an inclusive ninth grade biology setting to: engage students with disabilities in text-related learning, teach text-comprehension strategies that facilitate students' learning, and provide opportunities for students with disabilities to interact effectively with their peers. The study included twenty-six students, seven of whom were receiving special education services (Shook, et al, 2011). The class met Tuesday and Thursday for 30 minutes each period and used CSR as a way for students to review class material in groups after weekly teacher led instruction. Prepared materials with vocabulary specific to the units in the textbook were used for the weekly quizzes, having 20 words that were picked by the teacher (Shook, et al, 2011).

Data used to determine the effectiveness of the intervention were: Weekly average quiz grade for all students, weekly average quiz score for students without disabilities, and weekly average quiz score for students with disabilities (Shook, et al, 2011). Three weeks prior to the use of CSR, the average quiz score was a 75%, but after a three-week period in which the CSR was implemented in the classroom the average score was a 93.87%. Shook, et al, (2011) found that the students with disabilities improved their quiz scores on an average of 34 points, while students without disabilities improved 13 points on the quizzes. Shook, Hazelkorn, and Lozano (2011) go on to state that not only did the students' vocabulary scores go up, but their social skills also improved due to the active group work with peers whom they may have never chosen to work. Working in groups can effectively improve science vocabulary comprehension as well as improve social skills in an inclusive classroom (Shook, et al, 2011). Using CSR Shook, Hazelkorn, and Lozano (2011) found that students with learning disabilities can achieve at the same level as general education students, and this strategy increased learning for all.

Another CSR study used 10 high school English classrooms across five school districts whose students were predominantly of Hispanic descent. Five teachers and their classrooms were assigned to use the CSR strategy and the other five teachers and their classes were assigned to controlled condition not implementing the CSR strategy (Kligner, et al, 2004). Results from observations of the classrooms implementing CSR and a standardized test measuring reading comprehension showed significant gains with the use of the CSR. In addition students who possessed a learning disability in a CSR classroom demonstrated higher gains then their counterpart who did not use the CSR strategy (Kligner, Vaughn, et al, 2004). Although these two interventions were studied at the two levels of high school and focused on different content areas, both displayed positive results with the use of the CSR strategy. This data alone can support that CSR can be used interchangeably at any level and would appear appropriate for use in a 6th grade classroom.

Intermediate Science Instruction in NYS

6th grade science curriculum.

The overall curriculum focus for 6th grade science classes in New York State is general science. General science in the 6th grade curriculum consists primarily of earth science with some astronomy. Students explore a variety of units including: Exploring Planet Earth, Earth's Changing Surface, and Earth's Water. Portions of Unit 1 Exploring Planet Earth, taught during this study included covering earth's interior, convection and the mantle, drifting continents, sea-floor spreading, and the theory of plate tectonics. The topics that will be covered during this research are forces in earth's crust, earthquakes and seismic waves, monitoring earthquakes, and earthquake safety. This material was covered using a hands-on approach to promote implementation of the scientific method. The science curriculum encourages students to think critically and reason scientifically in all of the unit areas. This 6^{th} grade curriculum helps prepare students for life science in 7^{th} grade and physical science in the 8^{th} grade where a New York State test is administered.

6th grade learners.

Sixth grade learners enter the middle school at an age where the science content they are taught is much more detailed than what they have been introduced before. Instead of having science in their regular classroom two to four times a week they are presented a wealth of material in a much different manner. As Buxton (2010) states, instruction becomes explicitly driven by a posted list of state content standards, while teacher talk and student note taking are the new instructional norm. The struggles of these young adolescents can also be attributed to the fact that science sometimes has been taught as if the goals were to make all students into scientists, and that many middle school teachers lack the understanding of the science material to educate these young adolescents (NSTA, 1986). Manning (1998) suggests that science instruction has plagued students due to an identity crisis. Middle school science education has vacillated, in both orientation and philosophy, between an extension of elementary school instruction, and an attempt to be a junior high version of high school instruction (Rakow & Barufaldi, 1991).

This new type of instruction comes at an age where young adolescents are suspicious and guarded (Walsh, 2006). Walsh (2006) further explains that these students are mercurial, in that good days and bad days are magnified and exaggerated by mood swings and social crises. This new instruction on such detailed content can be overwhelming for students at this age. Students may require initial persuasion to attempt new activities that are not intrinsically motivating (Appleton & Lawrenz, 2011). However, this is also an age where students develop the line "I don't care," as Walsh (2006) states referring to the science curriculum being taught. Walsh (2006) further explains, "I don't care" can mean they don't care today, they don't care about the assignment, or they don't care for their teacher. Most of these students become disengaged and are passively aggressive rather than openly defiant (Walsh, 2006). This type of student has tendencies to express angry words, menacing looks, and apparent disregard for the subject; which usually is expressing the student's ongoing discouragement in school (Walsh, 2006). These young adolescents tend to be deeply depressed about something else, which can be seen in half completed worksheets, passive compliance, and glassy-eyed stares, by a single student, groups of students, or whole classes (Walsh, 2006). This demonstrates how young adolescents at the middle school level are a complex group and attention to detail with instruction is imperative in order for teachers and students to succeed.

The learning of science by sixth grades can be further interpreted by gender. Manning (1998) suggests that many middle school students experience science only as a body of facts, principles and procedures to be mastered and recalled on demand; and due to science being taught this way it can be attributed as a major reason for the gender gap in achievement in the physical life sciences. This was previously noted by Lee and Burkam (1996), as they stated males tend to do better than females in physical science; however females held the advantage in the life science. Lee and Burkam (1996) also found in a study that females benefited much more than boys did from laboratory experiences, leaving them to conclude that laboratory experiences along with hands on experiences in physical science would help promote gender equity and science achievement at the middle school level. A study by Meech and Jones (1996) involving 5th and 6th grade students self-reports' of confidence, motivational goals, and learning strategies displayed that males showed greater confidence in their science abilities. Furthermore average achieving females reported greater use of meaningful learning strategies, whereas low ability males reported a stronger mastery orientation than low-ability females (Meech & Jones, 1996). Meech and Jones (1996) found that both genders showed greater confidence and mastery motivation in small group instruction than in whole-class instruction. The positive results of hands on and small group instruction are both elements the CSR strategy offers and should be able to benefit not only both genders, but all the students as individuals.

NYS science scores 4th and 8th grade.

In order to see middle school student's performance on the New York State science test scores, two different areas were analyzed. First, the state science test scores of fourth graders from the 2010-2011 school year were analyzed to determine how the district performed. The students that had taken this particular exam are now in sixth grade at the middle school. The other set of science test scores were also from the 2010-2011 school year, this time focused on the district's eighth grade performance. These students are two years removed from sixth grade and represent the growth as science learners in the middle school.

The New York State science test scores for the fourth grade as well as the eighth grade state science test scores are based off a scale that classifies these individuals' performance into levels. There are four levels, with level 4 demonstrating that students exceeded the proficiency standard set. The levels ascend from worst to best: Level 1 – Student performance does not demonstrate an understanding of the science content expected at this grade level, Level 2 – student performance demonstrates a partial understanding of the science content expected at this grade level, Level 3 – student performance demonstrates an understanding of the science content expected at this grade level, and Level 4 – student performance demonstrates a thorough understanding of the science content expected at this grade level. The state test scores from the 2010-2011 school years of the fourth grade and eighth grade are placed under each of these levels as percentages that met each criterion (NYS School Report Card, 2010-2011).

The fourth grade state science test scores display that overall 77% of the individuals scored at a level 3 or a level 4, in comparison to New York State overall average of 88% scoring a level 3 or level 4. However, only 29% of these individuals reached the level 4 status of exceeding the proficiency standard, while the average of individuals reaching this benchmark for New York State was 52%. The next set of data reveals that out of these fourth graders 93% of them was at least a level 2 through a level 4, leaving only 7% of the students who had taken the state science test in fourth grade at the level 1 benchmark. Compared to New York State, 98% of the individuals scored between a level 2 and level 4 while only 2% fell at level 1 (NYS School Report Card, 2010-2011).

The eighth grade science test scores demonstrated that 71% of the district scored at a level 3 or a level 4, in comparison with New York State's average of 72%. Only 18% of the students in eighth grade posted a level 4 status, while the average for New York State was 28%. The individuals were 97% being within a level 2 through a level 4 status, leaving only 3% of the individuals who took the test being labeled level 1. New York State overall posted only 94% of the individuals falling at a level 2 through a level 4, while having 6% of the individuals fall under the level 1 criteria (NYS School Report Card, 2010-2011). With test scores around the average of New York State and science content being full of difficult new terms, it will be determined if the CSR intervention will be able to promote conceptual understanding of science vocabulary in these middle school students.

