12-1-2014

The Effects of Integrated Science Inquiry and Literacy Instruction

James H. Menke

The Effects of Integrated Science Inquiry and Literacy Instruction

By

James Menke

A Graduate Field Experience

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Arts

Urban Special Education

At Cardinal Stritch University

Milwaukee, Wisconsin

2014

Approval Page

This Graduate Field Experience
James Menke
Has been approved for Cardinal
Stritch University by

Elizabeth Beveridge
(Advisor)

December 20, 2014
(Date)

Abstract

The effects of integrated literacy and science inquiry instruction were investigated and researched through a case study with students ranging from grades 3-6. In all, five students took part in the case study over the course of four weeks and 16, 55-minute sessions. Previous research indicated positive results in using inquiry based science instruction, literacy practices such as self-questioning and reciprocal teaching, and integrating literacy and science. Positive impacts were noted in comprehension, science content understanding, and ability to create a structured paragraph. The investigation made connections to the outcomes, limitations, previous research, and the need for further research.

Table of Contents

List of Tables and Charts

CHAPTER 1

INTRODUCTION

Introduction

A push for cross-curricular instruction between literacy and other subjects in the United States has begun. The goal of such a push is to help students continue to gain literacy skills and strive in the associated disciplines. Two disciplines that are being integrated at a growing rate are science and literacy (Romance & Vitale 2011). Science is a way to discover knowledge, and moreover, the science standards state the purpose of science is to acquire knowledge from research and experimentation (National Research Council, 1996). To acquire such knowledge students must possess or gain literacy skills. This was the focus of this case study, which had a goal of increasing comprehension through integrated literacy and science instruction. The case study was conducted over the course of 16 sessions from July 7 through July 31, 2014. The study was conducted at an urban literacy center in a Midwestern city. The literacy center provided three 55-minute blocks of time, one of which was scientific literacy. The other two blocks of time, which were not addressed in this study, included one-on-one tutoring in literacy and a reading, writing workshop. The students were separated in groups based on their reading abilities. In this study, two students were identified prior to the study as learning to read and three students were reading to learn. In this chapter a description of the students, and an overview of the research will be provided with connections to Common Core and Next Generation Science Standards.

Students

The case study took place at an urban literacy center and five students were randomly chosen to partake in the study. These students were all identified by parents and teachers as needing extra support to help them close the gap between them and their grade-level peers. The participants of the study included five students, who were going into grades 3-6. Four of the students were African American and

one student was white. Four of the five students were boys while one of the students was a girl. The students were divided into two groups, "learning to read" and "reading to learn." The students in the learning to read group included two students [1]Nathan and Lorenzo who were building onto their foundational reading skills. Three students participated in the reading to learn group, Demarcus, Meg, and Taylor, who were beginning to utilize their current reading skills to learn new information.

Nathan

Nathan was held back and remaining in 3rd grade for the 2014-2015 school year. According to documentation provided by the parent, he was moving to a new school in a suburban school district where he no longer would receive special education services. Nathan previously had an Individual Education Plan (IEP) and was located in a More Restrictive Placement (MRP) away from his general education peers. To move to the new school, the parent waived his special education services. His grandmother stated, "due to his developmental challenges associated with his Attention Deficit Hyperactivity Disorder (ADHD) reading has been a challenge." His behaviors were identified as a barrier that impeded his ability to learn as he sometimes got overwhelmed and sometimes was off task in conversations or activities. His mother stated that Nathan was one grade level behind his grade level peers academically. Nathan previously attended summer school and had weaknesses in areas of sight-word vocabulary, sounding out words, reading comprehension, writing, and reading accuracy. Additionally, Nathan struggled with penmanship and written expression. Nathan's strengths were in math and working with his hands. Specific areas that were targeted in the science literacy class included reading comprehension, penmanship, and written expression.

Lorenzo

Lorenzo would have been entering the fourth grade for the 2014-2015 school year. According to documentation provided by the parent, he attended a school in a suburban school district. Lorenzo never

[1] Pseudonyms were used in place of student names to maintain confidentiality.

had an IEP. His mother described his academic progress as "very good." Weaknesses Lorenzo had were in fluency and reading comprehension. At times his mother stated he needed to be redirected but overall his behaviors were beneficial for the learning environment. Lorenzo's strengths were in the area of expressing himself verbally and his interest in school and his interest in learning new things. Specific areas that were targeted in the science literacy class included reading comprehension and written expression to target Lorenzo's specific weaknesses.

Demarcus

Demarcus was the oldest student in the study. According to documentation provided by the parent, He attended a private school and would have been entering 6th grade for the 2014-2015 school year. Demarcus did not have an IEP or a known disability. He had strengths in reading fluency and exhibiting positive behaviors in the classroom setting. Demarcus had a weakness in reading comprehension and verbal discourse. Specific areas that were targeted in the science literacy class included reading comprehension and verbal discourse.

Meg

Meg would have been entering 4th grade at a suburban elementary school. According to documentation provided by the parent, Meg was diagnosed with ADD and this affected her ability to remain on topic and focus meaningfully during class. She did not have an IEP. Meg had weaknesses in reading comprehension and writing. She also had difficulties in spelling completing assignments on time and organization. Her strengths included her love for school and her reading fluency. Specific areas that were targeted in the science literacy class included reading comprehension and written expression.

Taylor

Taylor would have been entering 5th grade at a Montessori school. According to documentation provided by the parent he did not have an IEP or a known disability. Taylor was previously in speech to

help him in pronunciation and at times had a difficulty concentrating or maintaining attention when he became uncomfortable or didn't understand something. In reading, Taylor's teacher estimated he was six months behind in his grade level peers. Taylor had weaknesses in writing, expressing himself verbally, and reading comprehension. He also had areas of difficulty in organization, motivation, written expression, and spelling. He had an academic strength in math. Specific areas that were targeted in the science literacy class included reading comprehension written and verbal discourse.

Connection to the Standards

The five students were nearing proficiency for their grade level on the Common Core State Standards (Common Core State Standards Initiative, 2014) in reading, writing, and speaking and language. In addition, the students demonstrated limited knowledge of forces and in understanding grade level vocabulary, science processes, and science content related to forces based on pre-assessments. To identify strands that were targeted through the science and literacy integrated instruction, the Common Core State Standards (CCSS) and the Next Generation Science Standards (NGSS) were utilized. The instructional practice during the case study was presented through three units: forces, gravity, and magnetism. Science standards that were addressed specifically connected to the content include: 5-PS2-1 "Support an argument that the gravitational force exerted by earth on objects is directed down," MS-PS2-4 "Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects," MS-PS2-5 "Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact," and, 3-PS2-2 "Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion" (NGSS Lead States, 2014). These standards were addressed because the goal is for students to reach such standards by the completion of their grade level and the students did not demonstrate such mastery on a pre-assessment. Students built up their reasoning through hands-on activities, videos, text,

and class discussions to build an argument. Additionally, through the inquiry process the students were responsible for conducting investigations by asking questions, predicting, researching, observing, building up evidence, and sharing their findings about magnetism, gravity, and forces. Science and engineering practices that were also addressed include: "planning and carrying out an investigation," "asking questions and defining problems," "engaging in argument from evidence," "constructing explanations and designing solutions," and "obtaining, evaluating, and communicating information" (NGSS Lead States, 2014). The standards and science and engineering practices were used to create and investigate questions the students created, find evidence, build a conclusion from the evidence, and communicate their findings with a focus on summarizing through oral and written discourse. This was noted as important for students to be prepared for Science, Technology, Engineering and Mathematics (STEM) careers.

The literacy standards that were addressed fit into three areas of the Common Core State Standards (Common Core State Standards Initiative, 2014): speaking and listening, writing, and comprehension. Throughout all of the lessons students practiced their ability to listen and communicate with each other. One standard that was addressed was SL.5.1, which states students will engage in discussions where they build off of each other's ideas. Discussions were facilitated at the beginning of each lesson to bring about background knowledge and throughout most lessons as students discussed their reasoning, understanding, and questions. The students specifically learned how to build off of each other's ideas and disagree with dignity. In addition, another standard addressed in this area was SL.5.4 as students were required to report on their understanding of ideas and opinions where they used proper organization, and relevant evidence, and spoke clearly using appropriate volume, and pace. This standard was addressed in the same manner as the one prior. The students were responsible for organizing and using relevant evidence. A way in which the researcher addressed this was through questioning the students. The researcher routinely asked the questions, "why" and "how" to guide their thinking and presentation of ideas.

In addition, students worked toward mastering writing standards. These standards were mainly addressed through three lessons where students were responsible for writing summaries of what they had discovered about forces, gravity, and magnetism. The first standard in this area was W.4.2 as students were responsible for writing explanatory texts to clearly inform the reader of ideas. In addition, the standard W.4.7 related very well to the science integration, as students were responsible according to this standard to conduct research projects. Lastly, the standard W.4.4 addressed the organization of the writing, which was the focus item on the first writing lesson and assessed on a pre and post assessment. Many of the students in this study had a weakness in writing, and it was predicted they would benefit from such instruction.

Lastly, comprehension was the major focus of this research study. Comprehension was taught through reading informative texts as a way to gain knowledge on a given topic. All of the students in this case study had a specific weakness in comprehension. The standard that was specifically addressed in this case study was RI.5.10. This standard was chosen as it explicitly discussed the need for students to comprehend text from different subject areas including science at the student's grade level. This was addressed in the case study by students learning strategies through self-questioning and reciprocal teaching.

The goal of this study was to find the effects of literacy integrated science inquiry on students' reading comprehension, retention of science content, and scientific processes and thinking. The benefits of such integration could be beneficial for both science and literacy. In the upcoming chapter, a review of research will be provided specifically addressing literacy strategies, science inquiry, and integrated literacy and science inquiry.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

Literacy integrated science was the subject for this case study. The goal of the study was to increase reading comprehension and comprehension of science content, processes, and thinking through an integrated approach to science and literacy. The research was broken into three categories: literacy strategies, science strategies, and the strategies for integrating science and literacy. Literacy strategies that were researched include: reciprocal teaching, self-questioning and story mapping, teacher questioning, and writing through discovery writing. Additionally, the articles on science strategies demonstrated a need for hands on learning and instruction taught through inquiry. Lastly, the articles that addressed the integration of the subjects were diverse in the manner of incorporation the science and literacy. However, they all demonstrated positive outcomes for students. In the remaining portion of this introduction a basis for the need of such a practice is discussed.

Inquiry is comprised of students observing, posing questions, researching what is currently understood, planning an investigation where the students collect, analyze, and interpret data, and students offering explanations, conclusions, and share their findings. Students need to be taught how to accomplish all of these stages. However, they must also understand the order of the stages and inclusion of each will be dependent on each question and investigation (National Science Teacher Association, 2004).

Science is a discipline that has major connections to literacy, mathematics, music, technology, health, and art, and has the capability of developing critical thinking and problem solving skills. Literacy is a major part of science and scientific inquiry. Students utilize reading

skills while researching. These include the use of new vocabulary, utilizing headings and illustrations, and the use of reading fluency and comprehension to gain understanding from the text (Miller, 2006). In addition, students partake in written and spoken discourse as they plan their investigation, record and analyze data, and share their findings.

To complete scientific investigations students utilize spoken and written language, reading fluency and comprehension, as well as content knowledge and critical and rational thinking (National Science Education Standards, 1996). These skills stretch across all major subjects reading, written and spoken discourse, and mathematics. Due to the fact that science instruction expands into literacy, teachers are able to teach literacy skills through science instruction (Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2011). This could mitigate the limited amount of time allocated to science instruction through interdisciplinary instruction. This interdisciplinary instruction could target literacy skills while instructing in the subject of science.

In creating a literacy integrated science inquiry lesson, it is imperative to use research-based strategies in literacy, science inquiry, as well as in the way in which the subjects are integrated. In the subsequent sections of this chapter, studies that address the important questions concerning this case study will be summarized. These questions include: What literacy strategies could be taught within science inquiry? What are the research based science strategies and effects of science inquiry on science content? What are the research based strategies and effects on embedding literacy and scientific inquiry? With the goal of better utilizing instructional time science blocks can integrate literacy skills and prepare students for science, technology, engineering, and mathematics (STEM) careers.

Reading Comprehension and Writing Strategies

Throughout science instruction, students routinely participate in literacy activities. To form a basis for understanding, students use text as a major resource. According to Miller (2006), throughout science inquiry there are numerous opportunities for reading applications. In addition to the numerous avenues of improving students' reading, there are many ways to improve students' written and spoken discourse. Shwartz, Weizman, Forus, Sutherland, Merrit, & Krajcik (2009) state, "science is a social process—one that involves particular ways of talking, reasoning, observing, analyzing, and writing" (p. 44). In the upcoming section comprehension is addressed through articles about self-questioning, story mapping, reciprocal learning, and questioning moves. Additionally, discovery learning is discussed through an article as a way to benefit students' writing.

Students begin using comprehension and problem solving strategies at a very young age (Bransford, Brown, & Cocking, 2004). What the children understand is very powerful and it lays the foundation for future understanding. Students may problem solve and comprehend through pictures, attempting to sound out words, or relating it to their personal experience. The first study gives the foundation of where students are coming from and what they are understanding, thinking, and problem solving at a young age. It is imperative to use students' previous understanding as a starting point and a resource while teaching new skills and content.

Martin & Kragler (2010) investigated the ways kindergarten students "monitored and self-regulated their understanding of texts" (p. 141). The study used both quantitative data and qualitative data to find the habits of the students in concern to how they understood text, thought through text, and problem solved. The researchers hypothesized a pattern would emerge from the students' reading strategies including ability to self-regulate/monitor when asked questions

about their reading by the researcher. The dependent variables were the ways in which the students self-regulated and monitored their understanding of the text. The independent variables included the students reading from fictional text and nonfictional text.

Participants for the study were from a rural school in the Midwest. They attended a half-day class: one group of 14 in the morning, one group of 14 in the afternoon. There were 28 students in the study and the make up of the group was not diverse (biracial: 1, white: 27). Fourteen of the students were girls and 14 were boys. The range in abilities included students who could formally read to students who were at the beginning stages of reading. The students all spoke English. The teacher had 25 years of experience and an instructional aide assisted the students who struggled. Students in the morning and afternoon sessions were taught in the same manner.

In collecting data, the researchers interviewed the students on three occasions. In the beginning of the school year (October-November) the students read fictional books; in the winter (January-February) the students read nonfiction books, and during the spring (April-May), the students read fictional books. The books were high interest books for this age group. The researchers asked the students questions to gain a better understanding of how the students monitored and self-regulated. Once the students read over the introduction of the major concepts of the story two questions were asked, “What are you thinking?” and “What are you doing to understand the story?” (Martin, 2010, p. 145). Other questions that were asked after the student had finished reading included “What was hard? What was easy? Did you have a problem?” and "What did you do?” (Martin, 2010, p. 145). To avoid limitations such as students stating strategies they did not use, anecdotal notes were utilized as the students read. The researchers looked for patterns in strategies students used while reading. The chi square likelihood ratio was

utilized for a quantitative analysis. The qualitative analysis investigated the difference between observed responses and expected responses and also compared interviews involving nonfiction text and fictional text.

The results of the study indicated that students identified having a problem more often with the fictional text (50% of the time). Students had a problem with the nonfiction text 18.2% of the time. While reading nonfiction text, students made significantly more comments than while reading fictional text. The majority of the comments were general in nature 12 of 16. The students made comments about events or characters 11 times and five comments were connections to the student's past experiences. Students commented on not knowing what they were thinking seven times; five of which were while reading nonfiction text. To help the students understand the text they most frequently focused on the words (18 times). On 14 occasions the students read to understand, and on 11 occasions, they looked at the pictures to help them understand the text. Most frequently, students used these strategies while reading nonfiction text. In response to the question "What did you do?" the majority of the students stated they sounded out the word.

Martin & Kragler (2010) found that students interact more with the text while reading nonfiction texts than fiction texts. Reading was found to be a problem solving activity that students used a variety of techniques to solve such problems. Students made predictions from pictures and from their personal experience. Students also attempted to sound words out, use the context of the word, and the vocabulary words they had previously learned. The results indicated students lacked effective reading comprehension strategies. Martin & Kragler (2010) believed that "Research-based strategies, such as predicting, questioning, identifying important details, making inferences, summarizing, and using imagery, can lead young children to be more

metacognitive in their thinking" (p. 151). It is necessary to teach such strategies in a way in which students know which strategies to use when. This would lay a sound foundation for children as they begin to read more complex text. In addition, the researchers believed students must read a variety of text with a particular focus on nonfiction texts to help students construct meaning.

Effective strategies to use as a teacher could include modeling, think-alouds, guided practice, lessons on vocabulary, and the ability for students to be introduced to technology-based, informational, and fictional texts (Martin & Kragler 2010). These strategies could be instructed in conjunction with scientific inquiry to help students understand content of text, and gain the skills to use such strategies in other academic disciplines. Instruction through such strategies is imperative as is the way in which teachers communicate with students. Questioning moves are explored in the ensuing study, which could benefit students' depth of understanding, critical thinking, and literacy skills.

Lundy (2008) conducted a study to identify and describe the best questioning moves in upper elementary classes to promote learning. The researcher defined questioning moves in this study as ways teachers utilize questions as a method to scaffold the understanding of their students. The researchers investigated the role of teachers in leading student engagement in this qualitative study that was premised on a constructivist view, students learn through interacting and engaging in learning in a social environment. The researchers specifically sought to analyze how teachers question to promote engagement and construct understanding. Lundy (2008) hypothesized that exemplary teachers used similar questioning moves to promote engagement and construct understanding.

The participants included two 4th grade teachers that were identified as exemplary. The initial pool of participants were identified by administrators in a diverse school district in southern Florida identified the teachers. To narrow the list of teachers, each of the teachers took a survey about their literacy orientation and the teachers were selected by characteristics associated with constructivist view of teaching literacy. And, to limit the selection to two teachers, the remaining teachers were briefly observed to find the teachers who most represented a constructivist view. An exemplary teacher was identified as someone who facilitates classroom interaction, uses a variety of appropriate reading materials, instruct and demonstrate thinking strategies, engages students in a wide-range of reading and writing activities.

Each teacher was observed for 90 minutes five times and videotaped twice. The videos were used later in an interview where the teachers explained their questioning moves. The interviews, observations, and tape recordings were analyzed to investigate the focus of the study. The teachers that were analyzed both taught 4th grade and had teaching experience of 10 years or more. One of teachers had 15 students and taught in a more diverse school (45% Hispanic, 37% African American, 13% Caucasian, and 4% Multi-cultural) with 92 percent of students on free or reduced lunch. The other teacher was in a school with less diversity (Caucasian 74%), and had only 35 percent of students on free or reduced lunch. She taught a class of 22 students. The researcher analyzed through pattern analysis, interview analysis, and conversation analysis. The data was first gathered and made into a case study for each teacher; then, the two teachers' data was compared.

The first teacher who taught in a more diverse school taught reading through a model with 30 minutes devoted to a whole group strategy lesson, 45 minutes of independent reading (with individual reading conferences), 30 minutes of read aloud, and 15 minutes devoted to word

study. During the strategy lesson the students gathered for a direct instruction through a type of read aloud. Types of lessons she performed while being observed include how characters change with time and recognizing the setting and its importance. The teacher first identified the strategy and the purpose; then, read aloud while thinking aloud, and then, promoted talk time for students to demonstrate their use of the strategy during stopping points in the text. During the independent reading block with individual conferences, the teacher began the conferences by asking "What have you been working on today as a reader?" (Lundy, 2008, p. 122). The teacher stated that what she gains from conferencing guides her instruction and gave her insight into each reader. As she conferenced the students read individually on selected books completing thinking sheets in a reading response journal. The sheets were meant for a tool for students to share their thinking as they read.

The second teacher, who taught in the less diverse school, had her 90-minute reading block broken into three sections. First, the students worked on word study for 15 minutes; then, a 30 minute strategy lesson, and lastly 45 minutes of differentiated reading which took place in small groups, partners, and individually. During the word study, the students were to focus on observations and connections to words. Students were to investigate and incorporate new words, pronunciations, and test different spelling approaches in a specified notebook. During the strategy lesson, high and low performing students were paired with average performing students. The teacher taught lessons on strategies like reading with a question in mind and reading for new information through a read aloud. During this block of time, she first stated the purpose; then, thought aloud as she demonstrated the strategy, and then, provided time for students to talk about the strategy. By asking an open-ended question about why this strategy was important or relevant to them, she brought student attention to the purpose. While performing the read aloud, she

stopped repeatedly and asked the students open-ended questions and students were assigned to work with their partner to demonstrate their ability to apply the strategy. As this occurs she was listening in on their conversations and brought them back together to discuss as a class. The students, then continued into differentiation where they either worked in conferences with the teacher (small group, partners, or individually) or with a think sheet, a graphic organizer, that guided the students to answer open ended questions and become more self-aware of using the reading strategies. For example one question she asked was "What have you learned today about yourself as a reader?" (Lundy, 2008, p. 122).