Methodology

The research on the use of CSR in a middle school science class was designed to answer the question, "Will Collaborative Strategic Reading (CSR) promote conceptual understanding in 6th grade science vocabulary?" The empirical study was completed in a 6th grade science program consisting of ninety-one students who were split into four different classes. Throughout the study the four classes are labeled as: Class A, Class B, Class C, and Class D. The research was completed using an ABAB design. An

"ABAB" research design can be defined as using one tactical method first which is called "A" and comparing it to a completely different tactical method which is called "B." Each tactical method was completed twice taking turns in the order of implementation, resulting in the "ABAB" research design. During the design, the study covered a total of four different science chapters from the *Prentice Hall Science Explorer: Earth Science*, by Pearson. These chapters were taught in the order they are listed: Chapter 1 – Earth's Interior, Chapter 2 – Plate Tectonics, Chapter 3 – Force in the Earth's Crust, and Chapter 4 – Monitoring Earthquakes and Safety. For the first and third science chapters, which had taken the part of "A" in the design, the teacher taught using a traditional approach to vocabulary development. The teacher's traditional approach in the classroom entails a routine of the students taking notes on vocabulary, followed by a power point that describes the vocabulary and sometimes has diagrams for visual learners. The teacher then uses independent reading where the student's read the section, sometimes partner reading is allowed, followed by a whole class discussion. Depending on the material being taught the teacher then incorporates videos, experiments, and group work into the instruction. For part "B" of the research design a Collaborative Strategic Reading (CSR) intervention was implemented, and was done so for the second and fourth science chapters. The research started a few weeks into the school year as it was decided both the researcher and teacher would benefit from some strategic planning before implementation of the CSR intervention. Some of the planning was due to the science program the teacher had planned which, lead him to jumping around from chapter to chapter as certain portions of the science curriculum fit together better than what the actual order of the text book had originally planned. Four quizzes and four tests were collected for each of the four chapters to see if the vocabulary intervention being implemented was promoting more conceptual understanding of the 6th grade vocabulary. The data of each of class's quizzes for the four chapters was collected and analyzed to determine the class's performances using the CSR intervention as compared to using the traditional method. After the data was analyzed the average grade of each class was calculated, and used to determine how each class did understanding the vocabulary, and how well the each of the classes comprehended the concepts. Each of the four classes also had an average test scored that was calculated, for each of the four science classes scored were analyzed to determine how each of the four classes performed on the vocabulary and the concepts. Using this data, the research produced evidence to indicate if the CSR intervention improved conceptual understanding of the science vocabulary for the second and fourth science chapters in comparison to the first and third science chapters that did not involve the CSR intervention.

Participants

Deidentified data from ninety-one 6th grade participants were involved in the empirical study examining whether the vocabulary intervention, Collaborative Strategic Reading (CSR) is effective in building conceptual development in four different 6th grade science classrooms (Class A, Class B, Class C and Class D). There was an approximate even split among male and females who participated in the study, with an age range of 11 – 12 years of age. There are 145 students enrolled in the 6th grade, who take part in science with an average class size of about 22 students (NYS Report Card, 2010-2011). Many of the middle school students in this study are from low-income families as the unemployment rate of this particular community has increased over the last four years, leading to many families having an unemployment plan that provides extra benefits. Poverty is shown as 64% of the students in this school receive free or reduced priced lunch.

According to the NYS Report Card (2010-2011), half of the middle school is made up of white Caucasian individuals as they account for 51% of the population, followed by a Hispanic and Latino population who make up 38% of the school, and 10% of individuals who are of African American descent. The students attending the middle school have an excellent attendance rate, as 95% of the students were present in school through the past year (2010-2011, NYS Report Card). There were only a total of seven school suspensions over the previous year.

Setting

The school where the study took place is located in a small city school district in New York State. The overall population for the middle school is approximately 450 students. For each grade level the students and teachers are split up into two teams, with two teachers for each grade's content areas. However, in this study only one of the science teachers participated. This science teacher instructs general science for four different classes every day of the week for forty minutes per class session. The study lasted approximately one month from Monday, September 24 through Friday, October 26. The class usually began with review of material taught the day before, followed by new material, and then closure of the content taught that day.

Design

The overall goal of the study was to determine if implementing the vocabulary

Collaborative Strategic Reading (CSR) would improve 6th grade students' conceptual understanding in science. A total of four different science chapters were covered during the research. Each science chapter consisted of at least two to five sections of content. Each of the four science classes met everyday of the week for forty-minute class sessions. The study was an ABAB design, and the first and third chapters (A) had the instruction led by the teacher's traditional approach for vocabulary and concept development. The second and fourth chapters (B) were lead by the teacher; however the CSR strategy was implemented for each section of the chapter to promote conceptual understanding of the vocabulary.

The students in each of the four science classes were divided into groups of five or six, where each participant had an individual role for their group. Some of the classes had odd number of students, which is why some groups had five members and others had six members. These individual roles rotated with each new CSR implemented, so every student in the groups of five performed each role by the end of the study. However, the groups that had six members did not have the opportunity to perform each role due to a total of five CSR sessions being conducted in the study. Each section of the 2nd chapter and 4th chapter that introduced new vocabulary had a 35-minute CSR session during which students were put into their groups at random selection by their teacher and worked together. The teacher set aside fifteen minutes the day before implementation to go over the CSR strategy that was used. Each of the four classes was lectured on the purpose of the strategy, the six different individual roles, and the three parts of the CSR strategy. Before the 30-minute CSR session began, a CSR Roles sheet was passed out to each group (See Appendix A). This sheet explained each role in detail and was reference for students, while a sheet of loose leaf paper was provided for the students to use to write down ideas and questions. There were six roles for each group and each had responsibilities to follow: 1.) Leader = leads the groups through the CSR, tells the group what to read next, asks teacher for assistance, gathers materials, and makes sure everyone in the group is doing their job. 2.) Clunk/Click Expert = reminds the groups of steps to follow when figuring out tough concepts or vocabulary words that the group doesn't understand. 3.) Announcer = holds the note card and calls on other students to read from the note card, text, or ask others to share an idea. 4.) Encourager = gives positive feedback to responses of other group members. 5.) Recorder = records the vocabulary words and concepts the group knows and the words/concepts the group is struggling with, or writes down certain areas of the section the group doesn't understand. This role was initially labeled "Reporter," but the description of the job made more sense to call it "Recorder" instead. 6.) Time Keeper = keeps track of time for each of the three parts of the CSR, but also adds input for the three sections of the CSR. Since some of the groups in the four science classes had odd numbers, some groups had five members. During these instances the roles of the 4.) Encourager and 6.) Time Keeper was combined to be one role for the student.

At the start of each CSR session, each leader of their group went to the front table and retrieved a note card that had a portion of text from that chapter's section and the new vocabulary words from that section of the chapter. These note cards helped guide the instruction process of the CSR session. Each CSR session lasted only 35 minutes, so there were only an additional five minutes left in class once the CSR strategy was completed. Originally the CSR Strategy was broken into three 10 minute sections totaling 30 minutes, but the teacher thought it would be a good idea to give the student's an additional five minutes for part two of the CSR strategy. The CSR strategy was divided into three segments. The first ten minutes of the CSR, the announcer read the note card to the group, then called on group members to share information and ideas related to the note card as well as the new vocabulary presented, and the recorder wrote down what they already knew as well as what they didn't know on the loose-leaf paper that was provided. In order to urge the students to brainstorm together about the new material, a couple of follow-up questions were added to the note card referring to the text and new vocabulary. In the second segment the groups were given fifteen minutes to read the section from their text to see what they understood (Click) or still didn't understand (Clunk) from the text and vocabulary presented on their note card and make the necessary corrections to their loose-leaf paper. The announcer called on individuals from the group to read and then asked each member to share any new ideas or information. The last ten minutes of the CSR session the leader of the group completed a wrap up and review, each group looked to see where they made generalizations and connections to their prior knowledge. This time was also used for the groups to tell the recorder what to write down. They were told to write down on their loose leaf paper any important concepts they found, words they still didn't understand, as well as any material that still didn't make sense to the group. The final five minutes of class was used as a whole class wrap-up to clear up any misconceptions the groups had and to build discussion on the concepts addressed that day.

During every chapter, a quiz was taken following the completion of the halfway point during the next class. This varied at times as the chapters' sections ranged from two to five sections due the amount of material being covered. The quiz contained eight multiple-choice vocabulary oriented questions, while also including two short answer questions related to the vocabulary terms. This changed from what was previously planned. Initially there was going to be ten matching vocabulary questions and five short answer questions for each quiz however, after talking with the cooperating teacher he liked preferred using multiple choice for his quizzes and felt five short answer questions was to much as it would lead to the quiz taking up too much time of that day's class. At the end of the last section of each chapter the teacher administered a test that he designed. The test makeup included ten multiple-choice questions, a diagram that needed to be labeled followed by two short answer questions.

Data Collection

All four science chapters taught during the study included one quiz focused on vocabulary and one test covering all the content of the chapter. The quiz was handed out upon the completion of the halfway point of each chapter, and consisted of eight multiple-choice questions based off the vocabulary words from the sections as well as two short answer questions pertaining to the vocabulary covered so far in the chapter. Then the teacher administered the test upon the completion of all the content in the chapter.