Both teachers demonstrated questioning moves and used the premise of using a few powerful questions would be more effective than several less engaging but more specific questions. The questions they used were simple but open ended to allow for students to be active participants with the text and often times with other students. Question moves that were used include asking students to ask their own questions about the story, probes to cause the students to elaborate on their ideas, to show students have control over understanding their reading, showing evidence for thoughts or ideas, and checking to see the students understanding of the strategy. The first teacher most often probed for more information and for more support of their ideas with evidence. The second teacher questioned mostly during the modeling period of her lesson, which restricted the evidence for critically thinking as the students were in the whole group and in the beginning stages of understanding the practice. Contrary to the second teacher, the first teacher asked deeper questions primarily in the individual conferences after the modeling where her students talked more and focused on ideas. Teachers believed professional development influenced the their strategies in a major way. The researcher found that the first teacher was involved in training with more intensity and depth with more support than the second teacher.

Lundy (2008) suggested that teachers who received more intense training with necessary support would be more successful in implementing inquiry-based instruction than those who do not.

Questioning could be utilized in literacy and science as a tool to bring about critical thinking, understanding, and comprehension. Students increased their ability to communicate effectively by actively listening and talking about the content. Additional ways, story mapping and self-questioning, to bring about comprehension are discussed in the upcoming article.

Taylor, Alber, and Walker (2002) conducted a study to compare the effects of story mapping, self-questioning, and no intervention on students with special education needs on literal and inferential reading comprehension. The researchers hypothesized interventions that encouraged active reading would benefit students with reading difficulties most, thus the most effective strategies were hypothesized to be self-questioning and story mapping. However, the researchers wanted to find which one was most effective as finding the more effective intervention could have a major implication for teachers and students. The independent variables included the interventions of story mapping, self-questioning, and no intervention. The dependent variable was the comprehension exam results.

The participants of this study were five students with learning disabilities ages 9-12. The students were in grades 3-6 and four of them were boys and one of them was a girl. The students participated at a small elementary school in Mississippi and were selected based on low levels in reading comprehension according to the Wechsler Individual Achievement Test (Wechsler, 2005). Prior to assessing the two strategies, story mapping and self-questioning was taught across five-40 minute sessions in each area.

For self-questioning, the researcher provided each student with ten general questions to

answer at three designated areas. Two question sessions were during the reading and one after they finished reading. The students were permitted to listen to their own responses to the questions prior to taking the assessment through an audiotape. The students utilized story mapping after they read by responding to the following sections main characters, setting, problem, major events, and story outcomes. When the student received no intervention he or she would take the assessment immediately following the reading. After the students completed their intervention, they completed a comprehension assessment that was comprised of ten open-ended questions (five literal and five inferential).

By utilizing story mapping and self-questioning strategies students with special needs demonstrated the ability to answer comprehension questions with sufficient accuracy. The study found that there was a significant difference between story mapping and no intervention and self-questioning and no intervention. Both story mapping and self-questioning were more effective than no intervention on how well the students did on the comprehension assessments. However, there was no significant differences between self-questioning and story mapping, even though the self-questioning comprehension exam averages were slightly higher. Four out of the five students preferred the use of self-questioning because they were able to use a tape recorder. One of the students preferred the use of story mapping, as he or she did not like to be interrupted as he or she read.

The results concluded that self-questioning and story mapping were successful ways of instructing reading. Story mapping may be more effective for visual learners while auditory learners may be more effective while using the self-questioning approach. This study has limitations in that only five students partook in the study and the approaches were led through questions created by the teacher and teacher created story-mapping worksheet. Other approaches

to developing student questioning and story mapping skills should be investigated with further investigations involving more participants.

Story mapping and self-questioning were strategies that were effectively utilized during literacy instruction and combining such practices with science inquiry could benefit students in both subjects. In the ensuing article another way to instruct students during literacy is addressed. Reciprocal teaching is another instructional practice that could be utilized to assist students in both literacy and science

Kelly, Moore, & Tuck (1994), investigated the effects of reciprocal teaching on comprehension of students with poor comprehension in primary general education classrooms. The researchers predicted that there would be a significant increase in comprehension through the reciprocal teaching strategy. The researchers hypothesized the instructional practice of reciprocal teaching would significantly increase students' reading comprehension. The dependent variables were the students' comprehension test scores, while the independent variables included a control group who did not receive the intervention and two experimental groups who took part in the reciprocal teaching intervention.

The study was conducted at an urban elementary school on two classes over the course of a five-month period. The researchers used an experimental group (12 students) and a comparison group (6 students) to understand the effects of a reciprocal teaching intervention. The students in the two groups were in grades 4 and 5, and the students in the experimental group were students between 6 months and two years behind in reading comprehension based on the normative scale from the Progressive Achievement Test (PAT; Reid & Elley, 1991). The experimental group had 12 participants; six from each class, with varied decoding skills from three years behind to

grade appropriate levels. The student make up of the experimental groups included six girls and six boys. After classroom instruction, the experimental group was involved in the 20-minute intervention each day while the comparison group was instead assigned a reading assignment with the rest of the class during this time. Both the comparison and the experimental group took the same assessments daily and in addition a pretest at the beginning of the study and a post-test at the end of the study. The experimental group procedure was as follows: First, the instructor would prompt a discussion about a stories title. This was meant to help students form predictions about what they were going to read. After the discussion students read a brief passage from the story and then were required create a summary through thought and develop one question on their own. In addition, students were to make a prediction about future events and ask for clarification when necessary. Students rotated as leaders of the discussions that took place after each passage. Teachers were to model the metacognitive techniques and the expectations of the students during the first few weeks and as necessary after that time frame. The students from both groups were assessed daily by short classroom assessments. The PAT, which was designed to measure factual and inferential comprehension, was also utilized to assess pre and post abilities of the intervention.

The results of the study demonstrate immense gains for the experimental group. The students all took a pre and post assessment with the PAT for comprehension. The pre-assessment had a significantly high variance in average scores between the three groups, experimental group 1, experimental group 2, and the comparison group. The pre-assessments comprehension scores indicated experimental group 1 had a mean of 18.0 while the mean for the experimental group 2 was 16.2. The mean for the comparison group was 25.3 on the pre-assessment. After the intervention, students from the three groups variance decreased significantly. On the posttest,

the students' means from experimental group 1 and group 2 were 24.7 and 23.7 respectably. The posttest for the comparison group increased to 26.2. The students in the intervention group averaged over a one grade-level increase according to the PAT in the five months of the study.

The researchers concluded that the reciprocal teaching intervention was very encouraging. The experimental groups both made large academic gains while there was no such large gain for the comparison group. This also increased the validity of the study, as repeated exposure did not cause a significant increase in the comparison group's exam scores. In addition, the results indicated direct and explicit metacognitive training assisted students in closing the gap between them and their peers in terms of comprehension of text. The results were promising because additional resources, teacher aids or teachers, were not needed for such interventions to be made. This would be important as schools are limited on resources, and one major goal of integrating literacy and science instruction would be to utilize resources effectively and without seeking further services from other staff members. In this study, through the reciprocal teaching method teachers demonstrated further evidence of the ability of teachers to intervene and assist students performing below grade level. Based on the PAT and daily assessments students became better readers in the areas of encoding, organizing and integrating what they read into comprehension.

This article also gave an option in how to provide student literacy instruction during a science and literacy integrated class. As important as reading skills are to inquiry and could be utilized in cross-curricular lessons, so could teaching the students written and verbal discourse. The upcoming article investigated if teaching students through hands on activities and discovery learning activities would benefit their learning and writing skills.

Treadwell (2010) investigated if discovery learning increased writing success. The researcher investigated if students receiving instruction from discovery learning will increase their test scores more than students who do not receive instruction from discovery learning. Engagement, understanding of proficiency, and writing skills were investigated as well. The study was conducted through a mixed methods study where qualitative and quantitative data was collected. The independent variables were the type of instruction the students received (traditional or discovery based). The dependent variables were the students' performance on tests, engagement, understanding of what proficient writing looks like, and writing skills.

The researcher hypothesized that students who receive instruction through discovery learning will have significantly higher test scores, higher student engagement, a better understanding of what proficient writing looks like, and the ability to master skills in writing. The problem that was noted by the researcher was that a school consistently had low writing scores on the Georgia state mandated writing assessments. The researcher believed the low-test scores were due to the traditional model teacher directed writing instruction. The public elementary school had a diverse population of students (53% White, 21% Hispanic, 11% Black, 11% Asian, and 4% multiracial) of 1,120 students. Fifteen percent of the students received special education services and 36 percent of the students received free or reduced lunch. Two classrooms of 46 fifth grade students participated in the study. All of the participants continued learning through a traditional writing workshop. Half of the students received discovery learning embedded into the traditional workshop. The discovery learning 60 minute class was organized by starting with a mini lesson, then a discovery learning component, next independent writing time, followed by time for students to share and reflect. The same was true with the students being taught by the instructor led lessons with the exemption of the discovery-learning

component. The group of students that took part in the discovery learning actively learned while socializing and bridging the content to themselves and the world around them for 10-15 minutes after the mini lesson. A major way the teacher instructed this class was by having the students explore the topic with classmates. One way this was accomplished was by having groups of students work together, make discoveries and draw conclusions on selected passages. The selected passages might have been off-topic, had limited depth or detail, or were missing a main idea. Students would discuss what they observed from each passage in regards to areas in need of improvement or writing successes exhibited by the passage.

Data was collected through pre and posttests, student interviews, and teacher journaling to triangulate the data and make any conclusions dependable. The pre and posttests were administered to both the control and experimental groups on the first and last day (day 40) of the study. The students had two hours to complete the exam where they responded to undisclosed writing prompts. The pre and posttests were formatted resembling the Georgia writing assessments. A rubric was created based on the state standards. Student interviews were conducted to understand the students' interpretations and to interpret if skills and content were retained. Nine students from each group participated in the interviews from different academic abilities (3 low, 3 average, 3 high). Interviews occurred at the beginning and end of the study. Teachers kept a journal and reflected on writing instruction. The teachers were asked to do so at least once per week. The researcher coded the journal entries and looked for themes that related to student achievement and the impact of discovery learning.

The quantitative results gathered from the students' pre and posttest from their writing demonstrated no significant difference between the control and experimental groups. However, the experimental group's scores on average did increase more than the control group and the

standard deviation was also lower than the control group. The qualitative results were more promising. In analyzing the teachers' journal entries the researcher focused on "skill recognition and application, writing expectations, and on-task behavior" (Treadwell, 2010, p. 121). The control group teacher wrote in one excerpt that the more she talked during directed instruction the fewer students listened and followed along. She said they want to do something rather than listen to her lecture. The experimental group teacher talked more about the ways in which she acted as a facilitator and informed the students of the different expectations that they were less accustomed to such as disagreeing with others or sharing a negative review of sample passages. The experimental group teacher found due to the process of discovery learning, students were able to investigate and understand the mini lesson more fully while also ridding misconceptions. The students in the interviews identified cooperative learning as a successful way to learn. The experimental group appreciated how the discovery-learning portion of the lesson gave them the chance to work with pieces of writing. During the opportunities to explore exemplary and inadequate passages, students also learned both whatnot to do and what was a good idea to include in writing. For example, one student realized repeating words like "very" in one sentence or the word "it" in succeeding sentences was not desirable. Students in the control group stated they wish they had more opportunity to participate with other students. In addition, students saw benefits in working with hands on activities to improve their ability to write. A student from the control group described a great lesson as one that gave her the opportunity to work with other students to allow them the opportunity to play a game, to explore the lesson further, and work together with other students until they were ready to show their mastery on their own. Students from the experimental group stated how they connected to lessons that were hands on and solidified skills because of them.

The researcher concluded that writer's workshop was an effective way to instruct writing due to the large increase of both group scores. Although, the difference between the control and experimental groups was not significant, the scores from the experimental group exceeded those of the control group; thus, discovery learning had a positive influence on writing scores. The qualitative portion of the study demonstrated a positive impact on student on task-behaviors, ability to understand and apply new skills, and engagement throughout the writing process.

The previous study found value in a teacher working as a facilitator, giving students choices, opportunities to cooperatively learn, and play with the content and skills within the learning intention. Because science inquiry is such a strategy of exploration and discovery, utilizing discovery learning for writing could be a beneficial addition. Throughout all of the previous articles, strategies to benefit student literacy were investigated. Such strategies included reciprocal teaching, student questioning, story mapping, self-questioning, and discovery learning. Students require literacy instruction to improve and understand all text they come in contact with. In addition, students need time to develop their science content knowledge and critical thinking and problem solving skills. Not only do these skills help supply students the necessary STEM capabilities but also provide our society high achieving professionals in a variety of high need careers including healthcare, engineering, architecture, agriculture, information technology, energy, and manufacturing. These same professionals would positively impact our economy (Jobs for the Future, 2007). One way of preserving such time for both subjects would be by integrating literacy into science. In the following chapter, strategies for science inquiry and the effects of scientific inquiry will be addressed.

Scientific Inquiry and Comprehension of Content

Science inquiry and hands on learning are identified as ways to benefit science comprehension. The National Science Education Standards (1996) state that inquiry is a major contributor to content understanding. Science based inquiry is a way in which teachers are able to help students, students help students, and students help themselves rid their misconceptions about subjects. In addition, inquiry as a research based science strategy is built on knowledge, assessment, and learners (Bransford, Brown, & Cocking, 2004). First, the objective of the lesson must be centered on a goal of learning content and skills from standards (Lead States, 2014). Additionally, formative assessments guide where lessons begin and where the lessons go to best serve the students. While summative assessments depict the set of lessons or unit success. Lastly, the teacher has the capability of using inquiry to reach the learners through their experience and interests, hands on learning, choice, and control (Bransford, Brown, & Cocking, 2004). In this section, the ability of students to rid misconceptions and the best science based practices are identified and analyzed through case studies.

The study conducted by Morrison (2013), explored how exemplary science inquiry teachers developed their conceptions of science inquiry and how they defined science inquiry. Moreover, the study investigated how these teachers instructed science and what they would recommend to other teachers in attempting to implement science inquiry. The dependent variables include the conceptions of inquiry science held by exemplary teachers, how these teachers developed their conceptions on integrated science inquiry, how they instructed integrated science and literacy instruction in their classrooms, and their recommendations to other instructors attempting to teach through scientific inquiry while the independent variables

were the exemplary teachers' experience. The researcher hypothesized, exemplary teachers share commonalities in instructional practices and conceptions of inquiry-based science and their ideas and instructional practice that could be beneficial for teachers attempting to implement such an instructional strategy in the classroom.

Teachers were initially identified by past enrollment in a graduate course taught by the researcher or involvement in a previous project by the researcher. The pool of teachers was narrowed to eight, as they were recognized for teaching science through inquiry. The researcher narrowed the eight to six teachers by identifying exemplary teachers through a pre-observation. An exemplary teacher was identified as a teacher who invited their students to investigate their own questions, create a design for the investigation, perform data collection, and produce conclusions (based on National Science Education Standards). Six teachers were identified based on the observations and each of them had at least five years of teaching experience. The teachers were from two school districts, and two taught 4^{th} grade and four taught 5^{th} grade.

During the first year, the six teachers participated in four focus group sessions. During these sessions, the researcher provided the teachers questions to guide discussion. The teachers discussed what science inquiry is, how they built their understanding of science inquiry, difficulties understanding and instructing inquiry based science, recommendations for teachers attempting to implement science inquiry in their classrooms, and other questions related to the subject. The discussions were recorded and later transcribed. A survey was also competed by the teachers about how their ideas changed, were solidified, their goals related to science inquiry, and new strategies they learned. The following year, the teachers created a lesson to demonstrate their implementation of science inquiry. These teachers were observed, and the observer graded the lesson through a rubric adapted from the National Science Education Standards. After the

lesson, the observer interviewed the teacher, to gain details about the teachers' thoughts on the lesson, the planning process, the assessment strategies, and how the lesson could be improved.

The exemplary teachers all had similar characteristics. First, they were all problem solvers and their conception of science inquiry came at a young age as a student. Many talked of how role models encouraged exploration and interaction with the world around them. Teaching through inquiry was a process the teachers have gone through. The teachers spoke of continuing to try to relinquish some of the control and give the students exploratory freedom. In being observed, the exemplary teachers all demonstrated student engagement through scientific questions, creating investigations, data collection, creating explanation from evidence they found, and creating a summary. Omitted from many of the teachers' lessons was an opportunity to research. A major justification for not implementing time for students to research was that research took a significant amount of time. Teachers felt it important for students to have content knowledge of a subject, but moreover, the correct answer was less important to them than the process that developed student critical thinking. For planning inquiry based lessons, the teachers indicated there was not a simple process they followed, but that the teachers turned lessons into inquiry by doing what they expect students to do investigate, ask questions, and assess. The major way teachers assessed student learning was through formative assessments through classroom discussions and student summaries. Additionally, the teachers believed for other teachers to successfully implement inquiry in their classrooms, the teachers must be taught through doing and "buy-into" the process for it to be successful in their own classrooms. Continued conversations, collaboration, professional development could also be helpful as the exemplary teachers all felt they grew through the focus group sessions.

Teachers stressed the growth of students through inquiry; however, the students were not assessed on growth of content knowledge for the purpose of this study. To understand inquiry instruction, as successful further research should be completed on not only growth in students understanding through discussions and creating summaries, but also on their understanding of specific content. Significant limitations include that all of the teachers either took a class and/or were involved in a previous research study with the researcher. The teachers were aware of how the researcher viewed inquiry based science instruction and learned from him previously. Having a more diverse group of teachers that do not have direct connections to the researcher may provide different or more varied results. Also, all of the teachers were only observed one time; if lessons were observed, more depth could have been gained. As the first article addressed how teachers developed their conceptions of science inquiry and how they defined science inquiry, the following article examines the effects of inquiry based instruction on students' misconceptions.

Alfa and Zoubeir (2009) investigated the alternative conceptions of 9th grader students from Lebanon on electricity. The major purpose of the research was to investigate the effects of inquiry-based science instruction on those misconceptions. The researchers hypothesized that the students from Lebanon would have the same misconceptions about electricity as other students from other countries as identified by literature. In addition, the researchers hypothesized science based inquiry instruction would positively influence students' ability to reject their preconceptions and form an accurate holistic understanding of electricity. The independent variable was the science inquiry-based instruction and the dependent variables were the students' assessment results.

The population that was involved in the study included 12 students (5 boys, 7 girls). The students were in 9th grade and ages 14 and 15. The students were enrolled in a physics course that met once every three days for 90 minutes. The physics course was aligned to the Lebanese education standards. The replacement instruction and assessment took place during their physics course for a four-month period.

During the four months, the curriculum, *Physics by Inquiry* by McDermott & Shaffer (1992) was utilized. The curriculum was chosen because it specifically addresses misconceptions and employed inquiry as the primary mode of instruction. It was a hands-on curriculum that students used batteries and bulbs to gain a deeper understanding of text and the concepts of electricity. The curriculum was broken into three parts. The students needed to explain reasoning through predictions and justification through sequential lessons taught to improve the students' holistic understanding. Because of students' difficulties processing the information purely from text further strategies were in place to investigate reasoning and representative examples. The first was qualitative and built to introduce the new concepts and begin to build their understanding of the basics of electricity. The second part was built to confront their misconceptions and was a combination of qualitative and quantitative. The third was quantitative as the students were responsible for describing the algebraic relationship between light bulbs and batteries. The students were given 15 assessments. They each completed a pretest prior to instruction and two pre-quizzes once instruction began. To monitor progress nine quizzes and one homework assessment were assigned throughout the four months. Two tests were assigned to gain a comprehensive view of the students' understanding.

Every student demonstrated at least one misconception about electricity. The most frequent misconception was that students believed a battery provided a constant current and that

current would simply be divided by additional components such as light bulbs. While instructed the students routinely overgeneralized their findings. Most of the overgeneralizations and other misconceptions were addressed as all of the students exceeded the mean test score on the final exam by 2. The studies population of 9th grade students averaged 50 out of 100 while the comparison group averaged 48 out of 100 from a population of students from college and high school.

The researcher found that misconceptions were identified in previous literature; however, in previous studies preconceptions were identified as taking repeated exposure and explanation to reject and understand the concept. This was less evident in this study as students quickly rejected the misconception and did not revert back to them. Although all students exceeded the mean, the effect of the inquiry instruction did not benefit all students equally. The positive effects were noticeable in this study of identifying and confronting misconceptions, and the researcher found that it demonstrated the importance of confronting misconceptions through inquiry to build a stronger foundational understanding. The study suggested inquiry could benefit learning environments and would help students understand material more holistically.

The study conducted by Alfa and Zoubeir (2009) demonstrated the benefits of inquiry based science instruction on misconceptions, as a teacher was able to use inquiry as a tool to rid many of the students' established misunderstandings. The following study was more focused on the results of using inquiry based science instruction and the consequences for not using such a strategy by examining similarities and differences between high performing schools and low performing schools in the area of science.

The study conducted by Oliveira, Wilcox, Angelis, Applbee, Amodeo, and Snyder (2013) explored research based science strategies for middle school science. The purpose of the study was to identify which classroom, and school/administrative practices make the largest impact on high performing science schools. The study was aimed at making a more holistic picture of the science strategies used in middle schools by looking at schools' socio-ecological systems by examining the differences between average performing schools and high performing schools. The major areas of focus of the qualitative study were administrative practices, homework, differentiated instruction, student collaboration, and inquiry based teaching (the dependent variables). The study was conducted by investigating how the dependent variables were carried out at high performing schools and average performing schools (independent variables) in science. The researchers hypothesized there were commonalities that were major reasons for a school's performance in science. The possible commonalities that were investigated include time for students to partake in hands on activities, the utilization of the textbook, time for collaboration, time allocated for inquiry based instruction, homework, administrative roles, and school and classroom culture.