The quiz for each chapter was formatted the same for the four science classes (see appendix B) and for the four different chapters (see appendix C), however the content on each was different. For each 6th grade class, the quiz and test completed was collected, separated by class, and graded by the teacher. The quiz and test followed a grading rubric that can be found under appendix H & I. All the individual scores for each of the four science classes were added together in order to find an average quiz and test score for each chapter and class. Once this data was calculated, each of the four classes was represented for each of the four chapters with an average quiz score and an average test score. From here the data was analyzed.

Data Analysis

The quiz and test scores were examined in order to determine the effectiveness of the CSR vocabulary strategy in the four 6th grade science classrooms. The quiz and test scores for chapter 1 (no CSR) of the study set the baseline data for which the chapter 2 scores (CSR) were compared too. Chapter 3 quiz and test scores (No CSR) represented more baseline data and were compared to the quiz and test scores of chapters two and four (CSR). At the end of the study, the data helped determine if the CSR intervention improved overall achievement for each of the four science classes versus their regular science instruction. All four of the science chapters were also compared to each other The mean data for each class quiz and test score for all four chapters were reported (see appendix D). The data for the quiz and test scores for each of the four classes was then represented in a bar graph by their mean score (see results). The data from this bar graph was broken down into three areas for each chapter to show if the achievement was higher on the (a.) Vocabulary oriented multiple-choice questions from the quizzes, (b.) The short answer questions from the quizzes (Concept), or (c.) Chapter tests. Another bar graph was created displaying the combined mean of the CSR quizzes and test scores in comparison with the combined quiz and test scores of the class's regular instruction. A validity checklist (Appendix B, attached) was kept to assess the teacher and be sure all the correct procedures were followed during implementation of the CSR strategy for the twenty times it was completed, five CSR lessons for four classrooms.

Limitations

Some of the limitations to this study are the restraint of time that can be dedicated to this empirical design by myself as well as the teacher involved. The reasoning for this was due only having approximately a month to complete the study. If more time was available the study could have easily been stretched out to evaluate data from more chapters providing more data that could be collected and analyzed. Resulting in another limitation being the fact that only four quizzes and four chapter tests for the four science classes were collected during the study and the data of the mean scores could be misleading. Also considering the study was only conducted over the course of four science chapters and is a brand new strategy for the researcher and the teacher, more time could have lead to more familiarity of the strategy for the students and improved implementation. Another issue was the amount of time given in each school period, as forty minutes for a class period at times was simply not enough. Forty minutes goes by very quickly in a classroom, especially when you factor in taking attendance, transitioning the three steps, and reviewing the new strategy.

Results

The data from the empirical study was collected to determine if the use of the CSR intervention led to an increase of student's conceptual understanding of the science vocabulary studied. In order to achieve this the data was broken down into class averages for each of the four classes used in the experiment. A quiz and a test grade for each of the four classes were collected for each of the four chapters used during the study, for a total of eight data points. This data was analyzed multiple ways in order to determine strengths or weaknesses of the CSR intervention used.

Test and Quiz Averages

Figure 1: Class Averages for Each Chapters Quiz/Test Scores

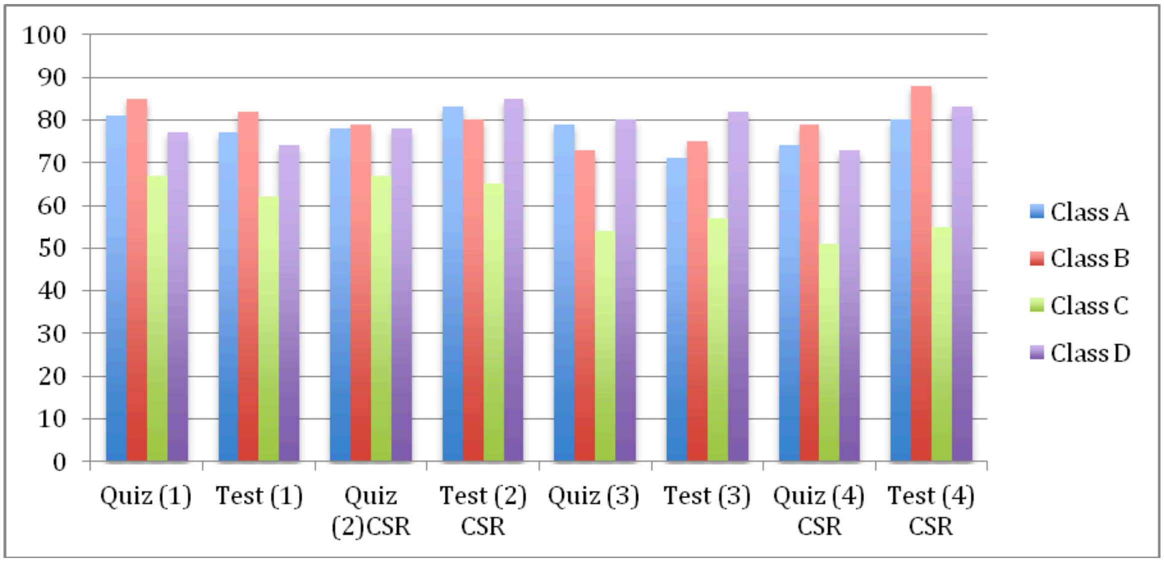

Figure 1: This graph represents each of the four class' average quiz grade and test grade during the study, for each of the chapters taught. Each quiz and test that was done under the use of the CSR intervention is labeled.

The first portion of data that was analyzed was the results of each of the four individual classes. Each of the four classes amassed an average score for a quiz and test grade for each of the four chapters used in the study. This study was an ABAB design, so the first and third chapters data is representative of the class grades following the teacher's traditional teaching approach in the classroom. The data from the second and fourth chapters is representative of the class results when the CSR intervention was implemented (Figure 1). When looking at the results of the first chapter (No CSR) of the study, the teacher's traditional approach of teaching the classes produced better or equal average quiz grades for almost every class in comparison to chapter two when the CSR was implemented. The only exception was Class D, which had a better average quiz grade by 1% when the CSR intervention was implemented. The same scenario occurred for chapter three (No CSR) and chapter four (CSR) average quiz grades, as the teacher's traditional approach to teaching the chapter produced better grades in comparison to the CSR approach in all but one class. In this case Class B actually improved their chapter three average quiz grade from 73% to 79% for chapter four when the CSR was implemented. The highest class average quiz grade recorded came out of class B which had an 88% during the chapter one quiz (No CSR), while the lowest average class quiz grade of 51% was found in Class C during chapter four where the CSR was used.

Still using the data from Figure 1, the study results were analyzed to look at all four classes average test grades. These results however, found the CSR intervention on the positive side of the spectrum. When comparing the average test grades of the first chapter and second chapter for all four classes, the second chapter which used the CSR intervention produced better grades in all but one class in comparison to chapter one's average test grades when the teacher used the traditional teaching approach. Class B's test average dropped from 82% in chapter one to 80% during chapter two. The same held true when each of the four classes average test grades were analyzed for chapters three and four. Chapter four which used the CSR intervention produced better scores in three out of four class periods, when compared to the teacher's traditional approach used in chapter three. In this case class C's class test average went from a 57% on chapter 3 to a 55% for chapter 4's test. The highest average test grade overall for all four chapters was recorded at 88% during chapter four (CSR) by Class B and the lowest average test grade overall out of the four classes was a 55% also on chapter four (CSR) by Class C.

Figure 2: Chapters 1&3 Combined Quiz/Test Averages vs. CSR Chapters 2 & 4 Combined Quiz/Test Averages

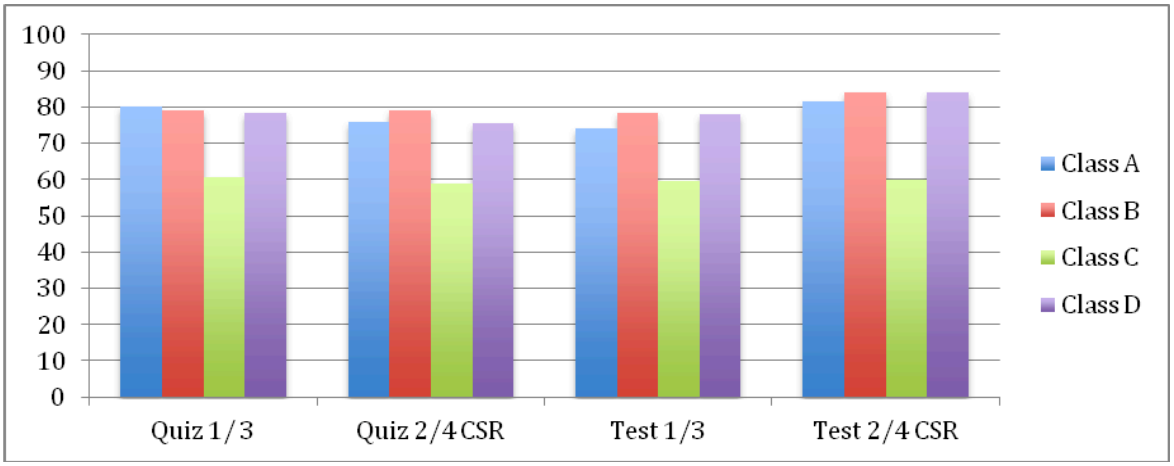

Figure 2: Represents each class' average of the quizzes and tests for the combined chapters under the use of the teacher's traditional approach vs. the use of the CSR intervention of the classroom.