The sample of the study included ten middles schools with similar demographics in the state of New York. Of the ten schools seven were high performing and three were in the average range. The demographics were distributed relatively evenly; one school from each group had a majority of students on free lunch, and the number of students who took the tests was distributed quite evenly between the two groups ranging from 68-333 students. The average performing schools were on average more diverse than the high performing schools. All but one school's majority of students were white. At the other school, 97 percent of the students were African American (an average-performing school). The seven high performing schools consistently

scored high on science based state assessments for at least three years, and the three average performing schools were within the average range based on the same measure over the same period. The assessments were state summative assessments that were given to eighth graders at the end of each school year and meant to depict knowledge of content and skills in relation to New York's state standards for math, science and technology. The exams were comprised of open-ended and multiple-choice questions. The researchers correlated the focus items to the two groups (high performing and average performing schools) to identify which focus items were the most effective.

Research teams were assigned to each school and investigated three primary areas transcribed interviews, field observations, and documentary evidence. The teams were also responsible for creating a case study for each school. Individuals from the teams interviewed a total of 83 teachers and administrators from the 10 schools for about 40 minutes each. Documentary evidence was collected from each schools in the form of science related intervention history, assessments, professional development information, lesson plans, and curriculum maps. To triangulate all of the data, the teams also observed an average of three compete science lessons that were about 45 minutes each. To maintain validity, data was triangulated through the three acquisition areas, the data identifying high performing and average performing schools was identified through three consecutive years of data, and multiple teams investigated and analyzed each school and study.

The results at the microsystem level of the schools demonstrated that teachers at the high performing schools put a larger emphasis on keeping students' motivation high by making the content relevant to the students, attaining their curiosity, and making it "fun." This was directly correlated with teachers utilizing inquiry based instruction and hands on activities. The schools

that were high achieving practiced inquiry based instruction more frequently and utilized the textbook (17% of the time) substantially less often than the average performing school classrooms (33% of the time). More collaboration and differentiation was a focus as well in the high performing schools. In the average performing school classrooms; however, there was much more time devoted to reviewing homework (18 minutes) while high performing school classrooms brought in new content.

The exosystems of the high performing schools demonstrated a larger emphasis on reaching all students through high-level science through proper differentiation as well as using interdisciplinary instruction to instruct science. In the average performing schools there was less differentiation, use of interdisciplinary instruction and the school environment was less conducive for learning science. In addition, the administration was more involved in creating a nurturing school environment that was focused on science in the high performing schools than the average performing schools. In the high performing schools the administration was in the classrooms frequently and knew most students in the school. Focused professional developments were also utilized more frequently at the high performing schools.

One conclusion that was derived from the study was the argument for teachers to learn how to and adopt inquiry based instruction in their classrooms. Another area that was highly beneficial to growth in science was the utilization of cross-curricular connections especially in reading and math. In addition, administrations that were involved in creating a culture of learning were beneficial in creating a school that was successfully implementing progressive science instruction. This benefitted the school-wide "ecological system," and in return increased the student engagement and science content knowledge and skills of students.

This section both identified research based science strategies and the effects of instructing through those practices. By bridging these articles together research based science strategies and the effects of scientific inquiry was evident. The study conducted by Oliveira, Wilcox, Angelis, Applbee, Amodeo, and Snyder (2013) indicated the importance of hands on activities, utilizing textbooks more strategically for less time, and the need for differentiation. The first article by Morrison (2013) drew on the knowledge and science inquiry conceptions of exemplary teachers to help other teachers understand research based science strategies and necessities for successful implementation. Alfa and Zoubeir (2009) demonstrated the effectiveness of inquiry on science content and a tool in addressing student misconceptions and raising student standardized test scores and content knowledge. In combination of the two disciplines it is imperative to use research-based strategies from each discipline but further understanding must be gained in how such implementation could take place. The possibility of preparing youth for STEM careers would be shared by both literacy instruction and science instruction, thus the combination of such disciplines could very well be advantageous to the students' futures.

Embedding Literacy in Science Inquiry

Literacy and science naturally complement each other as disciplines. In science inquiry students engage in reading and interact in written and verbal discourse while also investigating questions with hands on materials, interacting with peers, and engaging students. However, few studies have researched the effects of embedded literacy instruction in science-inquiry (Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2012). The first article examines ways in which teachers integrate literacy and science inquiry. This could open the door to different ways in which teachers implement an integrated curriculum and possible strategies an instructor could utilize while instructing students literacy through science inquiry.

Howes, Lim, and Campos (2009) investigated ways teachers integrate literacy with inquiry-based science. The researchers' goal was to help teachers share their practices, understanding, and meaning of inquiry to help others understand better ways to instruct their class. The qualitative study took place over the course of three years and was built from collaboration between graduate students and classroom teachers. The dependent variables were the way in which each teacher instructed the class and the independent variables included the teachers' backgrounds and grade they teach. The researchers hypothesized through an investigation a better understanding of science inquiry could be gathered and shared from teachers from different backgrounds and grade levels.

The participants were teachers from an urban school district in an elementary school. The students were primarily Latino (82%) and African American (14%). This school was meant to represent other urban schools with a high staff turnover rate and a high student to teacher ratio. The majority of the students' primary language was Spanish; however, they were all taught in English. The teachers were selected based on their belief that science benefits literacy, and by teachers who teach science. Three teachers were selected from the school. One was a third-year teacher who taught first grade and had a background in business. Another teacher was a second year teacher who taught fourth grade, and the third teacher was a Kindergarten teacher who taught preschool previously at a Montessori school.

During the first year, a partnership between the teachers in the urban school and the graduate students began. Together they collaborated as a team and reached out to the community with a community-planting day and science programs. Teachers were partnered with a graduate student based on the teachers interest in instructing science, the experience of the teacher, and the class size, as well as the teacher being welcoming of the graduate student. During this year,

the two of them co-planned, taught and researched. The teacher and graduate student also presented research at national conferences. The class time was used in the research as first-hand experience with the teachers. During the third year, each teacher was observed at least five times and the researchers interviewed the teacher two to four times to investigate the teachers understanding of inquiry and goals of combining the subjects. Once the observations and interviews were completed, summaries were created for each teacher that reviewed the strategies, goals, and perspectives each teacher possessed and utilized. Once the summaries were created the three teachers' strategies, goals, and perspectives were compared.

The first grade teacher's science class was highly text based. She had students help students create questions about animals, and then search, through identified text to find answers to their questions. After the students finished searching, the students informed others of their findings. The 4th grade teacher focused on talking about science and solving problems. He first informed the class of necessary information about a subject. The students then worked in groups to apply the information by trying to address the challenge through designing a solution to a problem. The kindergarten teacher also used text extensively; however, she also utilized classroom pets and investigations within the classroom. She focused on students observing and questioning. She felt learning to be a scientist was more important than the content the students were investigating.

In comparing each of the summaries, the researchers found that teachers viewed and executed inquiry in a variety of ways. The researchers found that the first grade teacher's way of incorporating science and literacy together was less advantageous. The researchers found that students needed ways to interact with the content and empirically study. Scientists and people use several ways to answer questions and use text would be one of those ways, but for students

to get more out of the instruction, they needed to use other modes of working with the content. The researchers made a clear contrast between a nonfiction study and scientific inquiry, as a simple nonfiction study would not represent scientific inquiry. The researchers also cautioned on the approach as students could begin to limit their understanding of science as fact finding. Lastly, in relation to the first grade teacher's approach, the researchers also found students who did not enjoy reading or were not strong readers could learn to dislike the subject of science. The fourth grade teacher believed hands on activities and talking science were the most important parts of inquiry. However, the researchers found that he limited the inquiry by not allowing the students to research their own questions. This approach allowed the students to be problem solvers; however, the students did not have the opportunity to be scientists, as they did not observe and ask questions and complete their own science investigation. The students worked in small groups and the researchers discovered this to be a great vehicle for the students to interact and ask questions about the subjects. The researchers established that though both the first and fourth grade teachers were doing some science inquiry in their classrooms, their practice could be improved. In the kindergarten classroom, the students researched through text while observing science in the real world. This was not accomplished in the other two classrooms, as the first grade classroom did not observe science in the real world while the fourth grade classroom did not utilize text as a major source for their understanding. The students in the kindergarten also improved sense making through talking with the teacher and one another. The teacher also gave students the ability to create and investigate their own questions, which was not the case in the fourth grade classroom. Classroom management was also not an issue in the kindergarten classroom as the students were very engaged. The researcher suggested teachers

were discouraged to use inquiry because of the fear of losing control and the possibility of losing the ability to manage each student's behavior.

Howes, Lim, and Campos (2009) found that integrating literacy practices into science inquiry is accomplished in a variety of ways; however, the researchers found the most successful implementation will include students creating and investigating their own questions, observing and/or interacting with the natural world, researching text, and having students talk about science. These phases are vital to perform a inquiry based literacy lesson to not only have students interact with the content through one or two modes of literacy for content understanding, but all the modes to develop problem solving, reading comprehension, writing skills, and science content and process knowledge and reading comprehension and vocabulary knowledge. The literacy effects will be investigated further in upcoming studies. In the following study, Fang & Wei (2010) investigated an integration of science and reading instruction to examine the effects on student knowledge of science content and processes and reading comprehension and vocabulary.

Fang & Wei (2010) investigated the impact of reading infused science inquiry on science content and processes. The study investigated the effects of integrated explicitly taught reading strategies within science inquiry instruction on 6th grade students' science literacy. The hypothesis was that infused science inquiry instruction would benefit students' science content and process understanding more than traditional instruction. The reading strategy instruction was the independent variable while the dependent variables included the students' science content and processing understanding.

Two instructors taught five classes each from one middle school that participated in the study. The 900-student population at the middle school was made up of 49% girls and 51% boys. The student population was a majority white (51%) and made up of about 38% African American, and 9% Hispanic, 4% Asian, and 2 percent other with approximately 50 percent receiving free or reduced lunch. The school was a low performing school in the district according to state reading assessments. All 6th grade students had the opportunity to take part in the study. Three classes from each instructor (140 students total) were randomly selected to be part of the experimental group assigned to receive integrated inquiry-based science instruction and reading. The other two classes (93 total students) from each teacher received inquiry based science instruction without additional reading components.

Each class met for 50 minutes per day, and the order of the lessons was based on the district-adopted textbook. Instruction was implemented from a science inquiry curriculum created by the two teachers, scientists, and science educators the previous year. The purpose of the curriculum was to captivate student interest in the subject, understand how scientists operate, and gain science content knowledge and problem solving and critical thinking skills. It pushed students to question, observe, record, predict, plan investigations, analyze results, propose explanations, and share their findings and conclusions. There was not any reading instruction; however, students were directed to read small sections from the text and complete short activity worksheets. This curriculum was utilized to teach the control group. The experimental group used a comparable curriculum as the control group. However, in addition to the curriculum the students were taught reading strategies on a one to two week rotation every Thursday. These lessons lasted between 15-20 minutes, and the instructors taught such strategies as predicting, concept mapping, paraphrasing, and note taking through the process of explaining, modeling,

guiding and applying. The experimental group students were also encouraged to read and respond to one science trade book per week through a home reading program. This gave the students the opportunity to apply the reading strategy again and it gave students further exposure to the content and vocabulary.

To measure the impact on science literacy, the students took a curriculum referenced science test developed by the teachers, scientists, and other science instructors from the curriculum that was utilized. Approximately, half of the test questions assessed science skills, one quarter of the questions assessed math skills using science content, and one quarter assessed reading skills through science content. The students also took Gates-MacGinitie Reading Tests (GMRT; MacGinitie W., MacGinitie R., Maria, & Dreyer, 2002), which assesses the students' general reading ability based on comprehension and vocabulary. According to the GMRT, the students from the experimental group significantly outperformed the control group. The experimental group had a mean total score of 66.60 and a standard deviation of 15. 54 compared to the control group who had a mean score of 57.64 and a standard deviation of 18.02. Additionally, on the curriculum referenced science test the students who received the integrated reading and science instruction significantly outperformed the control group as well. The experimental group had a mean total score of 13.08 and a standard deviation of 4. 54 compared to the control group who had a mean score of 10.83 and a standard deviation of 4.90. The mean scores were higher and the standard deviation was lower for all exams for the experimental group.

The results of this study indicated significant benefits from the integrated reading science instruction. Moreover, the study demonstrated that minimal time on such literacy mini lessons (15-20 minutes-once per week) during science provided a very large impact on student reading,

science content and students' science process understanding. The study also validated the benefit of the way in which they taught the mini lesson, through explaining the strategy, modeling the strategy, guiding student practice, and then providing an opportunity to independently practice the strategy. In this study it must be noted that students also had access to additional reading on the topic outside of the classroom that targeted science vocabulary and the lesson they were learning. In addition, this gave the students the opportunity to practice the literacy strategy they learned during the mini-lesson. Further research, could demonstrate the effect of different literacy strategies, a more frequent, shorter or longer installation of the literacy instructional practice, or a different resource used as an additional reading outside the classroom. Further research could help answer whether and how integrated reading in science inquiry benefits student learning.

Fang & Wei (2010) researched a sound implementation instructional framework that was utilized to truly benefit the students in literacy and science. The study conducted by Fang and Wei demonstrated that reading instruction with a limited allocation of time could be very effective. Practices that Fang and Wei seemed to highlight include the explain, model, guide, and apply mode of teaching the literacy lesson, instructing such a lesson in a short but precise manner, and using inquiry as a way to have students question, observe, record, predict, plan investigations, analyze results, propose explanations, and share their findings and conclusions. In the following study, an investigation examines the effects (including on writing) of using a science integrated literacy block rather than a traditional approach.

Cervetti, Barber, Dorph, Pearson, & Goldschmidt (2012) investigated the impact of an integrated science and literacy class on science understanding, science comprehension, science vocabulary, and science writing. This study compared classrooms that used an integrated

science and literacy block to classrooms that taught through nonintegrated science and literacy instruction. The independent variables were the modes of instruction, non-integrated science instruction and integrated science and literacy instruction, while the dependent variables were the students' science understanding, science comprehension, science vocabulary, and science writing. Cervetti, Barber, Dorph, Pearson, & Goldschmidt (2012) hypothesized that the students in an integrated science and literacy class would make larger increases in science understanding, science comprehension, science vocabulary, and science writing.

The research was conducted in a Southern state on 4th grade classes. There were a total of 94 teachers who participated in 16 school districts in diverse areas including rural, suburban, and urban areas. After the teachers were accepted to participate they were randomly assigned to teach either the integrated curriculum (treatment group) or the nonintegrated curriculum (comparison group). The comparison group of teachers had more experience by an average 2.4 years (11.6 vs. 9.2); more experience in a fourth grade classroom (5.6 vs. 4.4); and more of them had advanced degrees (51% vs. 34%); none of which was statistically significant, however. The students of the comparison group and treatment group had similar demographics. Students who receiving free or reduced lunch represented 52.9 percent of the student population in the control group while the treatment group was represented by 57.6 percent of the student population receiving free or reduced lunch. The comparison group population was 49.7 percent female, 35.7 percent African American and 53.1 percent white. The treatment group population was made up of 49.3 percent of females, 38.5 percent African Americans, and 48.5 percent white.

Both the treatment and comparison groups were involved in a science unit on light. The treatment instruction attempted to engage students through conducting investigations, discussions, writing, and reading. The treatment group investigated the science strands of light,

light energy, and light interactions. There were a total of 40 blocks of time allocated to the treatment group's implementation of the integrated literacy and science classes. These 40 blocks were divided into 4 units and the unit was roughly broken down by four sessions of hands on activities, two sessions of reading, an addition two of writing, and two sessions devoted to discourse. The discourse was carried out through student talk, small group discussions, and reflections on vocabulary connections; all of which were utilized as a formative assessment. The literacy strategies that were most focused on include making prediction, summarizing, and explaining by using evidence. These strategies were developed through modeling and explanations by the teacher, guided practice, and allotted time for independent practice. The control group used the same amount of time as the treatment group, but they used the materials and curriculum provided by their school to specifically connect to the state science standards which have three major strands, characteristics of light, light and color, and interactions of light. The materials varied between the groups but the teachers aligned their instruction to the standards making the study a "content-comparable comparison" (Cervetti, Barber, Dorph, Pearson, & Goldschmidt, p. 640, 2012).

Data collection was processed through a pre and post assessment at the beginning and end of each unit. The pretest and posttest was identical and examined student understanding of science vocabulary, light, and student reading comprehension. Other assessments that were completed include writing assessments before and after each unit as well as a teacher background survey and end of the unit survey that investigated the teacher's instructional practice during the designated block of time. The writing assessment prompted students to answer an open ended question with sufficient detail and evidence and were assessed based on rubrics that examined

the use of evidence, a topic and concluding sentence, clarity, vocabulary definition and count, and science content understanding.

The results of the students' assessment demonstrated that students made growth in both areas; however the growth was larger among those in the treatment group. In the area of science understanding, the treatment group's average growth was 2.99 while the growth of the comparison group was 1.46. On science vocabulary the treatment group made an average gain of .69 while the comparison group made an average growth of .39, and on reading comprehension the treatment group increased their scores by 2.38 on average while the comparative group increased by 1.18. The results of the student assessments indicate significant learning from both the control and treatment groups. On the measures of vocabulary, reading comprehension, and science understanding, both groups of students demonstrated statistically significant improvement. In science understanding students in the treatment group performed significantly better in the area of science understanding. Students in the treatment group scored significantly higher than those students in the control group on the vocabulary strand of the post-test as well. However, in comprehension no significant difference was found between the two groups even though the mean was higher for the treatment group.

In writing students in the treatment group demonstrated significant improvement in five of the seven subareas and demonstrated improvement in all areas. The two other areas conclusion and vocabulary definition demonstrated little to no effect. The areas with significant increases include science concepts, vocabulary count, evidence, introduction, and clarity. Moreover, although science knowledge was a positive contributor for successful writing performance, it was not attributable to student writing scores. The mean pretest estimate of the comparison group was 1.8 and the treatment group's pretest estimate was about 1.7. For the post

test the comparison group gain was .22 while the treatment group's gain was .60. Students' writing success was independently positively affected by literacy instruction embedded in science instruction.

The study demonstrated promising results for the benefits of an integrated approach to science and literacy. Science content understanding was not only significantly increased with integrated instruction; the scores of the treatment group were significantly higher scores than those from the control group. And, the benefits from such instructional practices stretched beyond content understanding. The results of the study demonstrated significant increases in student vocabulary, and writing. The area of comprehension showed higher levels of growth for the treatment group but the difference was not significant. Because of this, the researchers concluded that there was a significant benefit of using integrated literacy and science instruction but not significantly better than a traditional model of teaching. However, to inquire about the natural world, the researchers found it is best to utilize hands on experiences and literacy. This would be through using an inquiry cycle to investigate questions, through hands on experiences while using supportive information from text and discourse to develop the science concepts while also increasing student comprehension, skills in discourse, and possibly ability for students to problem solve. However, as Howes, Lim, & Campos (2009) found, not all ways of combining science and literacy are equally effective.

Although, Cervetti, Barber, Dorph, Pearson, & Goldschmidt (2012) did not discover a significant gain in comprehension, the gains in the other areas is definitely noteworthy. To gain a larger understanding further research must be completed and further examination of studies is necessary. In the previous articles effects were measured for the designated time (a year or less).

In the subsequent article Romance and Vitale, investigate if there were short term and long term compounded effects of science and literacy integrated instruction.

Romance & Vitale (2011), investigated the effects of implementing a multiyear instructional model, the Science IDEAS (BSCS, 2006), on reading comprehension and science in grades 3-5 and the transfer effects on students' reading comprehension and science understanding in grades 6-8. Science IDEAS was an instructional model that engaged students through inquiry-based instruction. It was an integrated model to teach students science, while also targeting reading comprehension, writing, and concept mapping in a 1.5 to 2-hour class. Romance & Vitale (2011) hypothesized an integrated science literacy instructional model would benefit students more than a traditional model on reading comprehension and science comprehension and understanding. The researchers also believed the benefits would compound for the students as they progressed through middle school. The independent variables were the instructional practices of the Science IDEAS model and traditional model. The dependent variables were the students test scores, which exhibited student reading comprehension, science comprehension, and science understanding.

The study was conducted in an urban school district in Southern Florida made up of a diverse group of students 47 percent white, 29 percent African American, 19 percent Hispanic, and five percent other population. Forty percent of the students qualified for free lunch services. It was a six-year study that targeted 12 elementary schools that represented the diversity in the district. These 12 elementary schools implemented Science IDEAS in the models designated grades, 3rd grade through 5th grade. These students (experimental group) spent 1.5 to 2-hours daily in the Science IDEAS model and had a half hour of instruction in literature per day. Twelve other elementary schools with similar demographics were selected as the control group.

These students partook in the district wide basal reading and language arts program as well as the district wide science curriculum for 30 minutes per day. Over the course of the study transfer skills were assessed in feeder middle schools to measure the transfer effects of the instruction. The middle school students were linked back to their 5th grade elementary schools to assess the transfer skills. The researchers monitored fidelity of implementation of the assessments and instructional design and found approximately 90 percent of the teachers implemented the model with fidelity.

To measure the effectiveness of each instructional technique students were assessed in reading comprehension and science through the *Iowa Tests of Basic Skills* (Hoover, Dunbar, & Frisbie, 2007). The results revealed students involved in the Science IDEAS model earned significantly higher scores in reading comprehension and science. In reading comprehension the Science IDEAS model students scored an average of .40 above grade equivalency. The same students scored .29 above grade equivalency in science. By 8th grade the students' average tests scores from the Science IDEAS model were above the control group's average by approximately a half of a grade in reading comprehension and science.

Due to these results, the researchers found that the study further demonstrated the positive effects of utilizing science as a way to effectively improve student reading comprehension. The researchers believed it was necessary to reverse the push for non-content-area basal reading programs to literacy being taught through integrated content area-instruction. Romance & Vitale (2011) found that students would benefit in both reading comprehension and science content by integrating the two subjects.

This section utilized four studies to gain a better understanding of both literacy embedded science instruction and the implication for utilizing such strategies. Although there is limited research, the research that exists shows great promise in both students' performance in literacy and in science, by integrating science and literacy. The strategies that were investigated include a broad range of integration practices from a 15 to 20 minute mini lesson taught within a science class once per week to a fully integrated reading, science curriculum, all of which had a positive outcome on student performance. Further research will be beneficial as it will give further depth to the current understanding, take into account different variables, and could bring about change in literacy and science education for the better.

Conclusion

Albert Einstein (1961) stated "Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning." Our students need to question, investigate, and discover for them to succeed in the ever-changing world. In a world where all information can be found through a touch of a button our students need to know more about ways of understanding and to access information rather than simple memorization of facts (November, 2013). This occurs through providing enough time for the subjects, but more over, an opportunity to explore and discover. One way this can be accomplished is through inquiry based science and literacy instruction (Fang & Wei, 2010). The integration of literacy and science is natural (Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2011), and by doing so, students could be allocated sufficient time for both subjects something that is not occurring throughout the United States today (Dorph, Shields, Tiffany-Morales, Hartry, McCaffrey, 2011).

To integrate the two subjects, literacy development must continue to be a priority. Martin & Kragler (2010) investigated the ways kindergarten students "monitored and self-regulated their understanding of texts" (p. 141). This study identified kindergarten students' abilities and gave a foundation of where many of our students are starting to understand how to read. The students demonstrated some self-monitoring and self-regulation; however, further skills could be developed through an science and literacy integrated program (Romance & Vitale (2011). Additional studies identified ways of increasing students' literacy skills and comprehension. The following studies investigated how this could be accomplished; such strategies that were investigated include teacher questioning moves (Lundy, 2008), students learning how to utilize self-questioning and story mapping (Taylor, Alber, & Walker, 2002), reciprocal teaching (Kelly, Moore, & Tuck, 1994), and discovery learning to increase writing proficiency (Treadwell, 2010).

The following section addressed research based science strategies. Dorph, Shields, Tiffany-Morales, Hartry, McCaffrey (2011) found teachers feel confident in their ability to instruct literacy; however, the majority of teachers did not feel confident in their ability to instruct science. The first study in this section explored how exemplary science inquiry teachers developed their conceptions of science inquiry, how they defined science inquiry, and moreover, advise for teachers trying to implement the instructional practice (Morrison, 2013). The following study by Alfa and Zoubeir (2009) investigated the alternative conceptions of 9th grade students from Lebanon on electricity. The study found that through science inquiry most misconceptions were addressed and student understanding was successfully revised. Lastly to close the section, Oliveira, Wilcox, Angelis, Applbee, Amodeo, and Snyder (2013) explored science inquiry strategies for middle school science. High and average performing schools practices were analyzed and the results indicated that high performing schools utilize more hands

on learning, less time dedicated to utilizing the text book, and benefitted from a more conducive school environment guided by teachers and administration. This section demonstrated what it takes for successful instruction to occur in science inquiry but it is still necessary to assure enough class time for science and benefit students in both subjects by integrating literacy and science.

Science and literacy integration has not sufficiently been researched; however, the research that has been conducted appears to demonstrate great benefits of the practice. Howes, Lim, and Campos (2009) investigated ways teachers integrate literacy with inquiry-based science. The practice included utilizing student questions to explore and discover material through both the real world and literature. The following study by Fang & Wei (2010) found that infused literacy and science inquiry experiences was a benefit to students science and compression skills, and Cervetti, Barber, Dorph, Pearson, & Goldschmidt (2012) found students' science understanding, science vocabulary, and science writing were significantly higher when students were involved in a curriculum that integrated science and literacy. The last study, Romance & Vitale (2011), discovered major differences over a longitudinal study between a traditional model of science and literacy instruction and the integration of the subjects. The students who were instructed through the integration of the subjects had significantly higher test scores in literacy and science.

This chapter presented a review of studies in reference to instructional practice of literacy embedded science inquiry. The relationship between science and literacy is undeniable, and the importance of skills students learn from science instruction can be great. However, the amount of time students are focusing on the subject is not enough. School districts are facing impeding pressure to perform higher in math and reading and those pressures are causing classrooms to

add time to those subjects and take away time from subjects like science. These studies demonstrated positive effects of such instruction and how to best implement such a measure. Through literacy-integrated science inquiry, students can benefit from great science instruction, developing literacy skills, and increasing their ability to problem solve and think critically. In the upcoming chapter, procedures for instruction and assessment will be discussed that were aimed at producing and measuring an increase in reading comprehension and retainment of science content, processes, and thinking through an integrated approach to science and literacy.

CHAPTER 3

PROCEDURES

Introduction

This case study focused on increasing student comprehension through an integrated approach to science inquiry and literacy. Research suggests that integrating both literacy and science benefits students more than literacy and science taught independently from one another (Romance & Vitale, 2011). The purpose of this study was to determine if the participants' comprehension skills would improve through an integrated approach to teaching science and literacy. Comprehension was measured through a Qualitative Reading Inventory, QRI-5 (Leslie, 2011). Retention of content, processes, and critical thinking was also measured through an assessment on content and scientific processes and thinking generated from a mix of questions created by the researcher and from the Seeds of Science instructional guide (*Gravity and Magnetism*: *Teacher's Guide*, 2009). It also examined the change in summation writing through a section for students to provide a structured paragraph about forces or scientists. The assessment is called Forces Summative Assessment (appendix A). Literacy instruction was embedded into three units on forces: Forces, Gravity, and Magnetism. Literacy strategies that were utilized include self-questioning, reciprocal teaching, open discussions, and writing summaries. The participants, procedures, and data collection are discussed in this chapter.

Participants

The participants of this case study were students who were learning to read, and reading to learn. The sample consisted of five students who were weak in the area of comprehension,

and would also benefit from instruction in writing summary paragraphs. The students were going into grades 3-6 and had varying fluency, comprehension, and writing levels. The participants in this case study included [2]Taylor, Meg, Demarcus, Nathan, and Lorenzo.

Each of the students was proficient in one or more academic areas; however, they each had weaknesses in the area of reading comprehension, which was the main target of the literacy instruction. To overcome limitations in reading comprehension, the students were taught comprehension strategies to increase their ability to comprehend what they read. Two of the students had been diagnosed with an attention deficit disorder, which interfered with their ability to remain on topic during instruction, but these students could benefit from the structure of the class, as it was inquiry based and discovery oriented.

The learning to read group was made up of two students. Lorenzo was moving from 3rd grade to 4th grade for the 2014-2015 school year, while Nathan was held back and remaining in 3rd grade for the 2014-2015 school year. Nathan was moving to a new school in a suburban school district where he no longer would receive special education services. Nathan previously had an Individual Education Plan (IEP) and was located in a More Restrictive Placement (MRP) away from his general education peers. His grandmother stated, "due to his developmental challenges associated with his ADHD reading has been a challenge." His behaviors were identified as a barrier that impeded his ability to learn as he sometimes got overwhelmed and sometimes was off task in conversations or activities. The activities and instruction was designed to be inquiry based, and with a goal of reaching students through activities centered on discovery. This may benefit Nathan as he had a strength in working with his hands according to his grandmother. His mother stated that Nathan was one grade level behind his grade level

[2] Pseudonyms were utilized to maintain confidentiality of participants

peers academically. Nathan previously attended summer school and had weaknesses in areas of sight-word vocabulary, sounding out words, reading comprehension, writing, and reading accuracy. The instruction was differentiated with open-ended questions to help all students positively increase his or her academic level and content understanding. Open-ended questions allow students to share their knowledge whether limited or not, and demonstrate their understanding, thus allowing students perform up to their level and grow from there. This too, should assist Nathan in making progress toward his grade level in reading. Specific areas that were targeted in this course included reading comprehension, and written expression. Comprehension was targeted specifically as students were taught to interact with the text by questioning and predicting. The students also engaged in summarizing their understanding through a structured paragraph that they were taught how to build.

Lorenzo attended a school in a suburban school district. His mother described his academic progress as "very good." Weaknesses Lorenzo had were in fluency and reading comprehension. Through this course, students learned how to read with a question in mind and interact with the text by predicting, questioning and answering. Lorenzo's strengths were in the area of expressing himself verbally and his interest in school and his interest in learning new things. Specific areas that were targeted in the science literacy class included reading comprehension and written expression to target Lorenzo's specific weaknesses. Learning to question, predict, answer, and revise as he read targeted comprehension. He also learned to structure his writing through lessons focused on organizing a paragraph with an introduction, a body with transitional words, and a conclusion. His strength in expressing himself verbally was utilized through verbal discourse.

The reading to learn group had students going into grades 4, 5, and 6. Demarcus was the oldest student of either group in the study. He attended a private school and would have been entering 6th grade for the 2014-2015 school year. He had strengths in reading fluency and exhibiting positive behaviors in the classroom setting. His positive behaviors would make a positive impact on the learning environment, and his ability to read fluently would help him focus specifically on comprehending the content. Demarcus had a weakness in reading comprehension and verbal discourse. Specific areas that were targeted in the science literacy class would help Demarcus' weaknesses of reading comprehension and verbal discourse by practicing the techniques self-questioning and reciprocal teaching and participating in classroom discussions.

Meg would have been entering 4th grade at a suburban elementary school. Meg was diagnosed with attention deficit disorder (ADD) and this affected her ability to remain on topic and focus meaningfully during class. However, she did not have an IEP. Meg had weaknesses in reading comprehension and writing. This was a specific area in which many of the lessons targeted and could turn Meg's weaknesses into strengths. The students were taught to question and answer and revise both as they read. They were also instructed on how to create a summary paragraph that was structured with an introduction, body, and a paragraph. She also had difficulties in spelling, completing assignments on time and organization. Her strengths included her love for school and her reading fluency. Her love of school would be a great asset to the class to help students remain positive and interested in learning. Specific areas that were targeted in the science literacy class included reading comprehension and written expression, which could make a great impact on Meg's abilities.

Taylor would have been entering 5th grade at a Montessori school. Taylor was previously in speech to help him in pronunciation and at times had a difficulty concentrating or maintaining attention when he became uncomfortable or didn't understand something. Additionally, the inquiry-based instruction may help Taylor maintain his attention. In reading, Taylor's teacher estimated he was six months behind in his grade level peers. Taylor had weaknesses in writing, expressing himself verbally, and reading comprehension. These three areas were large targets of the lessons on interacting with text as they read, discussions, and summary writing. He also had areas of difficulty in organization, motivation, written expression, and spelling, and these skills would be smaller areas of focus, but also addressed by instruction.

Procedures

The students worked with the researcher over a 4-week period of 16 sessions. Sessions took place Monday through Thursday for 55 minutes. The first two sessions were utilized for administering pre-assessments and to administer pre surveys on their feelings toward science and reading. The last two sessions were utilized to gather data on what the students learned and to administer post surveys on their feelings toward science and reading. The 12 other sessions were broken up into three units: Forces, Gravity, and Magnetism, after an introduction to how scientists investigate and who scientists are. Through each unit, students engaged in reading for new information and reading with a question in mind integrated into the science inquiry instruction. The students progressed through scientific investigation stages that included questioning, predicting, utilizing books to research, plan an investigation, execute investigation, record observations, document evidence for and against prediction, and share findings. *Gravity and Magnetism* (2009) was utilized as an instructional guide.

Every lesson began with students formulating their understanding through a hook and using their current understanding for the basis for a discussion. Examples of hooks included students throwing and catching a ball and identifying the forces that are acting on the ball, students identifying what they notice and wonder about magnets as they worked tangibly with magnets and iron, and students working together to perfect a definition of vocabulary words such as gravity. The students were taught proper ways of communicating with one another and the researcher modeled positive ways of building off of others' ideas and how to disagree with someone's ideas. The discussions at the beginning of each lesson were a way for the researcher to identify misconceptions and for the students to utilize and organize their background knowledge. This was also a way to hook the students into the lesson as well as a way to increase the students' ability to increase speaking and listening skills.

After the hook, the students were introduced to the learning objective and success criteria and were asked to put the objective and criteria in their own words to demonstrate understanding. After the introduction to the lesson, the students took part in the stages of scientific investigations through inquiry. These strategies were taught through a process of a description of the strategy, modeling the strategy, guided practice, and individual application. Students either learned new strategies or practiced the reading strategies they learned previously as part of every lesson. At the end of each lesson a final discussion was utilized to rid misconceptions and gain an understanding of where the students were at in understanding the content.

The first reading practice that was utilized was self-questioning. While self-questioning the students were assigned to question as they read. The students would ask questions and find answers, and revise questions and answers as they read. During guided practice students asked

and answered questions from one another as the instructor wrote on the smart board the students questions and responses. During independent practice this exercise enabled students to utilize paper and pencils and use white boards and markers. A graphic organizer was used in the beginning of independent practice (appendix B).

Another practice that was utilized was reciprocal teaching. During guided practice, each student took a role while reading text. The roles included questioner, predictor, summarizer, and clarifier. As each student took turns reading the text students took turns taking roles. This was also used individually with white boards and markers and the students took on all of the roles, by questioning, predicting, summarizing, and clarifying on their own.

In addition, students were instructed through lessons on summary writing. The priority was for students to utilize their understanding of the content and organize that understanding in a structured summary. Students were taught to write by using a topic sentence, 3-5 detailed sentences, and a concluding sentence. Students used prewriting by using an outline to organize (appendix C) their ideas after documenting observations and their findings from other sources.

Speaking and listening skills were not directly assessed; however, they were practiced and utilized to benefit student understanding and comprehension as well as utilized as a formative assessment of student understanding. Students were taught how to build off of each other's ideas and learn from each other. This occurred most prominently at the beginning of units as students explored and acquired knowledge through exploring the topic.

Table 1

Schedule of Lessons and Focused Literacy Strategy

Lesson	Topic	Focused Literacy Strategy
1	Scientists	Speaking and Listening
2	Introduction to Forces	Self-questioning
3	Forces	Self-questioning
4	Forces	Summary Writing
5	Introduction to Gravity	Speaking and Listening
6	Gravity	Self-questioning
7	Gravity	Self-questioning
8	Gravity	Summary Writing
9	Introduction to Magnetics	Speaking and Listening
10	Magnets	Reciprocal Teaching
11	Magnets	Reciprocal Teaching
12	Magnets	Summary Writing

Note. Other literacy strategies and topics may have been used during the same lesson as the focused literacy strategy.

Data Collection

Prior to and after instruction data was collected. The assessments collected data on reading comprehension and retention of content. Surveys were also utilized to gain a larger understanding of how the students perceived reading and the science literacy class. The assessments were given to gain a comprehensive look at the effects of the literacy integrated science inquiry. The primary goal of this case study was to find if such an integration of the subjects would benefit student comprehension.

The Qualitative Reading Inventory-5 (Leslie, L., & Caldwell, J., 2011) was utilized to assess students' growth in reading comprehension. Each student took a pre and post assessment prior to and after the 12 lessons and the results will be provided in the following chapter. The instructor asked the student eight questions (four explicit and four implicit) to gain an understanding of the students' comprehension. A student was at the independent level if he or she answered all eight questions correctly. If he or she answered between six and seven questions correctly he or she was said to be at the instructional level for that passage. Lastly, if he or she answered fewer than six questions correctly, he or she was said to be at the frustration level for that passage. The student was to continue moving up reading levels until he or she answered fewer than six correctly.

Additionally, retention of content, processes, and critical thinking were also measured through the Forces Summative Assessment. This was through a pre and post assessment that encompassed, short answer, multiple-choice, and a summary section. The researcher used selected multiple-choice questions from the Seeds of Science curriculum (*Gravity and Magnetism*: *Teacher's Guide,* 2009) and created the open-ended questions to gain a more holistic understanding of the students' knowledge. The short answer portion assessed students understanding of forces, gravity, and magnetism, as well as their ability to provide a real world example of a force. This section was assessed on a four-point scale: 4 advanced, 3 proficient, 2 basic, 1 minimal. The multiple-choice section was made up of 18 questions about forces, gravity, magnetism, scientific vocabulary, processes and thinking. The last section of this assessment was utilized to assess student summary writing and understanding. The students had the choice to either summarize their understanding of scientists or forces. The written summary

was also scored on a four-point scale in 3 categories: accurate content and mechanics, depth of content, and organization (appendix D).

Pre and post surveys and discussions were also administered. These were utilized to gather qualitative data. The surveys and discussions explored both the students and the parents' perceptions of the students' feelings toward science, reading, school, and the program. The surveys included a parent pre and post survey (appendix E), student motivation to read survey (appendix F) (Gambrell, L., Palmer, B., Codling, R., & Mazzoni, S., 1996), science interest survey (*Gravity and Magnetism: Teacher's Guide*, 2009), and general student survey and discussion questions created by the researcher (appendix G). All of these measures were utilized to give further understanding to the effects of the practice and to possibly support the acceptance or rejection of the hypothesis. These surveys were administered by the researcher at the literacy center prior to and after the twelve lessons.

Conclusion

The purpose of this study was to determine whether or not there was a positive effect on student comprehension in regards to reading comprehension and retention of content and scientific processes and thinking through integrating science and literacy instruction. The students were instructed at the urban literacy center through a 16-session study. Instruction was through a science inquiry practice that also integrated literacy instruction and practice. The literacy practices included speaking and listening, summary writing, self-questioning, and reciprocal teaching. The students engaged in three specific investigations on forces, gravity, and magnetism. While investigating these subjects, students read four texts, *What my sister taught me about magnets* (Barber, 2009), *Forces* (Baker, 2009), *Mystery forces* (Chase, 2009), and

Gravity is everywhere (Beals, 2009), to develop understanding and literacy skills, and summarized their findings through three written summaries and numerous discussions. The first and last two sessions were dedicated to assessment. The QRI-5 assessments measured the previous and post comprehension level of each student. Additionally, students were assessed on their understanding of scientific processes, content knowledge, and summary writing. The multiple-choice questions were generated from the curriculum while the researcher created the open-ended questions to gain a more holistic understanding of the students' knowledge. Lastly, several surveys were utilized to understand student interest and motivation, and a possible change in either.

By the end of the research study, it was expected the results would show that the students improved in comprehension and understanding of science content related to forces. In the following sections, results and conclusion, the effects will be discussed and the hypothesis will be accepted or rejected.

CHAPTER 4

RESULTS

Introduction

The purpose of this study was to determine if students' comprehension would increase through an integrated approach to literacy and science inquiry. Instruction was structured through science inquiry. Students were instructed through investigations on forces in three units: forces, gravity, and magnetism. Reading comprehension was the primary focus of the integrated literacy sessions. Students were taught reading comprehension strategies: self-questioning and reciprocal teaching. Students were responsible for writing a structured summary on their understanding of forces from their investigations. Data was collected through a group of pre and post assessments included the Qualitative Reading Inventory-5, QRI-5 (Leslie, 2011), for reading comprehension and Forces Summative Assessment, which assessed students' knowledge of forces, science processes and thinking. In the last section of the Forces Summative Assessment, the students' ability to build a summary paragraph about forces or scientists was tested. Lastly, for a more comprehensive look at the integration effects students took surveys on their reading motivation, and science and school interest and motivation. Additionally, parents completed a survey to identify any changes they had noticed in their child's reading, perception of science, or perception of the program. Data was collected from each of these areas and all surveys and assessments were administered prior to and after the instructional period. The assessments were utilized to find if there was an effect on the students' comprehension from the integrated science

and literacy instruction. In this chapter, the results to the QRI-5, Forces Summative Assessment, and the surveys are presented.