The next set of results that were analyzed, grouped the average quiz scores of chapter's one and three, which was taught based on the teachers traditional approach and compared them to the chapter's two and four class average quiz scores that had the CSR intervention implemented. This data represented (Figure 2) shows each class average for the combined quiz results. Class B recorded the best average quiz scores under the teacher's traditional approach with a mean of 80%, while Class C recorded the lowest average quiz score with a 60.5%. When we looked at each class's combined average quiz scores of chapters two and four when the chapters were taught using the CSR intervention, it was found that Class B produced the best mean quiz score with a 79%. Class C produced the lowest average quiz score recorded, with a mere 59%. The next portion of Figure 2 presented data that looked at each class' combined test average for chapters one and three. When this data was represented Class B produced the best test average for chapters one and three with a 78.5% under the teacher's traditional teaching method. Under the use of the CSR intervention for chapters two and four, Class B and Class D produced the best average test results with an 84% for both chapters.

Overall Average of Quiz & Test: No CSR vs. CSR

FIGURE 3: Overall Average of Quiz and Test: No CSR vs. CSR

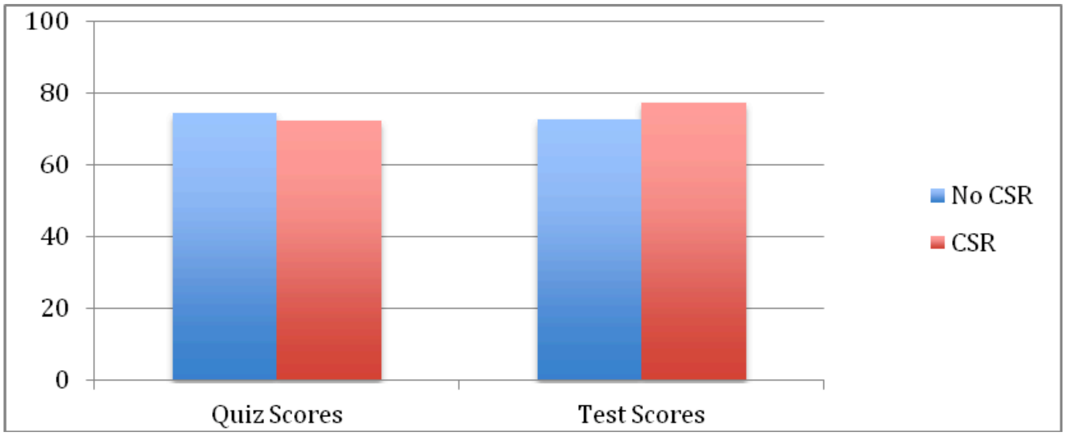

Figure 3: The graph illustrates all the class' combined average quizzes scores and test scores under the use of the teacher's traditional approach vs. the use of the CSR intervention.

To look closer at the average quiz and test scores of each, the classes were combined so that a true measure could show if the CSR intervention was effective. The combined class' average for the quiz grades for chapters one and three were graphed in Figure 3, and displayed a mean average under the teacher's traditional teaching method of 74.5%. This was compared in Figure 3 to the classes combined quiz grades for chapters two and four, under which the CSR intervention was used. The results of the mean quiz grade for all classes using the CSR came out to be 72.4%, showing that the teacher's traditional teaching method was more effective for the quiz by a small margin of 2.1%. However, when the average test scores of chapters one and three were combined under the teacher traditional teaching method, the same result did not hold true. In this case the combined class' average test results for chapters one and three was

72.5%, whereas the use of the CSR for chapter's two and four produced the class's combined average test results as 77.4%. This came out to be a 4.9% increase overall.

Overall Average Quiz & Test: No CSR vs. CSR (Class C Removed)

FIGURE 4: Overall Average Quiz & Test: No CSR vs. CSR (Class C Removed)

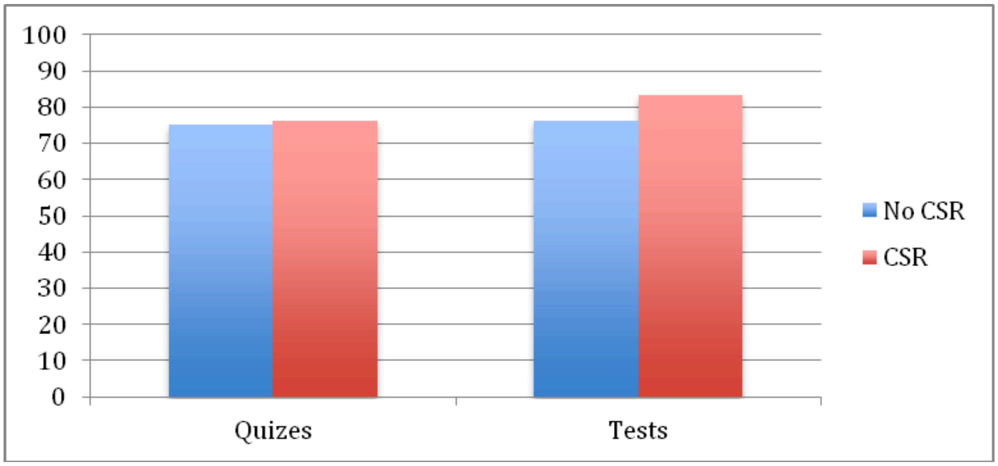

Figure 4: Illustrates the combined class' average quiz and test scores excluding class C under which, the teacher's traditional method was used vs. when the CSR intervention was used.

One constant theme during the analysis of these results was the underperforming scores of Class C throughout the study. During the entire study Class C produced the lowest average quiz grade and test grade for each of the four chapters, as well as out of all four classes. To further look at this particular class, the quiz and test averages for all four of the chapters (No CSR and CSR) were combined and totaled an overall average of 59.75% in both cases. With such a low overall average the overall quiz and test averages, if class C was pulled out of the data, would be under the teachers traditional method versus the CSR intervention implemented chapters. The overall average quiz scores for Class A, Class B, and Class D for chapters one and three (No CSR) were graphed in comparison to those three classes overall average quiz scores for chapters two and four where the CSR was used. This data is shown in Figure 4 and illustrates that the CSR produced a better overall quiz average over chapters 2 and 4 with a combined score of 76.2% an overall increase of 3.9%. This was in comparison to chapters 1 and 3 that used the teacher traditional method, where a score of 75.2% was produced a .07% increase. This wasn't the case from Figure 3, where all of class C average scores were included in the comparisons and illustrated that the CSR was less effective. The same analysis was done for the average test scores for Class A, Class B, and Class D excluding class C to see the improvement overall. This data was graphed in Figure 4 as well and showed chapters one and three overall average test scores improve to a score of 76.2% a small increase of only .07%. The overall test averages for chapters two and four where the CSR intervention was used demonstrated a score of 83.2% and a 5.8% increase from when class C was involved in the data. The two most interesting results from Figure 4 were the scores that show that CSR intervention demonstrated better quiz and test scores in all classes (Class C not included) in comparison to the teacher's traditional method. Another surprising find was the big jump on the classes average test scores during the use of the CSR when excluding class C, as the average test score jumped from a 77.3% to 83.2%.

After looking at the class averages for the quizzes and tests for all four of the chapters used in the study, a breakdown of each was done to see where each class was having success or struggling. In order to do so each class' quiz average was broken down to see how each did on the vocabulary portion of the quiz (8 multiple choice questions) and the two short answer questions that tested their conceptual understanding of the material. Each class vocabulary average and short answer average was transferred to appendix H. Three of the four classes did well on the vocabulary portion of the quizzes for each chapter. Only one exception was Class C in chapter four, where they scored better on the two short answer overall compared to the eight vocabulary questions. The quizzes overall demonstrated that most classes had a good grasp of the vocabulary, but struggled with the concepts at the time the quiz was administered.

The exact opposite occurred when the same process was done for the chapter tests for each class. Each test was analyzed to determine the average class score on the vocabulary portion of the test in comparison to the conceptual portions of the test and the data was tabulated in appendix J. In this case, the test had a diagram that needed to be labeled, followed by four short answer questions of which the students chose three to answer. Only three occurrences showed a class doing better on the vocabulary portion of the test in comparison to the conceptual portion of the test. These results demonstrate that each class as whole had more success with understanding the concepts of the material at the completion of the chapters.

Discussion

After the CSR experiment results were collected and analyzed it became apparent that this experiment for the most part had not produced the desired results. I thought the CSR intervention would promote better results, however in the end it did not demonstrate that the class grades were affected in a negative way either. As a whole I still think that the CSR intervention can be effective and useful, but in this case it fell short. There were a few positives that were produced, which seem to indicate that if the CSR strategy is adapted correctly then there is room in the classroom for this to be an effective alternative for students and the teacher delivering it.

Interpreting Results

The first set of data that was graphed and analyzed were the class averages for each of the four chapters quiz and test scores throughout the experiment. The trend while interpreting these results was that the quiz scores under the teacher's traditional approach were better than the quiz scores while using the CSR intervention. What was surprising to me in this case was how the CSR strategy put a huge emphasis on vocabulary for each section of the chapter, and yet under the CSR chapters the quiz scores were worse. The format of the quiz was vocabulary based having eight multiple-choice questions with only two short answer questions that connected the vocabulary and key concepts. This is why I was so shocked to see the chapters that were dedicated to the teacher's traditional approach producing better quiz results. It is possible that this approach of having the students define vocabulary words in their notebook, followed by a power point presentation reviewing them worked as evidenced by the quiz scores. The CSR approach promoted a lot of group discussion with its members about the information, until the groups came back together for a whole class discussion.

The other set of data from Figure 1, looked at the test results for all four classes and chapters. Under this set of data the CSR intervention produced better results during the experiment. While the students did not achieve high scores on the test, they did for the most part come up being better scores in comparison to when the teacher used his traditional approach. The format for all four test administered were the same for all four chapters, but this time the CSR approach produced better results. I believe that the group discussion of the CSR approach, along with tying the key concepts to the vocabulary benefitted the students. Each section students dissected the content in a way that was designed to help each individual in the group fully understand the material. When looking at the average test grades for each class they still struggled, but they did do better with the material using the CSR approach. This could be due to the test having more of an emphasis on the concepts of each chapter whereas the quiz was more vocabulary oriented. Despite each assessment's format, the chapters dedicated to the CSR approach came out a little better by a small margin.

After looking at each class's average quiz and test grades, another set of data was graphed and analyzed. This time in Figure 2, the average scores for the quiz and tests were combined by which strategy was used. Chapter 1 and 3 that used the teacher's traditional approach were compared to chapters 2 and 4, which used the CSR intervention. I graphed the material this way to see if combining the average quiz and test grades for each class would produce any differences in the results. There was no change in the view of the results. Again, only the test results supported the use of the CSR intervention. The same held true for each class's quiz average, as they were still better under the non-CSR approach.

When the data combined all the classes into one average for the quiz and test grades (Figure 3) based on the teaching method used, the results became a bit more insightful. The average quiz scores in this case for the CSR did not surpass the average quiz scores under the traditional approach used by the teacher, however the gap did close some. The CSR quiz scores when averaged together produced less than significant results but did get better. After grouping all the classes, the most encouraging piece of information found was the increased jump of the test average under the use of the CSR intervention. I believe that the class discussion among their groups really helped students gain a better insight on the material that was being given to them. Along with the group discussion, I believe that the CSR approach better prepared the students for tests because of the roles each student had under the intervention. The students worked together in their groups and basically taught each other the material from each section of the chapter. This was a guided instruction, but nevertheless an effective way for getting students to focus on the content. Why it did not work for the quizzes is a bit puzzling to me. As I mentioned before with the CSR approach being so vocabulary oriented, just like the quizzes were I was a bit confused to see the results be better when not using the CSR approach.

Under Figure 4, I provided evidence in all the results that there was a trend of underachieving data produced by Class C throughout the experiment. Their averages were significantly lower in each segment of the experiment and made me wonder what the results would have looked like if they were removed. While this was not part of the original design, possible reasons exist for why their average scores throughout the experiment were so bad. With a group of students of about 25 in Class C, it was the biggest class and also the one class that contained a cluster of students with high needs. Some of these students with high needs were eight individuals who were English as Second Language (ESL) students. Out of those eight there were four who had extremely limited speaking, reading, and writing skills in the English language. While it was a struggle to overcome the limited English skills in the general science classroom, the teacher grouped them together with a few students who were bilingual in hopes of these students translating material and guiding them through the experiment for all four segments.

As the results showed, the averages for Class C produced the lowest quiz and test averages for each segment and led me to see if, by taking this class out, there would be a significant difference for the overall effectiveness of the CSR intervention. When doing so Figure 4 of my "Findings," gave me the one breakthrough of the experiment. The overall quiz averages actually produced better results under the use of the CSR intervention in comparison to the teacher's traditional method. The scores were still lower than expected, but the CSR strategy did promote better understanding on the quiz. The test averages, which were already better when using the CSR intervention, created a bigger gap in comparison to the traditional method used. This helped suggest to me that the CSR intervention could be effective in a classroom. A factor here could be that the test included more conceptual based questions where Class C average test scores would have definitely suffered based on those eight students alone who were ESL students. However, the same would hold true for the quiz and test on the multiple choice portions, as it would be hard to expect these students to fully understand the question being asked, yet alone the answers they were given to choose from. With class C removed from the data it did show that the CSR can produce some positive results, however I would have rather had all classes improve as that is the sign of a truly effective strategy.

The last set of data that was analyzed were the average quiz scores for each grade, where they were broken down to see the class average on the vocabulary portion and the conceptual portion. The same breakdown was completed for each classes test averages and both can be seen in the Appendices labeled L & M. This data demonstrated that on the quizzes almost every class did better on the vocabulary portion, which was expected as the quiz was more vocabulary oriented. Though if they understood the vocabulary then most of the classes should have done at least as well on the conceptual questions that followed. Maybe there was a lot of guessing, or perhaps they remembered the word being tied into the question given; yet they appeared not to understand. A lot of scenarios could have occurred here to have the vocabulary be better than the conceptual questions. The opposite occurred for each class's test averages, where almost every class did better on the conceptual based questions. In this case, the classes could have struggled with the multiple-choice questions covering more material than was on the test, or perhaps they just understood the concepts a bit better. Did each class do better on the conceptual questions, because the conceptual questions tied in a lot of the vocabulary? Logically, if you knew the vocabulary you could usually also understand the conceptual questions that follow. As the grades were collected though, none of the four classes produced the expected grades on the tests making me think that that they understood only parts of the material. Perhaps they did better on the conceptual questions because they could get partial credit for their answers, whereas on multiple-choice questions their answers were either right or wrong. Overall, it became clear that the CSR strategy had not promoted conceptual understanding in the sixth grade science vocabulary.

Implications of Practice

With the experiment not working out as planned it becomes natural to look back at what might have gone wrong while implementing it in the classroom. Questions arose whether the CSR intervention actually was ineffective, or did this specific research design just not work. Based on the analysis of my results a combination of factors could have led to my experiment falling short of my desired expectations.

When I reexamined the experiment a number of ideas arose on what may have gone wrong. Due to the limited time constraints starting a week earlier would have provided the chance for each class to have fully understood the CSR intervention that they were about to use. The teacher gave the students a 15-minute short introduction on the CSR intervention the class before they began using it. If I were able to do this study again, I probably would have dedicated a full period to explaining the strategy as well as another full period of implementing the CSR intervention in a full class example session. I think this would have been a tremendous help in the implementation of the experiment as all the students would have been exposed to it twice with full explanations of how it works, the expectations of each individuals roles, and would have also had a full class simulated example of the CSR intervention being used. All three of these things would have helped each individual understand it better with being introduced to the CSR intervention before actually having them use it in their groups on their own. Instead the students did not appear to fully grasp the strategy until the third or fourth session of the five that were completed.

Besides expanding the introduction of the CSR intervention, another flaw in the experimental design could have been avoided. I knew that Class C was going to be the most challenging out of the four classes while implementing the experiment, however I believed too much in the strategy itself. This was the class that had eight ESL students, of those eight; four of these individuals had very limited English skills. From the literature review, there was one CSR experiment mentioned that showed that students who are English as a Second Language, were making significant gains with the use of the CSR strategy (Klingner, et al, 2004). Though the teacher and I never talked about excluding Class C from the experiment, we were well aware of the circumstances in that particular classroom. Now thinking back on the experiment, it may have been a good idea to do so. Under the CSR strategy there was writing, reading, and group discussion. Initially it was set so that the ELL students would be grouped together with a couple other bilingual students, which would allow these students to participate through translation. However, that never was the case as these students struggled with the CSR strategy as well as the teacher's own traditional method that was used in the other two chapters. Class C was not parallel to the other three classes and it can be seen very easily in the results for the class averages on the quizzes and tests. Throughout the experiment this class was well below the other class's averages.