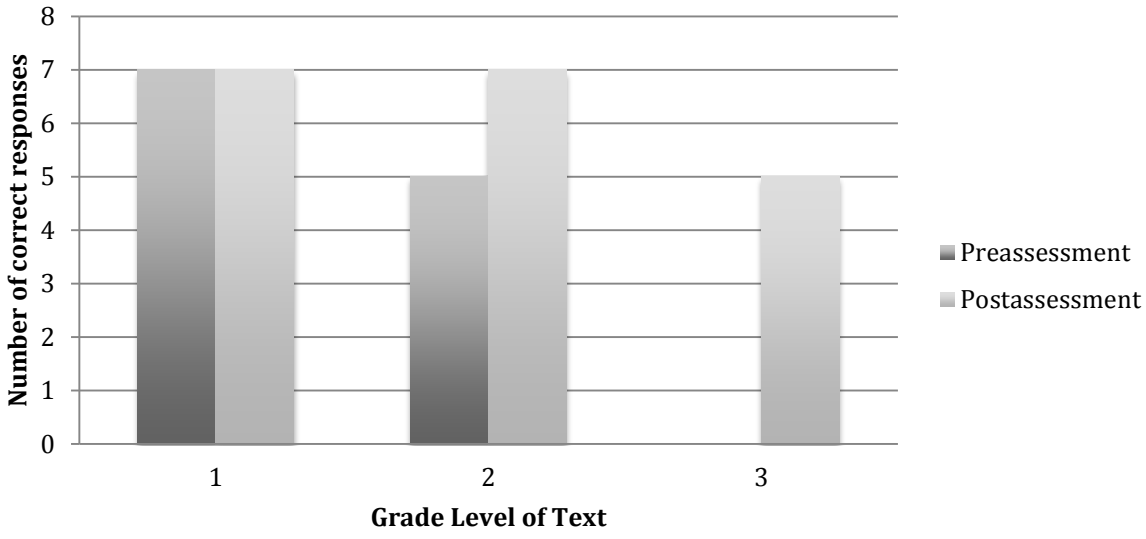
Qualitative Reading Inventory-5

Overall reading comprehension growth was measured through the Qualitative Reading Inventory-5. The students took the assessment prior to and after the instruction. For this study, the comprehension questions were used to assess if there was a change in students' comprehension. The students read at least two passages, both of which were nonfiction texts, and then answer eight (four explicit and four implicit) comprehension questions per passage. The QRI-5 results indicated that three of the five or 60 percent of the students demonstrated an increase in reading comprehension. Each student's results will be presented in the current section.

Nathan's pretest indicated he was over 1 grade level behind his peers. He read two passages, one at a 2nd grade reading level and one at a 1st grade reading level. On the 1st grade reading passage, Nathan demonstrated an instructional level of comprehension on the pretest. He answered 7 of the 8 questions correctly. On the same test after instruction, Nathan also demonstrated an instructional level of comprehension by answering 7 of the 8 comprehension questions correctly. On the 2nd grade reading passage, Nathan was at the frustration level for comprehension by answer 2 of 4 explicit questions correctly, and 3 of 4 implicit question correctly. On the post assessment from the same passage, Nathan demonstrated an instructional level of comprehension as he answered 4 of 4 explicit questions correctly and 3 of 4 implicit questions correctly. Due to the student meeting an instructional level of comprehension, he also was assessed at a third grade level. On this passage, he correctly answered 5 of the 8 questions

correctly and was at the frustration level of comprehension. Overall, Nathan demonstrated an increase in reading comprehension.

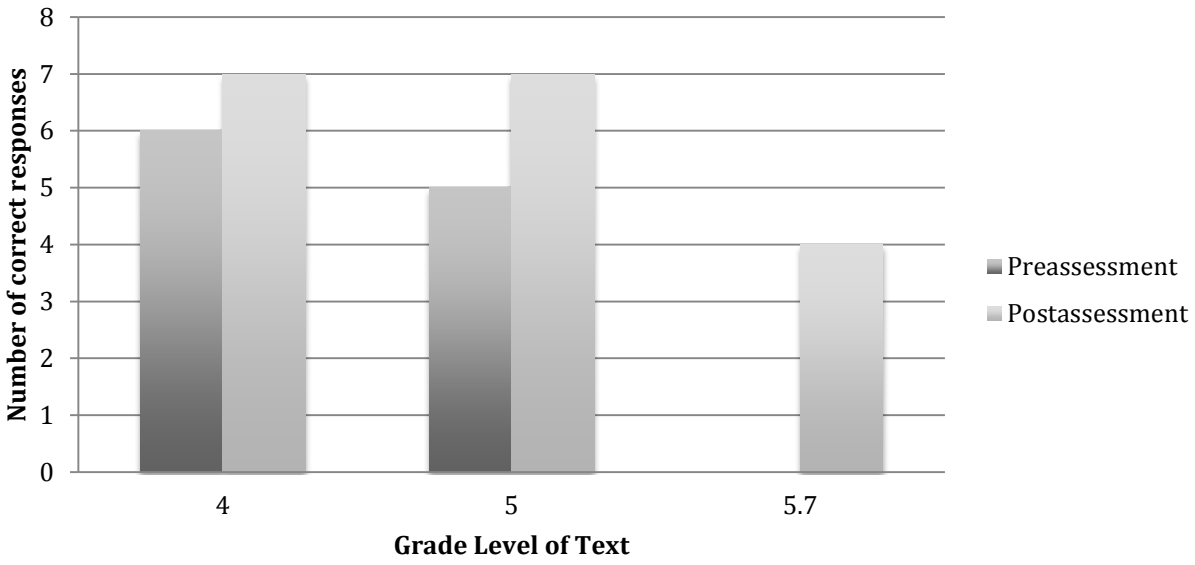
Chart 1:
Nathan's Pre/Post QRI-5 Comprehension Results



Lorenzo's QRI-5 results indicated a weakness in comprehension. On the pretest, Lorenzo started at the 4th grade reading passage and demonstrated an instructional level of comprehension. He answered 3 of 4 explicit questions correctly and 3 of 4 implicit questions correctly. On the same passage on the post assessment, he demonstrated an instructional level of comprehension by answering 4 of 4 explicit questions correctly, and 3 of 4 implicit questions correctly. Lorenzo was also assessed on a 5th grade passage (5.0 reading level). On this passage, he was at the frustration level of comprehension. He correctly answered 4 of 4 of the explicit questions and 1 of 4 implicit questions correctly. On his post assessment, he demonstrated an instructional level of comprehension by answering 7 of the 8 questions correctly including 3 of 4 of the explicit questions and 4 of 4 of the implicit questions. Due to the student meeting an instructional level of comprehension, he was assessed on a higher 5th grade passage (5.7 reading level). On this assessment, Lorenzo was at the frustration level of reading comprehension as he

answered 4 of the 8 questions correctly. Lorenzo also demonstrated growth in reading comprehension.

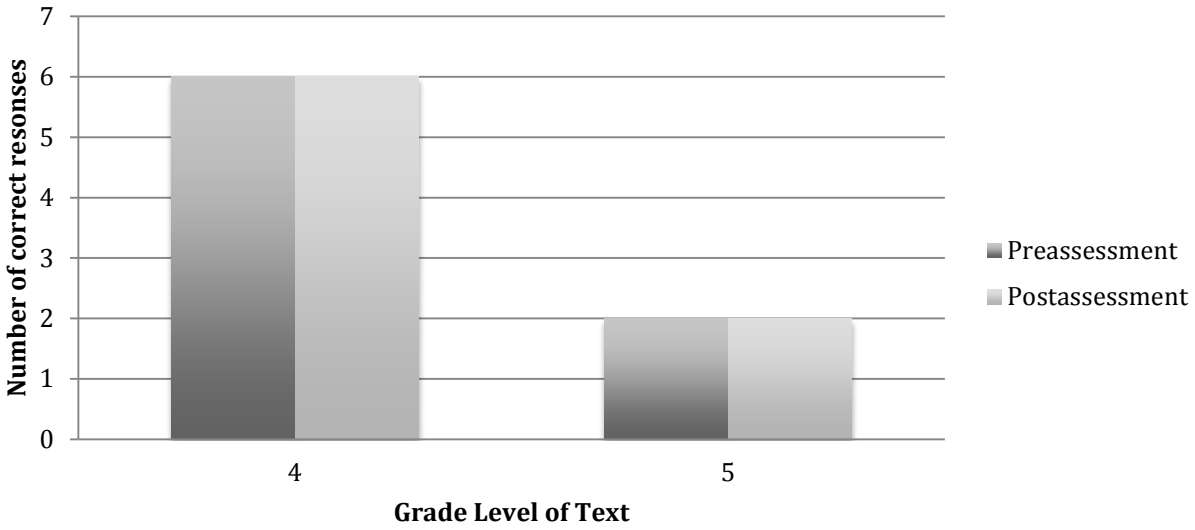
Chart 2
Lorenzo's Pre/Post QRI-5 Comprehension Results



Demarcus demonstrated a need for skills in comprehension on his pretest on the QRI-5. Demarcus read a 4th grade passage and demonstrated an instructional level of comprehension. He answered 3 explicit and 3 implicit questions correct. He answered 6 out of 8 comprehension questions correctly. On the posttest of the same passage, Demarcus answered the same questions correctly and demonstrated an instructional level of comprehension. As a pre-assessment, Demarcus was also assessed with a 5th grade passage. On this passage, he was at a frustration level of comprehension by answering 2 of the 8 comprehension questions correctly. On his post-assessment, he read the same passage. He was at the frustration level of comprehension. Demarcus answered 2 of the 8 questions correctly. Demarcus did not demonstrate growth in reading comprehension according to his results to the QRI-5.

Chart 3

Demarcus' Pre/Post QRI-5 Comprehension Results

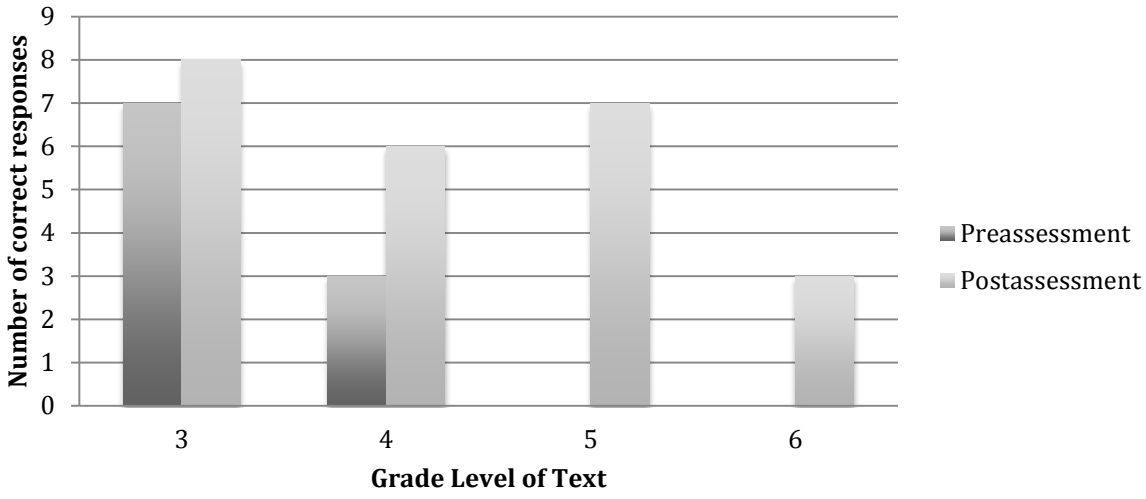


Meg's QRI-5 pretest indicated a weakness in comprehension. On the pretest, Meg read a 3rd grade passage and demonstrated an instructional level of comprehension. She answered 7 of the 8 questions correctly (3 of 4 on implicit and 4 of 4 on explicit questions). On the same passage after the instruction, Meg demonstrated an independent level of comprehension by answering 8 of the 8 questions correctly. On the pretest, she also read a 4th grade passage. On this passage she demonstrated a frustration level of comprehension by answering 0 of 4 explicit questions correctly and 3 of 4 implicit questions correctly. On the posttest, she read the same passage. She demonstrated an instructional level of comprehension by answering 3 of 4 explicit and 3 of 4 implicit questions correctly. Due to the student meeting an instructional level of comprehension, she was assessed on a 5th grade level as well. On the 5th grade passage, she demonstrated an instructional level of comprehension by answering 7 of 8 of the questions correctly. Due to the student meeting an instructional level of comprehension, she was also assessed on a 6th grade level passage. On the 6th grade reading passage, Meg was at a frustration

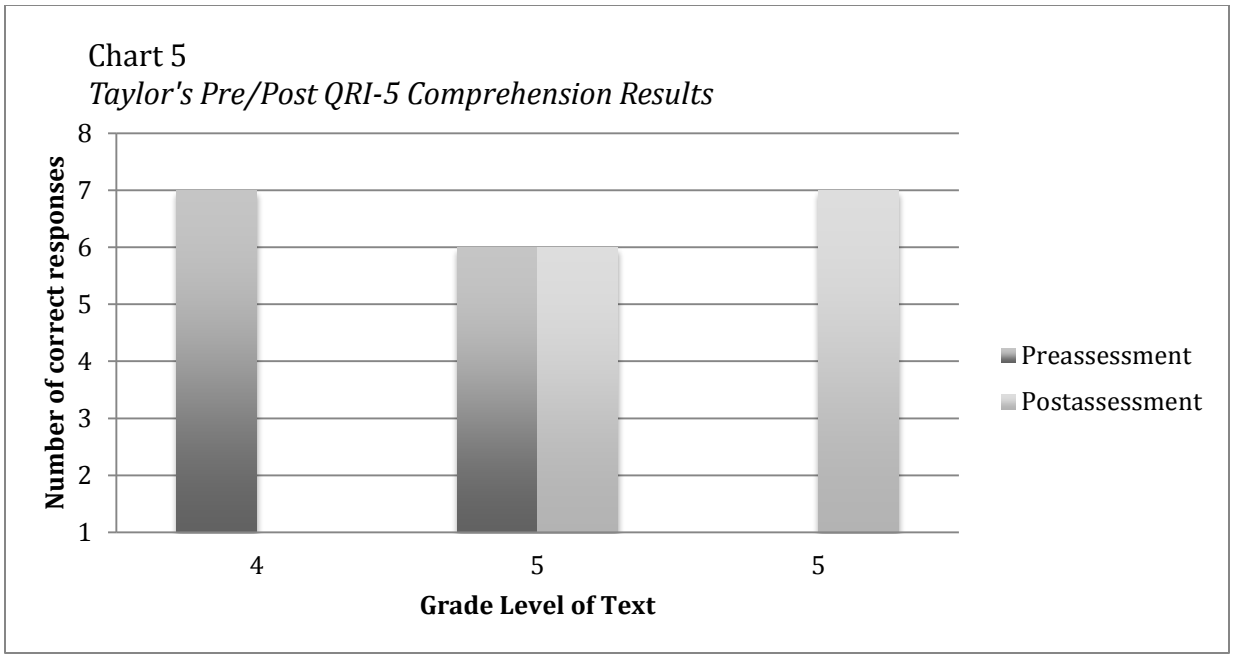
level of comprehension as she answered 3 of the 8 questions correctly. Meg demonstrated an increase in reading comprehension according to the QRI-5.

Chart 4

Meg's Pre/Post QRI-5 Comprehension Results



Taylor was assessed on one fourth and one 5th grade reading passage on the pretest and two different 5th grade reading passages on his posttest. He reached an instructional level of comprehension on all of the assessments. On the fourth grade passage he answered 7 of the 8 questions correctly. On the fifth grade passage for the pretest, he answered 6 of the 8 questions correctly (4 explicit, 2 implicit). On the posttest, Taylor answered 6 of 8 comprehension questions correctly on one passage and 7 of 8 on the other. It is not possible to identify if there was or was not growth based on the data from the QRI-5



The QRI-5 was utilized to measure growth in the area of comprehension. The data was gathered in systematic way to provide comparative data to identify if there was or was not a change. The conclusions that can be drawn from the data are provided in the following chapter, Conclusion.

Table 2

QRI-5 Pre and Post Comprehension Results

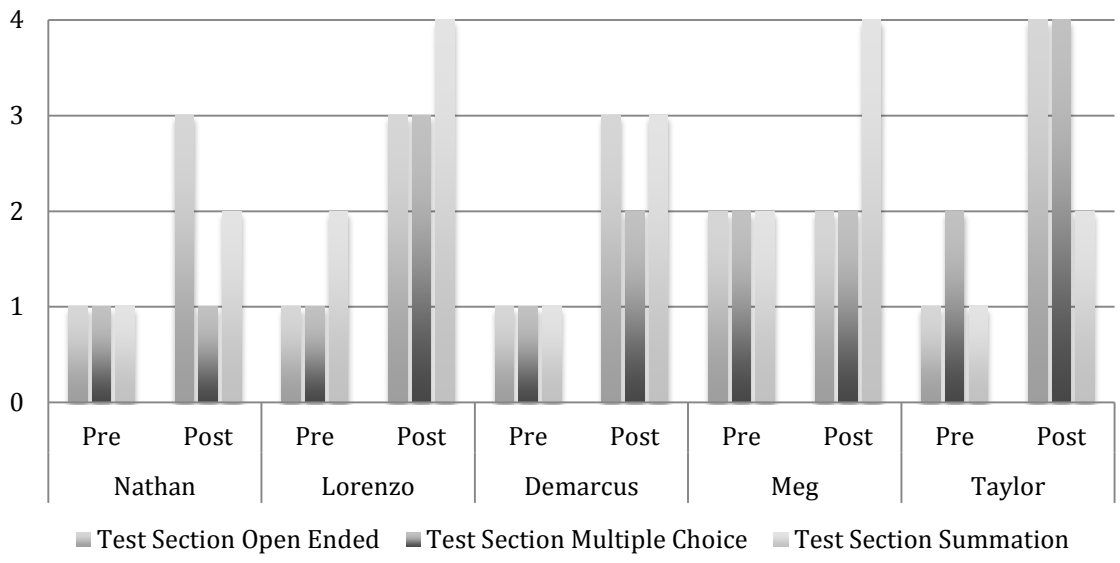
Student	Test	Grade Level	Score	Grade Level	Score	Grade Level	Score	Grade Level	Score
Nathan	Pre	1	7 of 8	2	5 of 8	-	-	-	-
	Post	1	7 of 8	2	7 of 8	3	5 of 8	-	-
Lorenzo	Pre	4	6 of 8	5	5 of 8	-	-	-	-
	Post	4	7 of 8	5	7 of 8	5.7	4 of 8	-	-
Demarcus	Pre	4	6 of 8	5	2 of 8	-	-	-	-
	Post	4	6 of 8	5	2 of 8	-	-	-	-
Meg	Pre	3	7 of 8	4	3 of 8	-	-	-	-
	Post	3	8 of 8	4	6 of 8	5	7 of 8	6	3 of 8
Taylor	Pre	4	7 of 8	5	6 of 8	-	-	-	-
	Post	5	6 of 8	5	7 of 8	-	-	-	-

Forces Summative Assessment

The Forces Summative Assessment had three parts: open ended questions, multiple choice questions, and summary. The open-ended questions were used as a place for students to briefly describe their understanding of the major areas of focus. The questions included: What is a force? What is gravity? What is magnetism? Explain a real world example of a force. The following section had 18 multiple-choice questions. The first seven questions were questions that addressed student understanding of forces, gravity, and magnetism. The next three questions were about vocabulary words associated with the three units. The following two questions were

about science processes, and the next three were assessing the students' ability to think like scientists. The final three questions addressed scientists' goals and role. The last section assessed students' ability to write a summation paragraph about their understanding of scientists or forces. The rubric was based on organization, depth of content, and accuracy of content.

Chart 6
Summative Forces Assessment Results



Note: 1 represents a minimal score; 2 represents a basic score; 3 represents a proficient score; a 4 represents an advanced score

Open-Ended Questions

The open-ended questions were scored based on a 4-point scale. The researcher summarized the rubric prior to the pre and post assessment. A score of 1 was minimal, 2 was basic, 3 was proficient, and 4 was advanced. A student earned a four by sharing four or more details, all of which were accurate and gave a complete explanation above the expectation. Students earned a 3 by providing 3 or more accurate details within a complete explanation.

Students earned a two by providing at least two accurate details within their explanation. Students earned a one with inaccurate information or less than 2 details in their explanation.

On the pre-assessment, the students' average score per question was 1.15. Meg demonstrated the highest scores as she earned a Basic (2), on "What is a force?" and "What is gravity?" while Taylor earned a Basic (2) on "Explain a real world example of a force." The scores indicated a minimal level of understanding on the major topics. On the pre-assessment Nathan earned a 4; Lorenzo earned a 4; Demarcus earned a 4; Meg earned a 6; Taylor earned a 5. The mean of the scores was 4.6.

On the post-assessments, the students' mean score per question was 2.50. This score was between the basic and proficient level. Taylor earned proficient on each of his responses and Demarcus earned proficient on all but "What is Magnetism?" where he earned a basic. Meg demonstrated a basic understanding on all of her responses. The cumulative scores included: Nathan 9, Lorenzo 10, Demarcus 11, Meg 8, and Taylor 12. The mean was 10. Each student demonstrated growth. The average growth per student was 1.35 per question. Nathan demonstrated an increase of 5, Lorenzo 6, Demarcus 7, Meg 2, and Taylor 7.