Shook, et al (2011) implemented the CSR experiment five days a week for 90 minutes class period sessions, while I only had 40-minute class periods. Shook, et al,(2011) delivered the CSR strategy with the intent of covering a whole science unit, while due to time constraints I was limited to approximately a month where we only had time to cover four science chapters. That was a lot of material to cover in a very short period of time, and very easily could have factored into the below mastery quiz and test scores that were collected. Some of the science content was very specific and the students had either very little or no prior knowledge of the material being taught to them. With all that said every CSR research article I had read did produce positive results, even in the case of Shook, et al, (2011) where they had an inclusive classroom. In their study all the individuals with learning disabilities produced better results and bigger gains under the use of the CSR intervention, whereas the individuals I worked with struggled throughout the experiment. This was disappointing, where I thought bringing a study to a minority classroom like the one Klingner, et al, (2004) had done would possibly bring those same positive results I had read about.

Implications for Further Research

Even with the differences from the CSR research, and the way I implemented the CSR intervention, there are plenty of other factors that I would now consider using going forward. First, I think the age of the student participants in the study made it more challenging than previous studies. The two CSR studies that were researched took place at the 9th and 10th grade level. The study I conducted was implemented at the sixth grade level. Even though the students were monitored throughout, I believe that possibly the CSR strategy was a bit to challenging for that age level. From the research on middle school learners, Walsh (2006) stated new type of instruction confronts young adolescents who are suspicious and guarded as well as being mercurial, in that good days and bad days of these students are magnified and exaggerated by mood swings and social crises. These influences may have factored into the outcomes of how the study turned out. The CSR strategy in my opinion can be effective; however, it may have been a little too complex and demanding of these individuals at this age and with the limited introduction provided. It is a significant change from your basic general classroom teacher in 5th grade to having a new teacher for each of the majority of your classes. On top of that as Walsh stated about the new instruction being difficult, now these individuals experience it from many different teachers with many different styles. My study falls into this very category. The CSR intervention may be best suited for individuals at the high school level, though I do think it could work at the middle school level, so long as it is setup and prepared appropriately for the individual students in the classroom. I think I assumed the students could handle it as if it was just another day in their science classroom, which was inaccurate.

Another issue that could have played a major role in the low scores throughout the experiment was the overall content that was taught throughout the study. I had no ability to adapt the subject material being taught as I entered the classroom a month into the school year. In this study, the individuals were assessed on four chapters: The Earth's Interior, Plate Tectonics, Forces in the Earth's Crust, and Monitoring Earthquakes & Earthquake Safety. The problem I found is that perhaps this material was two demanding, as it was all mostly new to these individuals. From my research the NSTA (1986) stated that students are not provided opportunities to explore science in their lives, rather science curricula tends to be watered down versions of the secondary science school courses. If this was true, this content was more challenging material than the students had been taught at the Elementary level. A group work strategy that is new to all of these individuals as well as the teacher may have been too much adjustment for the second month of school.

The more I delved into the science content that was taught, the more I looked deeper into my own research prior to the implementation of the study. I remembered that a lot of students bring in misconceptions about science material to the classroom. The research from Brusell and Marck's (2007) stated that conceptual change in students involves their own ideas about how the natural world works based on a rich tapestry of prior experiences and understandings. The teacher and I had also talked after the study was completed and pondered if the material itself was to concrete for them. As I remember elementary school, there is not much science taught in the classroom, and if so it wasn't going into the topics of plate tectonics or the forces of the earth's crust. Those first two chapters you could see that a lot of the material they were reading and learning was new to them. The one common theme for the majority of the individuals was that they knew about "Pangaea," in that one point all the continents were once combined. The latter two subjects were about earthquakes and all the individuals had some idea about what an earthquake was, however I would say very few actually knew any scientific background about it. This is where I felt that Brusell and Marcks were right about students bringing in these misconceptions about science. From the research Brunsell and Marcks (2007) stated students must first become dissatisfied with their initial ideas in science, in order for conceptual change. It was Li. & Li (2008) and Kang (2007) that found these same findings about student's prior misconceptions. During the last two chapters of the study where the material was not as concrete, I don't think the students were willing to let go of their prior understandings about earthquakes. The grades for the most part had improved, but it was unclear if it was due to easier content being taught or the familiarity of the CSR strategy. Even so the grade improvement was not as large as I had expected, they were still below average and not what I anticipated the CSR intervention to produce. Though from the research it states it takes more than one intervention model to effectively eliminate student alternate conceptions (Calik, et al, 2010).

Maybe this is true, as it seemed that some students still held on to their own ideas instead of accepting the scientific concepts about the content. Maybe, the CSR demanded too much of a sixth grader whose scientific background is minimal or misconstrued and is best suited for older individuals at higher grades. Possibly the material was too hard to be attempting to implement a strategy that is brand new to sixth grade students and the teacher. This could have lead to inadequate planning and introducing of the CSR intervention, ultimately leading to the results that were collected. This shouldn't deter future teachers from attempting the implementation of the CSR intervention in their own classroom. It is a great strategy that has proven results, however; results that worked at the high school level. More research should be conducted to see if this CSR strategy could be effective at the middle school level. The CSR strategy differentiates instruction, promotes engagement of all students, has evidence of positive impact on individuals with learning disabilities in an inclusive classroom, and lets the students teach each other, which at times can be the best instruction. While it did not generate the results I was looking for from my research study, there were no prior signs that the CSR strategy promoted understanding in sixth grade vocabulary. Unfortunately, the results were inconsistent throughout the experiment, which was not the result I was expecting. Nevertheless, I would definitely give this CSR strategy another opportunity in a middle school classroom due having proven research results on its side.

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Appendices

Appendix A

Group Roles in CSR Strategy

1.) **Leader** – Leads group during the CSR Activity and gathers needed material. They will come up and get the note card and make sure everyone has a text book.

2.) **Clunk Expert** – Reminds group of the steps to follow, and makes sure to tell recorder when coming across words or pieces of text that are difficult or not understood.

3.) **Announcer** – Holds the note card, calls on all members to share information, feedback, or comments. Will also pick group members to read from the text book, making sure everyone participates.

4.) **Encourager** – Gives positive feedback to members of the group and will report what information the group understands at the end.

5.) **Recorder** – Records any written information during the activity, including questions that are answered, words that the groups knows, as well as information the group still doesn't understand.

6.) **Timekeeper** – Keeps an eye on the clock and will tell group when it's time to move on to the next step of the activity. The timekeeper still participates in helping the group come up with answers and reads if called on.

✻ **If a group has only 5 members in it that the Encourager will also take on the role of the Timekeeper.**

Appendix B

Validity Checklist for Implementation of the CSR Strategy

1.) All students are into their CSR groups before the CSR session has begun? _____
2.) Teacher passed out note cards to the leader of the CSR groups? _____
3.) The teacher accurately tracks the ten-minute sessions of the CSR session? _____
4.) Teacher is actively engaged in the CSR strategy?
    a. Moves from group to group ______
    b. Allows students to think about their question or answer (doesn't just give the group the answer ______
5.) Allows times for the CSR groups to ask questions and make connections in the last part of the session. _____
6.) Has enough time to go over any misconceptions or build discussion on the new concepts. _____

Appendix C

Chapter 2 Note Card-Section 2.1 for CSR Strategy

In the 1700's, geologists thought that the continents had always remained in the same place. But early in the 1900's, one scientist named Alfred Wegner **hypothesized** that the **continents** were once joined together in a single landmass, and have since drifted apart. (Padilla, J. Michael. et al. (2009). Prentice Hall Science Explorer: *Earth science*. Pearson, Boston, Mass. p. 136-138.)

-As a group discuss and write down what a continent is, and can you write them down? (There are 7)
-Write what hypothesize means?
-Would you agree with Alfred Wegner's hypothesis about the continents?
  -If yes, write down as a group why?
  -If no, write down as a group why not?

<u>Key Vocabulary Terms</u>- Review these scientific terms with your group and see if your group can write a definition, or why write a reason to why they may be important.

-Continental Drift **- Pangaea** **- Fossil**

Appendix D

Chapter 2 Note Card-Section 2.2 for CSR Strategy

- Deep in the ocean, the temperature is near freezing. One example of this is the East Pacific Ridge. The area of the East Pacific Ridge has water sinking through cracks in the earth's **crust**. This water is then heated by hot material from the **mantle** of the earth. This hot water then spurts back into the ocean. The East Pacific Ridge is just one of many **mid-ocean ridges** that wind beneath the Earth's oceans. These mid-ocean ridges extend into all of the Earth's oceans. (Padilla, J. Michael. et al. (2009). Prentice Hall Science Explorer: *Earth science*. Pearson, Boston, Mass. p. 141-142.)

-What is important about hot water getting spurted back into the ocean? (Think magma)
-Why would geological features of such an environment as stated above, provide evidence for Alfred Wegner's hypothesis of **continental drift**?
-Gather ideas as a group and discuss what a mid-ocean ridge might be and what it might be telling us about **continental drift**?

Key Vocabulary Terms- Review these scientific terms with your group and see if your group can write a definition, or why write a reason to why they may be important.

-Mid-ocean ridge **- Sonar** **- Sea-floor spreading**
-Deep-ocean trench

Appendix E

Chapter 2 Note Card-Section 2.3 for CSR Strategy

If you have ever seen a broken eggshell, you can see that there is not a pattern in the eggshell pieces. The earth's **lithosphere**, its solid outer shell, is not one unbroken layer but many. It is more like the cracked eggshell, since its' broken into pieces separated by jagged cracks. A Canadian scientist named J. Tuzo Wilson, observed that there are cracks in the **continents** that are similar to the ones in the ocean floor. (Padilla, J. Michael. et al. (2009). Prentice Hall Science Explorer: *Earth science*. Pearson, Boston, Mass. p. 150-151.)

-Discuss what might be important about the earth's outer shell, the ***lithosphere***, being broken into pieces by jagged cracks.
-What might be important about the cracks in the continents begin similar to the cracks in the ocean floor? (We talked about the ocean floors in the last section)
-As a group can you make any predictions/ or hypothesize what this information might mean about the continents?

<u>Key Vocabulary Terms</u>- Review these scientific terms with your group and see if your group can write a definition, or why write a reason to why they may be important.

- Plate **- Scientific Theory** **- Plate Tectonics**
- Fault **- Divergent Boundary** **- Rift valley**
- Convergent Boundary **- Transform Boundary**

Appendix F

Chapter 4 Note Card-Section 4.1 for CSR Strategy

Earthquakes are dangerous, so people want to monitor them. To *monitor* means to "watch closely." Many societies have used technology to determine when and where earthquakes have occurred. During the late 1800's, scientists developed *seismographs,* which records seismic waves of the earthquake. A simple seismograph can consist of a **heavy weight** attached to a a **frame** by a **spring** or **wire**. A **pen** connected to the **weight** rests its point on a **drum** that can rotate. As the **drum** rotates slowly, the **pen** draws a **straight line on paper** wrapped tightly around the **drum**. With a seismograph the pen stays in place, while the paper on the drum moves, due to the weight resisting motion during a quake. (Padilla, J. Michael. et al. (2009). Prentice Hall Science Explorer: *Earth science*. Pearson, Boston, Mass. p. 178-179.)

- During an earthquake, what will cause the paper on the drum of the seismograph to move?
- Discuss in your group, are there different sized earthquakes? If so, how do scientists determine the size of them?

Key Vocabulary Terms- Review these scientific terms with your group and see if your group can write a definition, or why write a reason to why they may be important.

-Seismograph -Seismogram - Tilt-meters - Creep Meter -Laser-Ranging Devices - GPS Satellites

Appendix G

Chapter 4 Note Card: Section 4.2 for CSR Strategy

Geologists know that earthquakes are likely where **plate movements** store energy in the rock along **faults**. Geologists are can determine earthquake risk, by locating where faults are active and where past earthquakes have occurred(Remember they can't predict when and where an earthquake will happen). (Padilla, J. Michael. et al. (2009). Prentice Hall Science Explorer: *Earth science*. Pearson, Boston, Mass. p. 186-187.)

-What areas of the United States have the highest earthquake risk?
-Write down in your group, some of the ways earthquakes can cause damage?
-What are some ways to protect yourself during an earthquake?

Key Vocabulary Terms- Review these scientific terms with your group and see if your group can write a definition, or why write a reason to why they may be important.

-Liquefaction **-Aftershock**
- Tsunami **- Base-Isolated building**

Appendix H

Format of Chapter 3 Quiz

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Because stress is a force, it
a. takes energy out of rock.
b. adds energy to rock.
c. adds volume to rock.
d. makes rock harder.

____ 2. Which type of stress force produces reverse faults?
a. Shearing
b. Tension
c. Compression
d. Deformation

____ 3. Geologists know that wherever plate movement stores energy in the rock along faults,
a. earthquakes are not likely.
b. earthquakes are likely.
c. an earthquake is occurring.
d. an earthquake could never occur.

____ 4. A force that acts on rock to change its shape or volume is called
a. an aftershock.
b. friction.
c. liquefaction.
d. stress.

____ 5. In a strike-slip fault, the rocks on either side of the fault slip past each other sideways with little
a. noise.
b. shaking.
c. up-or-down motion.
d. movement.

____ 6. Geologists cannot yet predict earthquakes because
a. they have too much data.
b. they can't be sure when and where stress will be released along a fault.
c. they need to know where all past earthquakes occurred.
d. there are too many faults to monitor.

____ 7. Stress that pushes a mass of rock in two opposite directions is called
a. shearing.
b. tension.
c. compression.
d. deformation.

____ 8. What happens when friction between the opposite sides of a fault is high?
a. A plateau may form on one side of the fault.
b. The fault locks, and stress builds up until an earthquake occurs.
c. Folding of the crust may occur.
d. The rocks on both sides of the fault easily slide past each other.

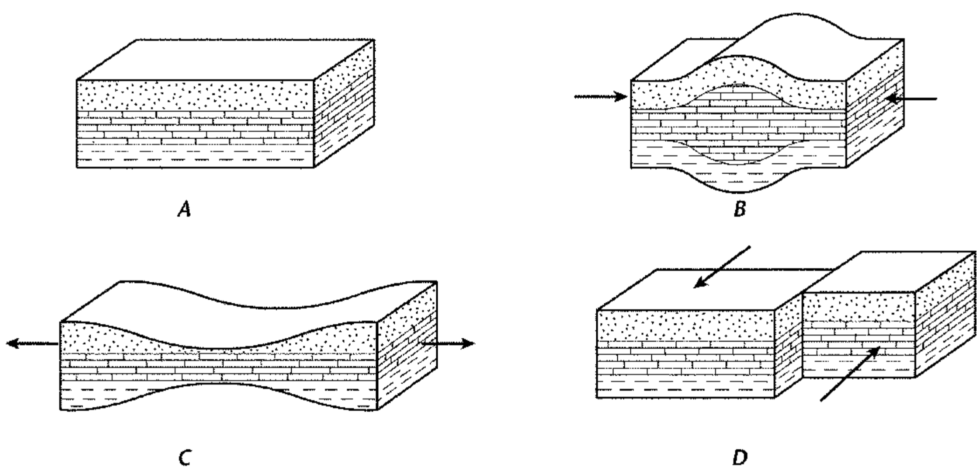
Appendix H

Format of Chapter 3 Quiz

Short Answer

Use the diagram to answer each question.

Rock Stress



9. Compare diagram B to diagram A. How is it different?
10. In diagram B, which type of fault will form if the stress force continues? Explain.

Appendix I

Chapter 3 Quiz Answer Section

MULTIPLE CHOICE

1. ANS: B PTS: 1 DIF: L2 REF: p. F-44
   OBJ: F.2.1.1 Explain how stress in the crust changes Earth's surface.
   STA: 1.S2.2.b BLM: comprehension
2. ANS: C PTS: 1 DIF: L1 REF: p. F-47
   OBJ: F.2.1.2 Describe where faults are usually found and why they form.
   STA: 4.Physical.2.2.c BLM: knowledge
3. ANS: B PTS: 1 DIF: L1 REF: p. F-69
   OBJ: F.2.4.1 Explain how geologists determine earthquake risk.
   BLM: knowledge
4. ANS: D PTS: 1 DIF: L1 REF: p. F-44
   OBJ: F.2.1.1 Explain how stress in the crust changes Earth's surface.
   STA: 1.S2.2.b BLM: knowledge
5. ANS: C PTS: 1 DIF: L1 REF: p. F-47
   OBJ: F.2.1.2 Describe where faults are usually found and why they form.
   STA: 4.Physical.2.2.c BLM: knowledge
6. ANS: B PTS: 1 DIF: L2 REF: p. F-65
   OBJ: F.2.3.3 Explain how seismographic data are used. BLM: comprehension
7. ANS: A PTS: 1 DIF: L1 REF: p. F-45
   OBJ: F.2.1.1 Explain how stress in the crust changes Earth's surface.
   STA: 4.Physical.2.2.c BLM: knowledge
8. ANS: B PTS: 1 DIF: L2 REF: p. F-64
   OBJ: F.2.3.2 Describe how geologists monitor faults. BLM: comprehension

SHORT ANSWER

9. ANS:
   Diagram B shows how compression affects rock layers, causing the layers to bulge in the center and occupy a smaller horizontal area.

   PTS: 1 DIF: L2 REF: p. F-45
   OBJ: F.2.1.1 Explain how stress in the crust changes Earth's surface.
   STA: 4.Physical.2.2.c BLM: analysis
10. ANS:
   A reverse fault will form. Compression will squeeze the rock until a fault occurs in which the rock forming the hanging wall slides up and over the footwall.

   PTS: 1 DIF: L2 REF: p. F-47
   OBJ: F.2.1.2 Describe where faults are usually found and why they form.
   STA: 4.Physical.2.2.c BLM: analysis

Appendix J

Format for Chapter 3 Test

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. The point beneath Earth's surface where rock breaks under stress and triggers an earthquake is called the
a. syncline.
b. footwall.
c. epicenter.
d. focus.