Chart 7
Results to Open Ended Questions

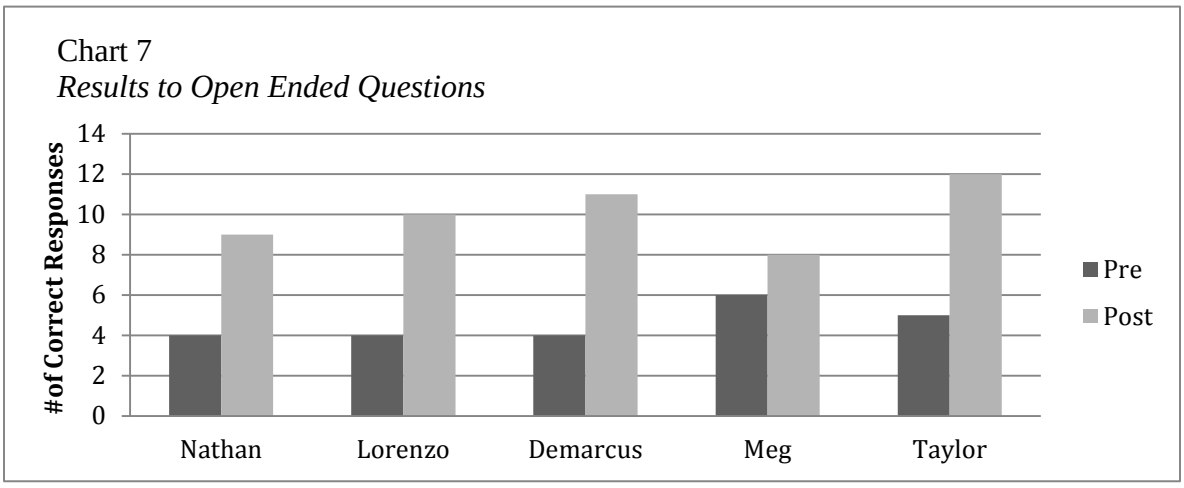


Table 3

Open Ended Questions Results

Student	Test	Score	Change
Nathan	Pre	4	-
	Post	9	+5
Lorenzo	Pre	4	-
	Post	10	+6
Demarcus	Pre	4	-
	Post	11	+7
Meg	Pre	6	-
	Post	8	+2
Taylor	Pre	5	-
	Post	12	+7
Mean	Pre	4.6	-
	Post	10	+5.4

Multiple Choice Questions

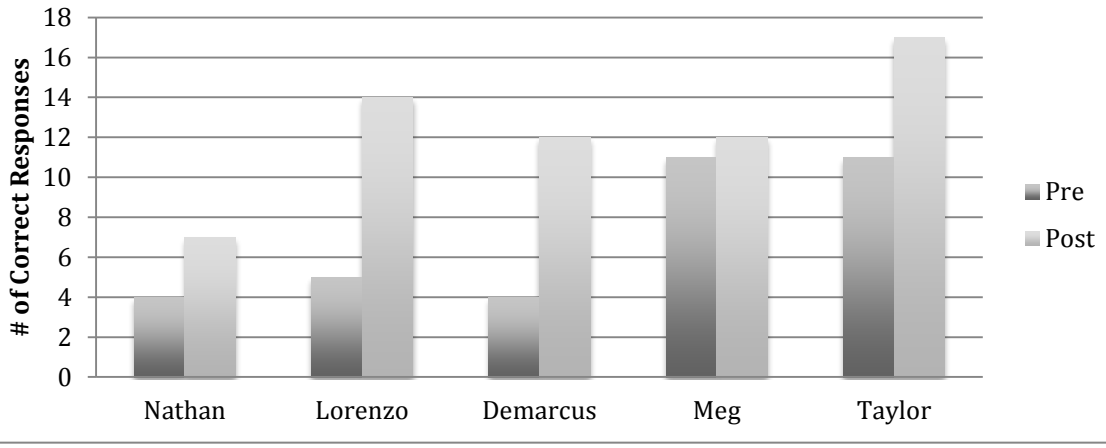
The multiple-choice section of the Forces Summative Exam had selected questions from the *Gravity and Magnetism* curriculum (2009). In all 18 multiple-choice questions were selected in the areas of assessing students understanding of forces, gravity, and magnetism, vocabulary related to the three units, science processes, scientific thinking, and scientists' goals and roles.

The pre-assessments indicated an average score between the five students of 7 out of 18 or 39 percent of the questions answered correctly. Meg and Taylor demonstrated the highest pre-

assessment scores with 11 of the 18 questions answered correctly. Meg answered all three of the questions specifically about scientists' goals and roles correctly on the pre assessment. Taylor demonstrated consistency across all sections of the assessment as he answered at least one wrong in each area. Demarcus, the other student in the reading to learn group, scored a 4 out 18 and demonstrated a minimal level of knowledge in all of the assessment areas. Lorenzo and Nathan scored 5 out of 18 and 4 out of 18 respectively. Both students demonstrated minimal level of knowledge in all of the assessment areas.

The post-assessment indicates an average score between the five students of 12.4 out of 18 or 69 percent of the questions answered correctly. Nathan answered 7 of the 18 questions correctly. Lorenzo answered 14 of the 18 questions correctly. Demarcus answered 12 of the questions correctly; Meg answered 12 of the questions correctly, and Taylor answered 17 of the questions correctly. The students each increased their scores on the post-assessment. Nathan score increased by 3, Lorenzo by 9, Demarcus by 8, Meg by 1, and Taylor by 6. The mean increase was 5.4.

Chart 8
Results to Multiple Choice Questions



Summation Paragraphs

The summation paragraph was scored based on a rubric (Appendix D) that addressed organization, depth of content, and accuracy of content. The instructor summarized the rubric prior to the pre and post assessment. Each part of the rubric was scored between 1 and 4 (minimal, basic, proficient, advanced).

On the pre-assessment of the summary paragraphs, the students earned a mean cumulative score of 5.6. The students' mean was 1.4 on organization, 1.8 on depth, and 1.4 in

Table 4

Multiple Choice Questions Results

Student	Test	Score	Change
Nathan	Pre	4	-
	Post	7	+3
Lorenzo	Pre	5	-
	Post	14	+9
Demarcus	Pre	4	-
	Post	12	+8
Meg	Pre	11	-
	Post	12	+1
Taylor	Pre	11	-
	Post	17	+6
Mean	Pre	7	-
	Post	12.4	+5.4

accuracy. Nathan earned a 6 on his pre-assessment. Lorenzo earned an 8 on his pre-assessment; Demarcus earned a 4 on his pre-assessment; Meg earned a 7, and Taylor earned a 3. Lorenzo earned a 2 on each of the categories with an introduction and conclusion and three accurate details and an example about scientists. Nathan earned a cumulative score of 4 while earning a 2 in the number of details and the example he provided about scientists. Meg earned 3 points for her use of details, a 2 for her accuracy, a 1 for organization, as she did not provide a topic sentence or a conclusion. Demarcus earned a cumulative score of 4 as he received a 2 for number of details and by providing an example; however, he did not provide organization or enough accurate detail. Taylor earned a 3, as he did not provide organization, sufficient details, or accurate details about scientists.

On the post-assessment on the summation paragraphs, the students averaged a cumulative score of 9.8. The students averaged a 3.2 on organization, 3.4 on depth of details, and 3.2 on accuracy of details. Lorenzo earned a cumulative score of 12 with his structured summary on forces. He utilized organization, depth, and accurate information. Lorenzo earned a 4 for organization, 4 for depth of details, and 4 for accuracy of information. Nathan earned a cumulative score of 8. He demonstrated proficient number of details and accuracy, but was missing an introduction. Nathan received a 2 for organization, 3 for depth of details, and 3 for accuracy of information. Meg earned a cumulative score of 12. She utilized organization, depth, and accurate information. Meg earned a 4 for organization, 4 for depth of details, and 4 for accuracy of information. Demarcus earned a cumulative score of 9. He earned a 3 for organization, 3 for depth of details, and 3 for accuracy. Taylor earned a cumulative score of 8. He earned a 3 for organization, 3 for depth of ideas, and a two for accuracy. Cumulatively students demonstrated growth from the pre to post assessments through the summation

assessment. Nathan increased his score by 2; Lorenzo by 4; Demarcus, Meg, and Taylor by 5. The mean increase was 4.2.

Chart 9

Results to Summation Paragraphs

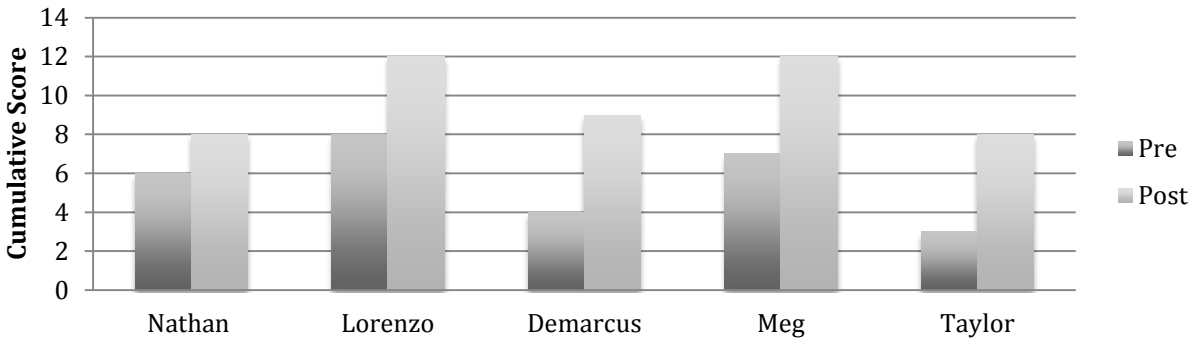


Table 5

Summation Paragraph Results

Student	Test	Score	Change
Nathan	Pre	6	-
	Post	8	+2
Lorenzo	Pre	8	-
	Post	12	+4
Demarcus	Pre	4	-
	Post	9	+5
Meg	Pre	7	-
	Post	12	+5
Taylor	Pre	3	-
	Post	8	+5
Mean	Pre	5.6	-
	Post	9.8	+4.2

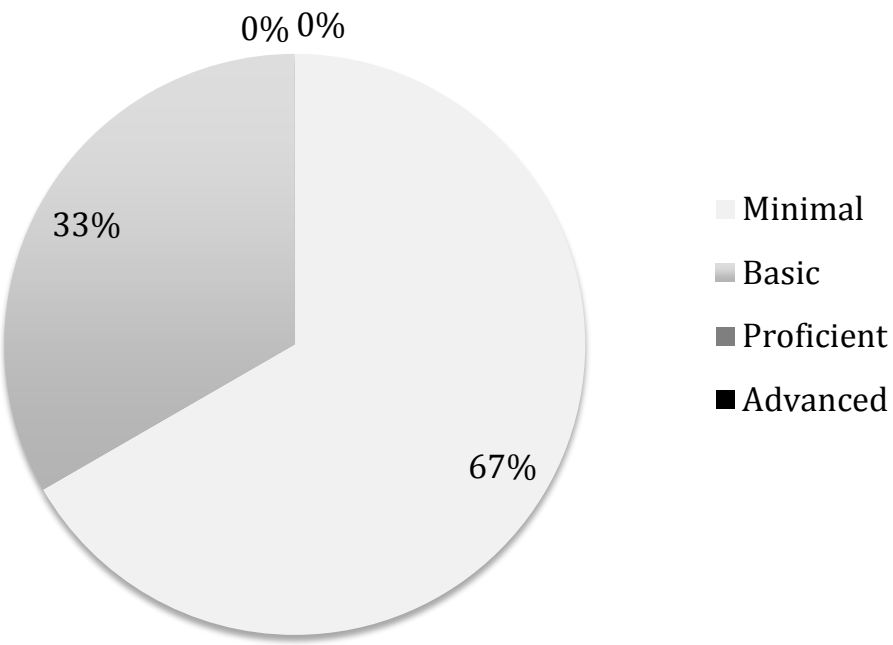
The purpose of the three sections of the Forces Summative Assessment was to gather a holistic view of student understanding. Table 6, Chart 6, Chart 7 and Chart 8 provide a holistic picture of student performance. Nathan, Lorenzo, Taylor, and Demarcus demonstrated growth by moving up at least one level of understanding on the Open-Ended Section of the Assessment. Nathan was the only student who did not demonstrate growth, as he did not move up at least one level on the multiple-choice section. On the summation portion of the assessment all students demonstrated growth of at least of one level. The significance of the results will be discussed in the following chapter, Conclusion.

Table 6

Student Performance on Forces Summative Assessment

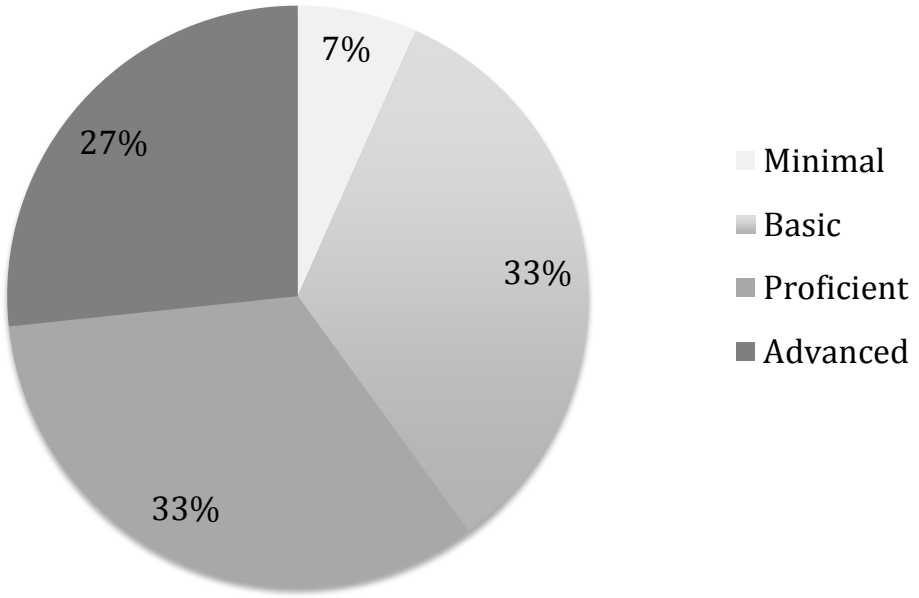
		Test Section		
Student	Test:	Open Ended	Multiple Choice	Summation
Nathan	Pre	1	1	1
	Post	3	1	2
Lorenzo	Pre	1	1	2
	Post	3	3	4
Demarcus	Pre	1	1	1
	Post	3	2	3
Meg	Pre	2	2	2
	Post	2	2	4
Taylor	Pre	1	2	1
	Post	4	4	2

Chart 10
Student Performance on Forces Summative Pre-Assessment



Note: The chart represents the percent of student tests that were in each category on the Forces Summative Pre-Assessment.

Chart 11
Student Performance on Forces Summative Post-Assessment



Note: The chart represents the percent of student tests that were in each category on the Forces Summative Post-Assessment.

Surveys and Discussions

A series of surveys and discussions were administered prior to and after instruction. The surveys included motivation to read (Gambrell, Palmer, Codling, & Mazzoni, 1996), attitude about science survey (*Gravity and Magnetism: Teacher's Guide*, 2009), general attitude survey-created by researcher, and parent general survey-created by researcher. These surveys were utilized to gather a more holistic understanding of the effects of the instruction. The motivation to read survey was measured quantitatively; the other surveys were analyzed through a qualitative analysis.

Motivation to Read Survey

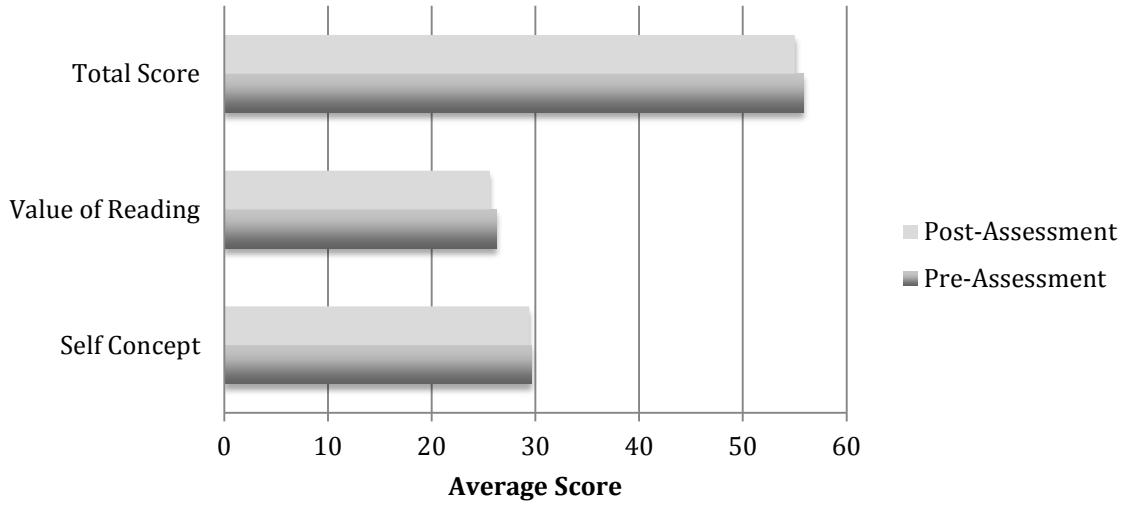
The motivation to read survey measured students' self-concept as a reader and their value of reading. The highest score a student could attain per section was 40 with a cumulative maximum of 80. The self-concept, value of reading, and total were analyzed as well as notable questions. Notable questions in the survey that were analyzed further because of their perceived importance include, "I am _____ (a poor reader, an okay reader, a good reader, a really good reader)," "When my teacher asks me a question about what I read, _____ (I can never think of an answer, I almost never think of an answer, I sometimes think of an answer, I can always think of an answer)," and "I worry about what other kids think about my reading _____ (a lot, sometimes, almost never, never)." The students received scores on each choice per question from 4 as most positive to 1 as most negative. The scores are summarized in Chart 8.

The students had an average cumulative score of 29.6 on their self-concept as a reader, and a 26.2 in their value of reading on the pre-survey. Their average total was 55.8. Lorenzo had a self-concept of 31 and a value of 25 on the pre-assessment with a total of 56. Nathan had a self-concept of 35 and a value of 31 on the pre-assessment with a total of 66. On the pre-assessment, Meg had a self-concept of 28 and a value of 26 with a total of 54. Demarcus had a self-concept of 27 with a value of 19 and a total of 46. Taylor had a self-concept of 27 and a value of 26 with a total 53. On the pre-survey, students answered the question, "I am a_____" with an average score of 2.6, and students, answered the question "When my teacher asks me a question about what I read _____" with an average score of 2.2. On the question "I worry

about what other kids think about my reading _____," students' answers averaged a score of 2.0.

On the post-survey, students averaged 29.4 on their self-concept, and a 25.6 in their value of reading. Their average total was 55.0. Lorenzo had a self-concept of 36 and a value of 27 with a total of 63. Nathan had a self-concept of 33 and a value of 31 with a total of 64. Meg had a self-concept of 24 and a value of 20 with a total of 44. Demarcus had a self-concept of 29 and a value of 23 with a total of 52. Taylor had a self-concept of 25 and a value of 27 with a total of 52. On the pre-survey, students answered the question, "I am a_____" with an average score of 3.0, and students answered the question, "When my teacher asks me a question about what I read _____" with an average score of 2.8. On the question "I worry about what other kids think about my reading _____," students' answers averaged a score of 2.6.

Chart 12
Motivation to Read Survey Results



Survey and Discussion Results

In this section of the results chapter, the findings of the parent and student general survey, the attitude about science survey, and the results to the pre and post discussions with the students will be identified. This analysis will analyze by looking specifically at each student.

Nathan

Nathan's parent and grandparent submitted responses through the survey. On the survey prior to the intervention they mentioned that Nathan enjoyed reading one on one with an adult, but struggled and became frustrated when prompted to read and write in the classroom. He loved learning about science and math. The grandmother noted he loved talking about what he learned at school, and was excited about what he learns especially when given the chance to ask his own questions. Additionally, they noted Nathan needed help organizing his thoughts. They also stated, Nathan also had low confidence in himself. Lastly, it was noted that Nathan at times got overwhelmed and was in need of learning strategies to cope with challenging work. Nathan stated that he enjoyed working with his hands, and loved reading about basketball. He liked making things in science and art. Nathan stated he did not enjoy using a textbook in science class and thought the science literacy class was going to be boring. After the instruction the parent recounted growth she had seen in her son. She stated that her son was more eager to read at home. Additionally, Nathan appreciated the opportunity to work with his hands, research his own questions, and enjoyed working with the teacher. Nathan stated he was very happy he was in the program, and he really enjoyed the science class.

Lorenzo

Lorenzo's parent responded to the survey. On the pre-survey, she noted that Lorenzo read when told to do so but did not pick up a book in his free time. She stated Lorenzo enjoyed

learning different and interesting things and at first was hesitant about attending the program. She stated at times he may need redirection, but overall his behavior was a benefit to the learning environment. Lorenzo stated that he thought reading was okay to do, and school was kind of fun. Lorenzo did not believe he could become a scientist because he felt he was not smart enough. He said he did not "really do" science in school. After the instruction Lorenzo said he learned a lot of science content and new words. His general survey indicated he enjoyed reading more, and was happy he did the program. His parent stated he became more comfortable with the program and he enjoyed coming to the science literacy class the most. Lorenzo said he felt it was more likely he could become a scientist but he still did not think he was smart enough.

Meg

Meg's mother completed the pre and post parent general survey. On the survey prior to the intervention she stated that Meg enjoyed reading at school more than at home. She loved to learn, enjoyed school and "show-off" her A's and B's. Her mother added that Meg enjoys projects. Meg was very optimistic on her surveys and said she loved reading, enjoyed science and likes "getting smarter." She said she does not like when she is challenged academically, but does like to read about science. After the intervention, Meg's mother completed the post parent general survey. Her mom stated that Meg came home and described scientific words and new vocabulary to her. Her mother said Meg enjoyed science the most as she was learning through activities. Her mother noticed an improvement in confidence and more fluency in her reading orally. She stated that Meg thought of herself as a better reader after the program. Meg said that she once felt fine about science, but now feels "excellent about it." She liked learning things in a "fun" way and said, "When I do it this way (learning in the science literacy class) then its funner and exciting than the way I do it in regular school." Meg's post general survey indicated she

enjoyed reading less than at the beginning of the program; however, in her discussion she rebuked that stating she still loves to read.

Demarcus

Demarcus' mother completed the parent survey. Prior to the instruction, she indicated that Demarcus enjoyed reading when it is something he is interested in. She stated that he sometimes was excited about what he learns but it depends on the subject. Additionally, Demarcus stated that he enjoyed reading comic and basketball books. He disliked reading in science and school as it was boring and he often times got in trouble. Demarcus found that science was fun and enjoyed mixing liquid in a previous science class. After the intervention, Demarcus found that studying science was fun. He thought he was a science type person and thought he was able to learn about science ideas. Demarcus' mother stated he loved that the classes were small and the teachers were nice to him. She also stated he really enjoyed working with the teacher in the science literacy class.

Taylor

Taylor's mother completed the parent general survey. She stated that Taylor was a very active kid who loved learning with peers. She said he was very relationship based and relies on that relationship to learn. At times, she said he was very sensitive. Taylor's mother also indicated that Taylor sometimes acted out when he did not understand something or if he was uncomfortable. She said he enjoyed the projects that were involved in science, but not the process. Taylor indicated he thought school was okay but it was boring. He said he really did not like science because he got in trouble in the past. Taylor also said he hated reading in science class, and people in school tend to irritate him. He did not like how teachers made him

sit down. After the intervention, Taylor said he appreciated acting like a scientist and the teacher helped him learn what science is all about. He indicated he liked science class more after the program and he was happy he went into the program even though he had to meet new people, which was uncomfortable. Taylor was surprised he learned as much as he did, and he felt better about his ability to understand science ideas. His mother said he enjoyed actively learning and thought the program was beneficial.

Conclusion

To determine if the instruction was effective the participants were assessed and surveyed prior to and after the instruction. A QRI-5 was completed to see if a change in reading comprehension occurred. Students were assessed through the Forces Summative Assessment to gain a holistic picture of students' long-term comprehension and understanding of the material. The surveys gave further information about the students view toward their own education. While this chapter detailed the results of the instruction, the next chapter will discuss these results further by making connections to other research, presenting the study's strengths and limitations.

CHAPTER 5

CONCLUSION

Introduction

This case study was designed to determine if a change in comprehension and science understanding would occur through integrated literacy and science inquiry instruction. The research focused on the effects of the instruction on five students moving into grades 3-6. These students were identified as needing additional intervention in reading and writing by parents and/or teachers. The students were instructed in groups of two or three over the course of 16 55-minute sessions. The students were taught about forces, magnetics and gravity. The content was taught through science inquiry integrated literacy lessons, and the literacy lessons included self-questioning, reciprocal teaching, open discussions, and writing summaries. Data was collected from surveys and assessments. This chapter will analyze and explain the results of the instruction, discuss the strengths and limitations of this case study, and provide recommendations for the students and further research.

Research and Standards

The Common Core Literacy Standards (Common Core State Standards Initiative, 2014), Next Generation Science Standards (NGSS Lead States, 2014), and previous research guided the instruction and basis for this study. This study addressed several Common Core Literacy Standards (Common Core State Standards Initiative, 2014). The most notable areas included: to determine the main ideas and how the main ideas are supported; integrate understanding from various text and experiences; and write informatively structured in an organized fashion. The

Seeds of Science instructional guide (*Gravity and Magnetism*: *Teacher's Guide*, 2009) was used as a tool to reach these standards; however, the lessons were structured to be more hands-on and discovery based. Students specifically interacted with the text by questioning, answering, predicting, and revising their ideas. Students were also taught how to create a strong structured paragraph that was integrated with 3-5 details, an introduction and conclusion.

The Next Generation Science Standards (NGSS Lead States, 2014) were utilized to guide the integration of science content and practices. These included: MS-PS2-4 "Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects," MS-PS2-5 "Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact," and, 3-PS2-2 "Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion" (NGSS Lead States, 2014). Students created a plan and investigated the topics of gravity, magnetism, and forces. Students presented their findings in presentations through verbal and written discourse after researching, and making observations and measurements.

Existing research indicated various implementation strategies of integrating science and literacy. For example, in one study conducted by Romance & Vitale (2011) students in an experimental group spent 1.5 to 2-hours daily in a Science IDEAS model, an integrated model to teach students science, while also targeting reading comprehension, writing, and concept mapping. The results of the multiyear study demonstrated on average higher literacy and science scores across the multiyear study for those students in the experimental group. Another study investigated the effects integrating the literacy practice explain, model, guide, and apply to

science instruction. Fang & Wei (2010) demonstrated a literacy practice that was used 15-20 minutes one time per week could have a large impact on student success. The students engaged in investigations where they analyzed, purposed explanations, questioned, observed, recorded, predicted and shared their findings. The literacy lessons were on concept mapping, paraphrasing, and note taking. After instruction, the students took an assessment on science literacy and one on reading comprehension and vocabulary. The result indicated benefits for the integrated instruction. Although existing research is primarily demonstrating positive results, further studies needed to be completed to support those findings through further investigations involving different variables, populations, and instructional strategies.

Explanation of Results

Generally the results to the assessments demonstrate promising conclusions. Comprehension measured by the QRI-5, science content and process understanding measured by the Forces Summative Assessment and the surveys about the students' feelings all show assurance in regards to student growth and the effect of integration.

Comprehension

The QRI-5 was utilized to measure the students' comprehension ability. The results of the assessment indicated that three of the students made evident growth. According to Kelly, Moore, and Tuck (1994), reciprocal teaching can be very beneficial for student comprehension. They found students significantly increased their reading comprehension after instruction on predicting, questioning, and clarifying while reading. This study used reciprocal teaching as well and similar results were found. Nathan increased his instructional level in terms of comprehension from the first grade level to the second. Lorenzo did the same from the 4th grade

level to the 5th grade level, and Meg increased her instructional level from the 3rd grade level to the 5th grade level. Taylor did not take the exams in the same structure as the other students. The other students continued to progress to a more difficult text, if they had comprehension scores at or above the instructional level. Taylor did not take the assessment that way due to an error in proctoring the assessment; instead, he was assessed on only two reading passages, and even though he demonstrated an instructional level of understanding on all of them, the assessor did not proctor an additional passage to find if the student was at a proficient or instructional level at a higher grade level text. Taylor's scores should not be looked at as relevant due to the fact they cannot be analyzed in the same manner as the other students' data. His scores neither demonstrate growth nor discount it. Demarcus did not demonstrate growth on the QRI-5 as he had the same scores on the same tests for the pre and post-assessment.

Taylor, Alber, and Walker's research (2002) found that self-questioning encouraged active reading and benefitted student reading comprehension. This study also demonstrated this in 3 of the 4 students' tests results. The instructor stated during instruction all of the students demonstrated willingness to practice, and each student demonstrated the ability to utilize the reading techniques. However, Demarcus was absent three days, and when he was in the classroom, he was frequently reluctant to go beyond surface level questions and responses. The students who demonstrated the greatest effort during the lessons were Meg and Lorenzo who were consistently on task and interested in learning. These students also were able to go beyond surface level questions, predictions, and answers. Taylor and Nathan were sometimes on task and giving the necessary effort; however, sometimes they engaged in off topic conversations or behaviors including walking out of the classroom, or giving up because the task was "too difficult" and needed redirection. This may have impacted their abilities to make a larger

improvement. Through analyzing the behaviors and engagement of the students there appears to be a correlation between the positive behaviors and the test results. This case study may demonstrate that the literacy techniques are not 100 percent effective, as Demarcus did not demonstrate growth. Additionally, due to the brief amount of time between the pre and post assessment and limited instruction for the students, further instruction may prove to demonstrate further growth in comprehension for all students.

Forces Summative Assessment

Science comprehension and understanding was measured through the Forces Summative Assessment. According to Alfa and Zouber's study on ridding 9th grade students' misconceptions on electricity (2009); most misconceptions were addressed by the instruction, as inquiry was a tool for students to revise misunderstanding. This was also demonstrated in the open-ended question portion of the Forces Summative Assessment. Four of the five students demonstrated an increase of over four points. The results indicated a promising impact on student learning. Moreover, the students demonstrated, a decrease in their misconceptions and an increase in their understanding. On the pre-assessment five responses demonstrated misconceptions by the students including that a magnet was made of rubber and that gravity only occurred on earth. On the post-assessment there were zero misconceptions demonstrating a growth in ridding misconceptions.

Meg was the student who did not make a substantial gain on the open-ended portion of the Forces Summative Assessment. She increased her score on a couple questions, and also increased her overall score to an 8, a point away from demonstrating proficiency. Meg was a student who was very engaged in the classroom; however, when it came time to test, she needed

to leave early. She may have rushed through the Forces Summative Assessment and not demonstrated her complete understanding on this portion. The other students had no such constraint while taking the exam and their scores all increased more substantially.

On the multiple-choice questions, Lorenzo and Demarcus demonstrated an increase in understanding. They increased their scores by nine and eight respectively. Additionally, Taylor made a large increase from his pre-assessment to his post-assessment going from a basic to an advanced on the exam. This demonstrates the second time he scored advanced on the post-assessments on the Forces Summative Assessment. And, although at times Taylor "shut down" because he felt the work was too difficult, he was highly focused on the question "why" and gaining a deeper understanding of text through self-questioning. Meg and Nathan demonstrated smaller increases as Nathan remained at the minimal level of understanding, and Meg demonstrated a basic understanding of the content on the pre and post assessment. As stated before Meg had a time constraint while taking the summative assessment, and this may have negatively affected her ability to demonstrate her growth. Nathan missed two days of class prior to the final assessment, which may have decreased his ability to demonstrate a basic or proficient understanding of the content. Although there is limited uniformity among the numbers, the students averaged a 30 percent increase as a group. Alfa and Zoubeir (2009) found similar results in their study as all students demonstrated an increase in understanding but the effect of the inquiry instruction did not benefit all students equally. However, the study also concluded inquiry could benefit learning environments and would help students understand material more holistically.

The students' summaries gave the students an ability to demonstrate growth in two major areas: science understanding and the practice of writing a summative paragraph. Cervetti,

Barber, Dorph, Pearson, & Goldschmidt (2012), research also included the dependent variable of writing. The control group used a district supplied curriculum that did not integrate science and literacy while the treatment group used a curriculum that integrated science inquiry and literacy. The study concluded that students' writing success was independently positively affected by literacy embedded in science instruction. In the current case study, it was found all the participants demonstrated growth based on proficiency. Both Meg and Lorenzo increased their scores from a basic level to an advanced level. Demarcus increased two levels as well as his scores increased from minimal to proficient. Lorenzo, Meg, and Demarcus demonstrated perseverance and continued on task behaviors during the writing portions of the instruction. Taylor and Nathan increased their scores from minimal to basic. At times, Nathan and Taylor demonstrated behaviors that were not conducive for learning. This frequently occurred during instruction on writing. This may be the cause of Nathan and Taylor making a smaller increase than the other students. Overall, the students demonstrated an ability to increase not only content knowledge but also written structure. The students utilized introductions, organized detailed sentences, and a conclusion statement relatively effectively. In Cervetti, Barber, Dorph, Pearson, & Goldschmidt (2012) research on the effect of an integrated science and literacy instruction on science understanding, science comprehension, science vocabulary, and science writing came to much of the same conclusion and because of this case study a stronger argument can be made for the positive effects of integrating the two subjects on science writing.

Examining each of the assessments, it is clear each student made growth in at least two areas. Although Nathan demonstrated limited growth on the multiple-choice section, he did demonstrate growth on the QRI-5 and open ended questions at the beginning of the Forces Summative Assessment. Nathan was less on task and was previously diagnosed with a disability

that hindered his ability to maintain attention and demonstrate positive behaviors. This may have negatively impacted his ability to make larger gains. While, Lorenzo demonstrated growth in all areas as he had proficient or advanced scores on all sections of the Forces Summative Assessment and also made an increase on the QRI-5. Lorenzo demonstrated very positive behaviors that assisted him in achieving such scores. Demarcus did not make an increase on the QRI-5; however, he demonstrated growth on the Forces Summative Assessment, most notably on the short answer and summation paragraph sections. Meg exhibited the most growth on the QRI-5 and demonstrated growth on the summation paragraph going from basic to advanced on the post-assessment. Taylor made growth on both the multiple-choice section of the Forces Summative Assessment and on the open-ended questions as he reached advanced in both of the areas. Meg, Demarcus, and Nathan were absent from at least one class and this may too have negatively affected their ability to reach higher scores, and although, the students' scores were not consistently increased across all exams, all test scores on the Forces Summative Assessment increased and the scores on the QRI-5 also averaged a substantial increase.

Student Attitudes

Oliverira, Wilcox, Angelis, Applbee, Amodeo, and Snyder (2013), found that schools that had science teachers who made the content relevant to the students, attained their curiosity, and made it fun had a higher performance in science. On surveys and in discussions with the students and parents or guardians, the students indicated they liked the class, the class increased their confidence, and the students appreciated the hands on approach. Howes, Lim, and Campos (2009) warned of using approaches to science that did not incorporate using hands on learning and used primarily only reading and writing. Through this form of instruction students may learn not to like science based on their low reading or writing levels. In this hands on learning

and inquiry-based instruction, students seemed to increase their likeness of science. Nathan noted he was very happy to be in the program and he enjoyed working with his hands, and his parent noted a change in that he was more willing to read at home. His increase in reading at home may be in part because of the increase in comprehension noted in the QRI-5 results. Lorenzo indicated that he enjoyed reading more at home as well and said he felt more confident in science; however, he still felt he was not "smart enough" to be a scientist. Although this is not the response the instructor hoped for, improvement can be seen across all assessments for Lorenzo, and Lorenzo noted his confidence increased. Meg's mother indicated that she always liked showing off her A's and B's to her mom. This class was designed for students to "show off" what they learned periodically, through discussing and individual work time where they demonstrated what they learned. Meg also said that she once felt fine about science prior to instruction, but now feels "excellent about it" after the instruction. She liked learning things in a "fun" way and said, "When I do it this way (learning in the science literacy class) then its funner and exciting than the way I do it in regular school." Taylor and Demarcus shared those similar feelings. A majority of the students' and parents' comments and survey results indicated a positive outlook on the science inquiry literacy class. This can be viewed, as a further reason why the instruction was successful because if the students enjoy what they are doing and the parents support it, it will more likely be a successful instructional practice. From the Oliverira, Wilcox, Angelis, Applbee, Amodeo, and Snyder (2013) article, the authors noted students having fun during instruction as a benefit to students retaining content and scoring higher on assessments. This seems to have occurred through this study as the survey and discussion results indicate the students had fun and the QRI-5 and Forces Summative Assessment indicate an increase in assessment scores from the pre to the post assessment.

Looking at the Motivation to Read Survey, an unexpected change is seen. The students' average scores actually decrease from a mean of 55.8 on the pre-survey to a 55.0 on the post-survey. In reviewing the responses the scores really do not indicate the entire picture. For instance, students indicated the most substantial change (change from pre to post survey, positive or negative change) on three questions, and all of which were positive changes: "I am a_____." "When my teacher asks me a question about what I read _____." and "I worry about what other kids think about my reading _____." The questions that dropped can be accounted for by less of a gross change than the above questions indicating a larger group change in the previous areas. Additionally, the pre and post surveys were surprisingly high especially after communicating with the students and parents about their attitude toward science, reading, and school most notably prior to the instruction.

The students' scores on the Motivation to Read Survey appear to be highly variable and do not necessarily represent what was exhibited in other surveys, discussions, or on assessments. Nathan's overall score decreased from 66 to 64. His parent and his discussion responses to discussions and other surveys indicate that this is not a true depiction of his motivation to read. His scores in comprehension according to the QRI-5 also increased, thus a decrease in confidence or motivation seems unlikely. His grandparent stated that he often hides his low confidence when possible, and this may be what occurred on his pre and/or post survey. Meg and Taylor had similar results as Nathan as her motivation to read decreased by ten from 54 to 44 and his decreased by one from 53 to 52 on the pre and post survey. This again does not reflect their or their parents' responses in the discussions or other surveys. It also does not correlate with their growth academically on the Forces Summative Assessment or QRI-5 results. According to the Motivation to Read Survey, Lorenzo increased his motivation to read. His

scores increased from 56 to 63. This increase seems to exemplify what occurred during the instruction process, as this is consistent with his academic growth (reading comprehension, science understanding, and writing skills). In addition, these results are supported by the other survey and discussion results. Similarly, Demarcus' Motivation to Read results increased by six. Due to the lack of consistency among students and with other surveys, discussions, and assessments results, the results from the Motivation to Read Survey do not appear to be very reliable, nor demonstrate a positive or negative reflection of the integrated science and literacy instruction.

Strengths and limitations

This case study demonstrated possible benefits in integrating science inquiry and literacy instruction, but was limited on the case study's reliability and reach. Strengths would be the increase in writing, reading comprehension, and science content scores depicted by the Forces Summative Assessment and QRI-5 results.

The QRI-5 results demonstrated growth among students in a short amount of time. The students' comprehension according to the QRI-5 increased. Meg, Lorenzo, and Nathan demonstrated larger increases in reading comprehension. Each of these students each comprehended up to an instructional level one-grade level higher on their post assessment. Although, the test had its limitations, the students generally demonstrated growth.

The students' results indicate that science inquiry integrated literacy instruction is beneficial to student learning. The Forces Summative Assessment demonstrated that holistically students made an increase in understanding the science content and demonstrating that through short answer and summaries. This suggests that the integrated approach of using both hands on

learning in science and literacy instruction was successful. For the open-ended questions section, Meg was the only student to increase her score by less than five. This demonstrates a strong possibility of the instruction benefitting the students' ability to answer the short answer questions correctly. The multiple-choice section showed a change in student scores as well. The students' scores increased a mean of 5.4 points or 30 percent. This also demonstrated a strong possibility of the instruction benefitting students' ability to answer the multiple-choice questions correctly. The students demonstrated a mean increase of 4.2 points on the summation paragraphs. In this section, all of the students except Nathan made at least a 4-point increase. The consistent increase exhibited from the pre to post Summative Forces Assessment demonstrate a strong possibility of the increase occurring due to the instructional practice.

Although several strengths can be identified, limitations are also apparent. First the number of student taught during each class was between 2 and 3 (5 students in two classes), which is difficult to envision in classrooms especially those varying between 20 to 30 students. This limits the ability to generalize into a larger classroom setting. According to the instructional guide, (*Gravity and Magnetism*: *Teacher's Guide*, 2009), there is enough materials for up to 30 students; however, the ability to monitor and reach the students with the same effect would need to be examined further. Additionally, the number of students in this case study undermines the reliability of the study. Some studies explored and introduced in Chapter 2 had over 1,000 participants making it appear as though these studies are more reliable than a study that only had five participants.

Additionally, longer-term effects are unknown. Students' comprehension and science knowledge and understanding could be highly variable during a short period but maybe the students would not show as large of a steady increase over the course of a longer study. The

opposite could also be true as the students could continue making increases or exceed their growth through the 16 sessions. Furthermore, the students' scores on the assessment most notably on the multiple choice section, were highly variable as one student demonstrated a minimal level of understanding on the post assessment and two others only demonstrated a basic understanding. The mean score was only 69 percent much lower than desired.

Lastly, the students were also taught through a reading writing workshop and one on one literacy tutoring during the same time as the study. Each student participated in three-55 minute courses all with a goal of increasing a student's ability to increase his or her literacy. This makes it difficult to predict which instructional practices were valuable or relevant to the students increase in test scores.

Recommendations

In this section, recommendations for the instructional practice for students, for future studies will be provided, and for students in this case study. First, the participants in this study all came from varying backgrounds, but all found success through this instructional practice. Two of the students were diagnosed with an attention deficit disorder, which makes it more difficult for students to focus. This instructional strategy was meant to have learners interact with the subject at hand and all of the students seemed to get more excited upon working with their hands and looked forward to discovering things while reading and through exploration. Thus, the first recommendation is to let the students actively engage in studying what they are researching, learning, and reading. Secondly, the students seemed to benefit from the integration of science and reading and writing. Howes, Lim, and Campos (2009) noted that students need ways to interact with content and empirically study. Reading is one way to grasp and

understand; however, for students to gain a better understanding they need to interact with the content in a variety of modes. Additionally, the Howes, Lim, and Campos (2009) found students benefit most by investigating their own questions, observing, researching text and talking science. These techniques were used throughout this case study and it proved an important part of helping students grasp the content. Fang and Wei (2010) took it a step further by exploring the effects of focused reading by integrating reading in science for only 15 to 20 minutes one time per week, and it was very successful in raising student performance in science and reading skills. These lessons demonstrated the great affect reading skills have on science understanding, but more than that it also demonstrated comprehension can be greatly impacted by a lesson limited on time and occurrences. Reading takes place across all subject areas, but discreet skills including vocabulary, affixes, and figures of speech, can be targeted in each academic area and should be, especially in the sciences.