____ 2. Compared to P waves and S waves, surface waves move
a. faster.
b. slower.
c. at the same rate.
d. farther from the epicenter.

____ 3. Which scale would most likely be used to tell how much earthquake damage was done to homes and other buildings?
a. the Richter scale
b. the Mercalli scale
c. the moment magnitude scale
d. the seismic scale

____ 4. What does a seismograph record?
a. the Mercalli scale rating for an earthquake
b. the speed of seismic waves
c. the ground movements caused by seismic waves
d. the location of the epicenter

____ 5. Geologists know that wherever plate movement stores energy in the rock along faults,
a. earthquakes are not likely.
b. earthquakes are likely.
c. an earthquake is occurring.
d. an earthquake could never occur.

____ 6. A force that acts on rock to change its shape or volume is called
a. an aftershock.
b. friction.
c. liquefaction.
d. stress.

____ 7. What happens when friction between the opposite sides of a fault is high?
a. A plateau may form on one side of the fault.
b. The fault locks, and stress builds up until an earthquake occurs.
c. Folding of the crust may occur.
d. The rocks on both sides of the fault easily slide past each other.

____ 8. In what direction do seismic waves carry the energy of an earthquake?
a. away from the focus
b. toward the focus
c. from the surface to the interior
d. through the mantle only

Appendix J

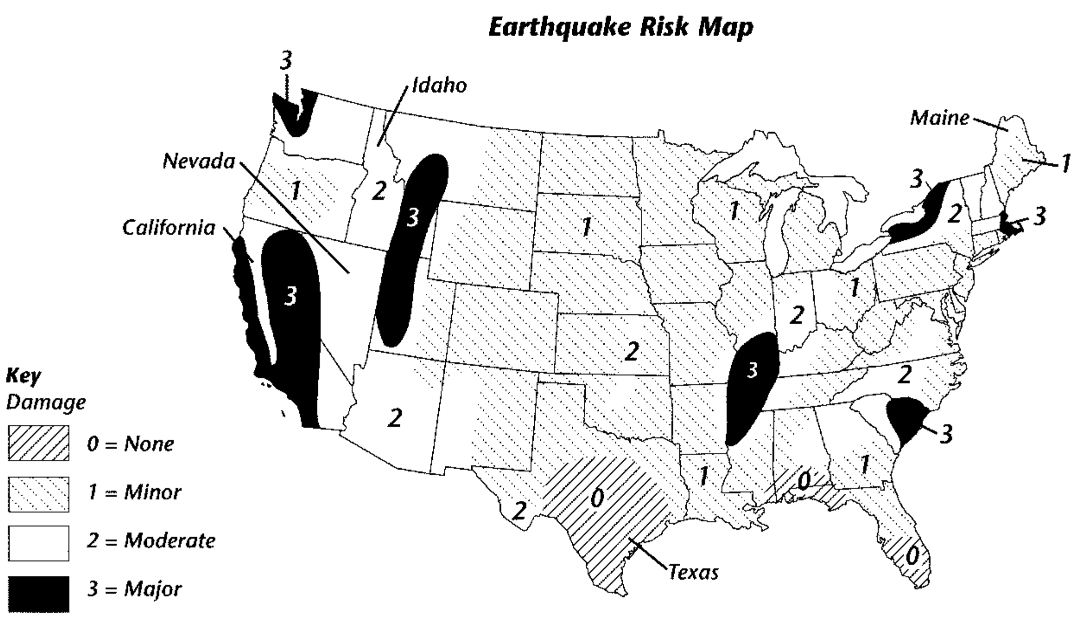
Format for Chapter 3 Test

____ 9. What type of earthquake wave can travel through both liquids and solids?
   a. P waves
   b. S waves
   c. focus waves
   d. surface waves

____ 10. The rating system that estimates the total energy released by an earthquake is called the
   a. Richter scale.
   b. moment magnitude scale.
   c. mechanical seismograph scale.
   d. Mercalli scale.

Short Answer

Use the diagram to answer each question.



11. How do California and Nevada compare in possible severity of earthquake damage?
12. According to the map, which part of the United States is least likely to suffer earthquake damage?

Appendix K

Chapter 3 Test Answer Section

MULTIPLE CHOICE

1. ANS: D PTS: 1 DIF: L1 REF: p. F-51
   OBJ: F.2.2.1 Describe how the energy of an earthquake travels through Earth.
   STA: 4.Physical.2.2.a BLM: knowledge

2. ANS: B PTS: 1 DIF: L1 REF: p. F-53
   OBJ: F.2.2.1 Describe how the energy of an earthquake travels through Earth.
   STA: 4.Physical.2.2.b BLM: knowledge

3. ANS: B PTS: 1 DIF: L2 REF: p. F-54
   OBJ: F.2.2.2 Identify the scales used to measure the strength of an earthquake.
   BLM: application

4. ANS: C PTS: 1 DIF: L2 REF: p. F-54
   OBJ: F.2.3.1 Explain how seismographs work. BLM: comprehension

5. ANS: B PTS: 1 DIF: L1 REF: p. F-69
   OBJ: F.2.4.1 Explain how geologists determine earthquake risk.
   BLM: knowledge

6. ANS: D PTS: 1 DIF: L1 REF: p. F-44
   OBJ: F.2.1.1 Explain how stress in the crust changes Earth's surface.
   STA: 1.S2.2.b BLM: knowledge

7. ANS: B PTS: 1 DIF: L2 REF: p. F-64
   OBJ: F.2.3.2 Describe how geologists monitor faults. BLM: comprehension

8. ANS: A PTS: 1 DIF: L1 REF: p. F-52
   OBJ: F.2.2.1 Describe how the energy of an earthquake travels through Earth.
   STA: 4.Physical.2.2.b BLM: knowledge

9. ANS: A PTS: 1 DIF: L2 REF: p. F-53
   OBJ: F.2.2.1 Describe how the energy of an earthquake travels through Earth.
   STA: 4.Physical.2.2.b BLM: comprehension

10. ANS: B PTS: 1 DIF: L1 REF: p. F-55
    OBJ: F.2.2.2 Identify the scales used to measure the strength of an earthquake.
    BLM: knowledge

SHORT ANSWER

11. ANS:
    Both states could suffer earthquakes causing moderate to major damage.
    PTS: 1 DIF: L2 REF: p. F-69
    OBJ: F.2.4.1 Explain how geologists determine earthquake risk.
    BLM: analysis

12. ANS:
    the southern part, including Texas, Mississippi, Alabama, and Florida
    PTS: 1 DIF: L2 REF: p. F-69
    OBJ: F.2.4.1 Explain how geologists determine earthquake risk.
    BLM: analysis

Appendix L

Quiz Breakdown: Mean Vocabulary, Mean Short Answer, and Overall Quiz Score

Key: **** = CSR Strategy Implemented***

S.A. = Short Answer

Vocabulary

	Chapter 1			Chapter 2*		
	Vocabulary	**S. A.**	**Quiz**	**Vocabulary**	**S. A.**	**Quiz**
Grade A	84%	78%	81%	84%	72%	78%
Grade B	90%	80%	85%	85%	75%	79%
Grade C	73%	61%	67%	71%	63%	67%
Grade D	83%	71%	77%	84%	72%	78%

	Chapter 3			Chapter 4*		
	Vocabulary	**S. A.**	**Quiz**	**Vocabulary**	**S. A.**	**Quiz**
Grade A	83%	75%	79%	78%	70%	74%
Grade B	78%	68%	73%	81%	77%	79%
Grade C	60%	48%	54%	48%	54%	51%
Grade D	84%	76%	80%	76%	70%	73%

Appendix M

Test Breakdown: Mean Vocabulary, Mean Short Answer, and Overall Test Score

Key: **** = CSR Strategy Implemented***

S.A. = Short Answer

Vocabulary

	Chapter 1			Chapter 2*		
	Vocabulary	**S. A.**	**Test**	**Vocabulary**	**S. A.**	**Test**
Grade A	**76%**	**78%**	**77%**	**81%**	**85%**	**83%**
Grade B	**80%**	**84%**	**82%**	**78%**	**82%**	**80%**
Grade C	**61%**	**63%**	**62%**	**66%**	**64%**	**65%**
Grade D	**72%**	**76%**	**74%**	**84%**	**86%**	**85%**

	Chapter 3			Chapter 4*		
	Vocabulary	**S. A.**	**Test**	**Vocabulary**	**S. A.**	**Test**
Grade A	**72%**	**70%**	**71%**	**82%**	**78%**	**80%**
Grade B	**74%**	**76%**	**75%**	**86%**	**90%**	**88%**
Grade C	**55%**	**59%**	**57%**	**53%**	**57%**	**55%**
Grade D	**80%**	**84%**	**82%**	**81%**	**85%**	**83%**