Further research and case studies need to take place to continue to identify strategies and demonstrate which practices work in different environments. This study was limited on the number of students in the classroom, the number of participants, the time and the comprehension exam as a QRI-5 is one way to evaluate comprehension, but with other assessments comprehension results could be more holistically understood. An additional suggestion would be to use more than one assessment to measure comprehension. One or more of these variables could be changed in future studies to understand more deeply what is effective instruction and what instruction is less effective.

One topic that continues to appear in studies is that when students are engaged they learn; the more teachers do this, the more successful students will be. Romance and Vitale (2011) study investigated the short and long term effect of integrated literacy and science instruction. The

study concluded that when students are engaged in such an instructional strategy the students could be as much as a grade level ahead of their peers who are not engaged in the same practice.

In this case study students' ages, abilities and knowledge were variable, and although, each student made increases, each student continues to require additional growth. Nathan demonstrated growth in comprehension and science content understanding. As stated previously students need to be positively engaged in lessons, and this was a positive experience for him in comparison to his previous academic settings, but his behaviors continue to be a hindrance on his academic progress. Creating an action plan as to how to help him use his behaviors positively is one suggestion; in addition to utilizing inquiry based and hands on learning. This seems to assist him in remaining on task and making progress academically. Continued practice on self questioning and reciprocal teaching may also benefit him as it appeared to be a successful way to help him understand text at a deeper level For Lorenzo, his confidence is one area of need. He still did not feel he was capable of becoming a scientist, and I believe if he continued working as a scientist and problem solving his confidence could be improved and he would open more doors for his future, as his academics are less of a concern. However, the instructional strategies seemed to have benefitted Lorenzo substantially as he made increases on all the assessments. Demarcus needs to continue working on his ability to interact with text and comprehending what he reads. He is a fluent reader; he needs to continue to grow in his comprehension. Demarcus used limited inferences and analysis while reading, and his questions, predictions, and answers were on the surface level. Continued instruction in this area may benefit his ability to understand text more holistically. Meg demonstrated growth in comprehension according to the QRI-5; however, her growth was limited on the assessments that measured content knowledge. Meg needs further instruction in listening and responding as this could assist her in her ability listen

and apply what she knows to what she hears others say. Often times during instruction it was noted that Meg did not build onto conversations, as she did not address the previous person's question or argument. Meg did an exceptional job engaging in the processes of self-questioning, and reciprocal teaching. To continue growing, these strategies could be continued and could help her continue to grow in reading comprehension. Lastly, Taylor demonstrated growth on the Summative Forces Assessment and although at times he got frustrated with the open-ended questions, and the discovery learning aspect of the instruction, he benefitted from the hands on learning and project based approach. Further instruction should be centered on such approaches to reach Taylor and help him make academic progress.

Conclusion

The results of the instruction demonstrated gains with most students in most areas. Although the results from each assessment did not demonstrate growth consistently, the average growth of the students was positive. The QRI-5 revealed that students improved their comprehension over the 4 weeks of integrated literacy and inquiry based science instruction. On the Forces Summative Assessment students demonstrated growth in writing, content understanding, and critical thinking. It is important to consider strengths and limitations of this study. Although, this study demonstrated a positive outlook on the ability of a teacher to reach students through an integrated literacy and inquiry based science instruction, there were only five total students with three and two students in each class. This chapter analyzed and explained the results of the instruction, discussed the strengths and limitations of this case study, and provided recommendations for the students and further research. The results of this case study support and enrich many conclusions from other research as integrated science and literacy instruction results reveal it was an effective way of teaching students.

References

Afra, N., Osta, I., & Zoubeir, W. (2009). Students' alternative conceptions about electricity and effect of inquiry-based teaching strategies. *International Journal of Science and Mathematics Education,* 7(1), 103-132.

Baker, J., & Tilson, J. (2009). *Forces*. Nashua, N.H.: Delta Education.

Barber, J., & Erickson, J. (2009). *What my sister taught me about magnets*. Nashua, NH: Delta Education.

Beals, K., & Bibby, D. (2009). *Gravity is everywhere*. Nashua, N.H.: Delta Education.

Bransford, J., Brown, A., & Cocking, R. (2004). *How people learn: brain, mind, experience, and school* (Expanded ed.). Washington, D.C.: National Academy Press.

BSCS (2006). BSCS Science: An Inquiry Approach. Dubuque, IA: Kendall/Hunt Publishing Company.

Cervetti, G., Barber, J., Dorph, R., Pearson, D., & Goldschmidt, P. (2012). The impact of an integrated approach to science and literacy in elementary school classrooms. *Journal of Research in Science Teaching*, *49(5),* 631-658.

Chase, A., & Gordon, J. (2009). *Mystery forces*. Nashua, NH: Delta Education.

Common Core State Standards Initiative. (2014). *English Language Arts Standards*. Retrieved August 9, 2014, from http://www.corestandards.org/ELA-Literacy/.

Dorph, R., Shields, P., Tiffany-Morales, J., Hartry, A., McCaffrey, T. (2011). High hopes–few opportunities: The status of elementary science education in California. Sacramento, CA: The Center for the Future of Teaching and Learning at WestEd.

Einstein, A. (1961). *Relativity: The special and the general theory; a popular exposition.* (17th ed.). New York: Crown Publishers.

Fang, Z., & Wei, Y. (2010). Improving middle school students' science literacy through reading infusion. *Journal of Educational Research, 103*(4), 262-273.

Gambrell, L., Palmer, B., Codling, R., & Mazzoni, S. (1996). Assessing Motivation To Read. *The Reading Teacher*, *49*(7), 518-533.

Gravity and Magnetism: Teacher's Guide. (2009). Nashua, NH: Delta Education, LLC.

Hammill, D., Brown, V., Larsen, S., & Wiederholt, J. (2007). *TOAL-4 test of adolescent and adult language* (4th ed.). Austin: Pro-Ed Inc.

Howes, E., Lim, M., & Campos, J. (2009). Journeys into inquiry-based elementary science: literacy practices, questioning, and empirical study. *Science Education*, 93(2), 189-217.

Hoover, H., Dunbar, S., & Frisbie, D. (2007). *Iowa Test of Basic Skills*. Chicago, IL: Riverside Publishing.

Jobs for the Future. (2007). *The STEM Workforce Challenge: the Role of the Public Workforce System in a National Solution for a Competitive Science, Technology, Engineering, and Mathematics (STEM) Workforce*. Retrieved from United States of America Department of Labor website: http://www.doleta.gov/youth_services/pdf/STEM_Report_4%2007.pdf

Lead States. (2014). Next Generation Science Standards: For States, By States. Retrieved July 7, 2014, from http://www.nextgenscience.org/three-dimensions.

Leslie, L., & Caldwell, J. (2011). *Qualitative reading inventory* (5th ed.). Boston: Pearson/Allyn & Bacon.

Lundy, Melinda M., "The nature of questioning moves used by exemplary teachers during reading instruction" (2008). Graduate Theses and Dissertations.

MacGinitie, W. H., MacGinitie, R. K. Maria, K. & Dreyer, L. G. (2002). *Gates-MacGinitie reading tests (4th ed.).* Itasca, IL: Riverside Publishing Company.

Martin, L. E., & Kragler, S. (2012). Early signs of self-regulating print: Kindergartners at work reading to understand fiction and nonfiction text. *Journal of Research in Childhood Education*, 26(2), 141.

McDermott, L. & Shaffer, P. (1992). Research as a guide for curriculum development: An example from introductory electricity. Part I: Investigation of student understanding. American Journal of Physics, 60, 994Y1003.

Miller, R. G. (2006). Unlocking reading comprehension with key science inquiry skills. *Science Scope*, 30-33.

National Research Council (1996). National science education standards. Washington, DC: National Academy Press.

NGSS Lead States. (2014). Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

November, A. (2013). 21st century learning -- a deep dive into the future of education". *YouTube*. Retrieved July 29, 2014, from https://www.youtube.com/watch?v=RTEcIl41BFU&feature=youtube_gdata.

Oliveira, A. W., Wilcox, K. C., Angelis, J., Applebee, A. N., Amodeo, V., & Snyder, M. A. (2013). Best practice in middle-school science. *Journal of Science Teacher Education*, *24*(2), 297-322.

Reid, N., & Elley, W. (1991). *Progressive Achievement Test of Reading Comprehension*. Wellington: NZCER.

Romance, N., & Vitale, M. (2011). An integrated interdisciplinary model for accelerating student achievement in science and reading comprehension across grades 3-8: implications for research and practice. *Society for Research on Educational Effectiveness*, 1-13.

Science Inquiry: NSTA Position Statement. (2004). National Science Teachers Association. Retrieved July 3, 2014, from http://www.nsta.org/about/positions/inquiry.aspx.

Shwartz, Y., Weizman, A., Forus, D., Sutherland, L., Merrit, J., & Krajcik, J. (2009). Talking science. *The Science Teacher*, 76(5), 44-47.

Taylor, L. K., Alber, S.R., & Walker, D. W. (2002). The comparative effects of a modified self-questioning strategy and story mapping on the reading comprehension of elementary students with learning disabilities. *Journal of Behavioral Education 11*(2), 69-87.

Torgesen, J., Wagner, R., & Rashotte, C. (2012). *Test of word reading efficiency* (2 ed.). Austin: Pro-Ed. Inc.

Treadwell, J. W. (2010). *The impact of discovery learning in writing instruction on fifth-grade student achievement.* (Order No. 3396813, Walden University). *ProQuest Dissertations and Theses*. Retrieved from http://0-search.proquest.com.topcat.switchinc.org/docview/305229886?accountid=9367.

Wechsler, D. (2005). *Wechsler Individual Achievement Test* (2nd ed.). London: Harcourt.

Appendix A: Forces Summative Assessment

Name _____

1. What is a force? _____

_____

_____

2. Explain a real world example of a force. _____

_____

_____

3. What is gravity? _____

_____

_____

4. What is magnetism? _____

_____

_____

CIRCLE THE CORRECT RESPONSE.

How is the force of gravity like magnetic force?

A. They can both attract
B. They can both repel
C. They occur on all objects
D. They both only work with metal.

A boy is holding a ball and lets it go. The ball falls to the ground. Why did the ball fall to the ground?

A. The earth and ball repelled
B. Magnetism
C. Electrostatic
D. Gravity

Which of these tells you how strongly Earth is pulling on a person?

A. The person's height
B. How much air is above the person
C. The person's speed
D. The person's weight

A car weighs 2,000 pounds on earth. IF the car is placed on the moon, which of these would be true?

A. the car would weigh nothing on the moon
B. the car would weigh more than 2,000 pounds
C. the car would weigh less than 2,000 pounds
D. the car would weigh 2,000 pounds

When does Earth pull on you?

A. only when you are falling
B. only when you are touching the ground
C. all the time
D. only when you are in outer space

A girl put an object on the table. She then used a magnet to push it away without touching it. What do you know about this object?

A. It is made of plastic
B. It is something that has a charge
C. It is another magnet
D. It is made of iron

What is true about magnets?

A. magnets are attracted to everything
B. magnets are attracted to plastic
C. magnets are attracted to iron and other magnets
D. magnets are attracted to all metals

To push apart means to _____.

A. repel
B. attract
C. gravity
D. compare

The part of a magnet that pushes or pulls is a _____.

A. iron
B. pole
C. mine
D. property

Deon used a magnet to _____ the metal pins that fell on the floor.

A. attract
B. charge
C. observe
D. compare

Clues that help prove or explain something

A. science
B. evidence
C. questions
D. predictions

To use any of your five senses to learn more about something is _____.

A. repelling
B. inventing
C. predicting
D. observing

Kim saw an ant dragging a little stick along the sidewalk. The ant was smaller than the stick. What could Kim do to see how strong the ant is?

A. replace the stick with a larger stick and see if the ant can carry it
B. get lots of ants and watch them all very carefully
C. make several accurate drawings of the ant carrying the stick
D. get someone to take photographs

There is a pond next to Juan's school. What is the best evidence that there are frogs living in the pond?

A. he hears croaking
B. he hears splashing
C. he saw pictures of frogs in a pond in a book he read
D. he saw frogs in a different pond

Sometimes stinky water flows out of a pipe into the pond. Juan has noticed that he doesn't hear as many frogs croaking at night as he used to. What might this evidence lead him to believe?

A. the frogs are sleeping
B. the polluted water may be killing or forcing the frogs to move
C. wild animals are eating the frogs
D. there are more frogs in the pond

Why do scientists look for evidence during investigations?

A. they need to find evidence so no one else will find it
B. they use evidence to make better explanations
C. they look for evidence so they can record it
D. they look for evidence to make sure their investigation is legal

Which of these is an important part of the work of scientists?

A. testing ideas about the world through investigations
B. voting with other scientists about how things work
C. doing what other scientists tell them to do
D. having opinions about how the world works

Someone who studies the natural world is a _____.

A. Scientist
B. Officer
C. Adaptation
D. Questioner

Write a summary related to forces **or** about what scientists do.

Appendix B: Self-Questioning

Question: _____

_____

Answer: _____

_____

_____

Revision: _____

_____

_____

_____

Question: _____

_____

Answer: _____

_____

_____

Revision: _____

_____

_____

_____

Question: _____

_____

Answer: _____

_____

_____

Revision: _____

_____

_____

_____

Appendix C: Writing Outline

Question _____

Additional questions _____

_____

Prediction: _____

because _____

RESEARCH!

What did you find out from other sources? _____

_____

_____

_____

_____

_____

_____

Plan Investigation _____

_____

_____

_____

_____

1)_____

2)_____

3)_____

4)_____

5)_____

What did you observe? _____

_____

_____

_____

_____

_____

_____

What evidence do you have to support or reject your prediction?

_____

_____

_____

_____

Comparison: _____

_____

What can you explain about your question and prediction now since you have completed the investigation?

_____

_____

_____

_____

_____

_____

PREWRITE:

Topic _____

_____

Detail I _____

_____

Detail II _____

_____

Detail III _____

_____

SUMMARY:

_____

_____

_____

_____

_____

Appendix D: Forces Summative Assessment Rubric

Summative Assessment Rubric

Short Answer Rubric

Proficient: 3	**Basic: 2**	**Minimal: 1**
States at least 3 relevant details.	States at least 2 relevant details.	States fewer than 2 relevant details.

Open Ended Cumulative Scoring

Score	**Percent**	**Category**
12	>100%	Advanced
9-11	>70%	Proficient
8	>60%	Basic
0-7	<60%	Minimal

Multiple Choice Cumulative Scoring

Score	**Percent**	**Category**
17-18	>90%	Advanced
13-16	>70%	Proficient
12	>60%	Basic
0-11	<60%	Minimal

Writing a Summary Rubric

	Advanced 4-points	Proficient 3 Points	Basic 2-Points	Minimal 1point
Organization	Summary has an clear and specific introduction and conclusion with 3-5 detailed sentences that transition effectively.	Summary has an introduction, 3-5 detailed sentences, and conclusion.	Summary has at least an introduction or conclusion and detailed sentences.	Summary is lacks organization and structure.
Depth of Content	Clearly states 4 or more important details including an example.	States at least 3 relevant details.	States at least 2 relevant details.	States fewer than 2 relevant details.
Accuracy of Content and Mechanics	At least 4 details content is accurate with fewer than 2 mechanical errors	At least 3 details are accurate with fewer than 5 mechanical errors	2 details are accurate with fewer than 7 mechanical errors.	Fewer than 2 accurate details or more than 6 mechanical errors

Writing Cumulative scores	**Category**
12	Advanced
9-11	Proficient
6-8	Basic
0-5	Minimal

Appendix E: Parent Pre and Post Survey

Child's Name _____

Your Name _____

Thank you for enrolling your student in Cardinal Stritch's Literacy Center this summer! I am James Menke, and I will be teaching your child science for the next four weeks. Below you will find a short survey that will give us a better understanding of where your child was at in the beginning of the program. Thank you for your time! Please fill out the survey to the best of your knowledge.

Please circle a number 1-5. A 1 does **not** describe your child at all. A **5 completely** describes your child.

My child enjoys reading. 1 2 3 4 5 **Please Explain.**

_____

_____

_____

My child enjoys school. 1 2 3 4 5 **Please Explain.**

_____

_____

_____

My child is excited about what he learns at school. 1 2 3 4 5 **Please Explain.**

_____

_____

_____

My child's attitude toward coming to Stritch's Literacy Center this summer is positive. 1 2 3 4 5 **Please Explain**

_____

_____

_____

(Survey continues on back)

My child enjoys science class. 1 2 3 4 5 **Please Explain**

_____

_____

_____

My child's behavior always benefits the learning environment at school. 1 2 3 4 5 **Please Explain**

_____

_____

_____

Any additional comments you would like to share

_____

_____

_____

_____

_____

Thank you for your time!

James Menke

Science Instructor

Cardinal Stritch Literacy Center

POST-Survey

Child's Name _____

Your Name _____

Thank you for enrolling your student in Cardinal Stritch's Literacy Center this summer! It has been a privilege teaching him or her about being a scientist. Below you will find a short survey that will give us a better understanding of how far your child has come during the program. Thank you for your time! Please fill out the survey to the best of your knowledge.

Please circle a number 1-5. A 1 does not describe your child at all. A **5** completely describes your child.

My child enjoys reading. 1 2 3 4 5

My child enjoys school. 1 2 3 4 5

My child is excited about what he learns at school. 1 2 3 4 5

My child's attitude toward coming to Stritch's Literacy Center this summer was positive. 1 2 3 4 5

My child enjoys science class. 1 2 3 4 5

My child's behavior always benefits the learning environment at school. 1 2 3 4 5

Please explain any changes you have seen in your child. If possible reference one or more of the survey questions above.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Enjoy the remaining weeks of summer!

James Menke

Science Instructor

Cardinal Stritch Literacy Center

Appendix F: Motivation to Read Survey

MOTIVATION TO READING PROFILE – R

Name: _____ Date_____

DOB _____ Grade: _____

Instructor: _____

A. I am in _____
- □ 2nd grade
- □ 3rd grade
- □ 4th grade
- □ 5th grade

B. I am a _____
- □ boy
- □ girl

1. My friends think I am _____
- □ A very good reader
- □ A good reader
- □ An OK reader
- □ A poor reader

2. Reading a book is something I like to do,
- □ Never
- □ Almost never
- □ Sometimes
- □ Often

3. When I come to a word I don't know, I can _____
- □ Almost always figure it out
- □ Sometimes figure it out
- □ Almost never figure it out
- □ Never figure it out

4. My friends think reading is _____
- □ Really fun
- □ Fun
- □ Ok to do
- □ No fun at all

5. I read _____
- Not as well as my friends
- About the same as my friends
- A little better than my friends
- A lot better than my friends

6. I tell my friends about good books I read.
- I never do this
- I almost never do this
- I do this some of the time
- I do this a lot

7. When I am reading by myself, I understand _____
- Everything I read
- Almost everything I read
- Almost none of what I read
- None of what I read

8. People who read a lot are _____
- Very interesting
- Sort of interesting
- Sort of boring
- very boring

9. I am _____
- A poor reader
- An OK reader
- A good reader
- A very good reader

10. I think libraries are _____
- A really great place to spend time
- A great place to spend time
- A boring place to spend time
- A really boring place to spend time

11. I worry about what other kids think about my read _____
- A lot

- Sometimes
- Almost never
- Never

12. I think becoming a good reader is _____
- Not very important
- Sort of important
- Important
- Very important

13. When my teacher asks me a question about what I have reading, _____
- I can never think of an answer
- I almost never think of an answer
- I sometimes think of an answer
- I can always think of an answer

14. I think spending time reading is _____
- Really boring
- Boring
- Great
- Really great

15. Reading is _____
- Very easy for me
- Kind of easy for me
- Kind of hard for me
- Very hard for me

16. When my teacher reads books out loud, I think it is _____
- Really great
- Great
- Boring
- Really boring

17. When I am in a group talking about books I have read, _____
- I hate to talk about my ideas
- I don't like to talk about my ideas
- I like to talk about my ideas
- I love to talk about my ideas

18. When I have free time, I spend _____
- None of my time reading
- Very little of my time reading
- Some on my time reading
- A lot of my time reading

19. When I read out loud, I am a _____
- Poor reader
- OK reader
- Good reader
- Very good reader

20. When someone gives me a book for a present, _____
- I am very happy
- I am happy
- I am unhappy
- I am very unhappy

Appendix G: General Student Survey and Discussion Questions

Name_____

Pre Survey – Why? will be discussed not answered on the survey

Please circle a number 1-5. A 1 does not describe you at all. A **5** completely describes you.

1. I enjoy reading. 1 2 3 4 5
   WHY?
2. I enjoy school. 1 2 3 4 5
   WHY?
3. I am excited about what I learn at school. 1 2 3 4 5
   WHY?
4. I am happy to be going to this program. 1 2 3 4 5
   WHY?
5. I enjoy science class. 1 2 3 4 5
   WHY?
6. I always have good behavior at school. 1 2 3 4 5
   WHY?

Post survey – Why? will be discussed not answered on the survey

Please circle a number 1-5. A 1 does not describe you at all. A **5** completely describes you.

1. I enjoy reading. 1 2 3 4 5
   WHY?

2. I enjoy school. 1 2 3 4 5
   WHY?

3. I am excited about what I learned at this program. 1 2 3 4 5
   WHY?

4. I am happy I did this program. 1 2 3 4 5
   WHY?

5. I enjoyed this science class. 1 2 3 4 5
   WHY?

6. I had good behavior during this science class. 1 2 3 4 5
   WHY?