Summer 8-2011

The Relationship Between Inquiry-Based Science Instruction and Student Achievement

Michael Louis Suarez
University of Southern Mississippi

The University of Southern Mississippi

THE RELATIONSHIP BETWEEN INQUIRY-BASED SCIENCE INSTRUCTION AND STUDENT ACHIEVEMENT

by

Michael Louis Suarez

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

August 2011

ABSTRACT

THE RELATIONSHIP BETWEEN INQUIRY-BASED SCIENCE INSTRUCTION AND STUDENT ACHIEVEMENT

by Michael Louis Suarez

August 2011

Teaching science through inquiry has become a focus of recent educational reform in Mississippi and other states. Based on the Constructivist learning theory, inquiry instruction can take many forms, but generally follows the scientific method by requiring students to learn concepts through experimentation and real-world, hands-on experiences.

This dissertation examines the relationship between the amounts of time spent using inquiry-based science instruction and student achievement as measured by the Mississippi State Science Assessment. The study also identifies teacher perceptions of inquiry and the amount of professional development received by participants on using inquiry-based instructional techniques. Finally, this study identifies factors that hinder the use of inquiry.

Using a 24-question written survey, the researcher collected quantitative data from 204 science teachers in grades K-8 in four southern Mississippi school districts. Participants rated their average amount of time spent using inquiry-based science instruction in their classrooms. These results were then compared to each school's average test score on the 2009-2010 Mississippi State Science

Assessment using a Spearman rho correlation. A significant positive relationship was found between amounts of time spent using inquiry-based science instruction and student achievement.

The participants also indicated their perceptions of inquiry, amount of professional development, and deterrents to inquiry usage on a five-point Likert scale survey. Overall, participants held a favorable opinion of inquiry-based instruction and felt that it was important for their students' success. Over half of participants had not attended professional development on inquiry-based instruction. A majority indicated a desire for professional development.

The most commonly identified factor hindering the use of inquiry was a lack of materials and resources. Many participants also indicated that time constraints prevented more frequent use of inquiry in their classrooms.

The University of Southern Mississippi

THE RELATIONSHIP BETWEEN INQUIRY-BASED SCIENCE INSTRUCTION AND STUDENT ACHIEVEMENT

by

Michael Louis Suarez

A Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

Approved:

Dr. David Lee______________________
Director

Dr. James Johnson________________

Dr. Gaylynn Parker_________________

Dr. Rose McNeese_________________

Susan A. Siltanen__________________
Dean of the Graduate School

August 2011

DEDICATION

I would like to dedicate this book to my wife, Kristen, and children, Austin and Emily. I could not have done it without your love and support. Thank you for always being there for me. I love you all very much!

I also dedicate this work to Jesus Christ, through whom all things are possible.

TABLE OF CONTENTS

ABSTRACT ii

DEDICATION iv

LIST OF TABLES vii

CHAPTER

I. INTRODUCTION……………………………………………………………..1

Statement of the Problem
Research Questions
Research Hypothesis
Definition of Terms
Delimitations
Assumptions
Justification

II. REVIEW OF LITERATURE...…………………………….……………7

What is Inquiry-Based Science Instruction?
Why is Inquiry-Based Science Instruction Needed?
Challenges to Implementing Inquiry-Based Science Instruction

III. METHODOLOGY……………………………………………………...35

Overview
Research Design
Participants
Instrumentation
Procedures
Data Analysis

IV. ANALYSIS OF DATA.……………………………………………...41

Introduction
Descriptive Statistics
Statistical Analysis
Ancillary Findings

V. SUMMARY…………………………………………………………………..58

Conclusions
Limitations
Recommendations for Policy or Practice
Recommendations for Future Research

APPENDIXES……………………………………………………………………….65

REFERENCES……………………………………………………………………… 70

LIST OF TABLES

Table

1. Characteristics of Participants 42

2. Inquiry Usage.. 44

3. Frequency of Likert-Type Questions 45

4. Descriptive Statistics for Likert-Scale Questions...................................... 51

5. Descriptive Statistics for Inquiry Usage by Participants 52

6. Mississippi State Science Assessment 52

7. Spearman rho Correlation Test Grades K-8 54

8. Spearman rho Correlation Test Grades K-5 54

9. Spearman rho Correlation Test Grades 6-8... 55

10. Teacher Perceptions of Inquiry 55

11. Professional Development.. 56

12. Descriptive Statistics Factors Hindering Inquiry Usage............................ 57

CHAPTER I

INTRODUCTION

For the past several decades, the focus of national educational goals has been to increase the competitiveness and educational ranking of United States students with students from other world counterparts. Despite these efforts, recent reports from the National Assessment of Educational Progress (NAEP) indicate that United States students continue to fall behind students in other developed countries in many subjects including science. A well educated, technology centered workforce is essential if the United States is to remain a major player on the world stage (Gordon, 2007).

In response to this demand, high stakes tests have become the standard used to measure each school's progress toward producing well-educated students. Recently, the quality of science instruction has taken the spotlight (Gordon, 2007). In 2011, student achievement on the Mississippi State Science Assessment, administered to all students in grades 5 and 8, will be factored into each school and school district's ability to meet adequate yearly progress (AYP). For the first time in Mississippi, this will directly tie quality science instruction to state and federal funding levels just as is done with student achievement scores in math and language arts.

Mississippi, like many states, recently began placing more emphasis on teaching science through inquiry-based learning. The 2010 Mississippi Science Curriculum includes an entirely new strand completely devoted to implementing inquiry into physical, earth, and life science. However, implementing inquiry requires a shift from a teacher-centered instructional program, to a student-centered instructional program in which students take an active role in their own learning rather than being passive recipients of teacher or textbook knowledge. This science reform requires an examination of science assessment practices and a refinement in teaching approaches to science inquiry (Pyle, 2008).

The National Science Education Standards define inquiry instruction as "involving students in a form of active learning that emphasizes questioning, data analysis, and critical thinking". They also suggest that students in all science courses should engage in scientific inquiry in order to develop higher order critical thinking and reasoning skills (National Research Council, 1996, p. 23).

Inquiry based science instruction can take many forms, but frequently closely follows the scientific method. The level of open exploration can be adjusted to fit the appropriate cognitive level of the students. Inquiry-based lessons can be performed individually but most often take place in small groups (Marzano, 2007).

The theory of constructivism forms the basis for inquiry-based learning. Focused mainly on the works of Piaget, Dewey, and Vygotsky, constructivism centers on the belief that individuals gain knowledge through real life experiences. Students learn best when faced with real world problems to solve. Therefore, in inquiry-based science, the teacher should act as the facilitator of knowledge by guiding the students through their own levels of cognitive development and understanding. Rather than being a passive absorber of knowledge, constructivists believe the student should take an active role in his or her own learning by being authentically engaged in the problem solving process (Eisler & Eisler, 2001).

Many states have used The National Science Education Standards as the foundation for their science curriculums. The standards, developed by the National Research Commission, provide guidelines for science instruction and assessment. Centered on the constructivist theory, the standards highly focused on teaching science through inquiry (National Research Council, 1996).

However, opponents of constructivism fear that students may develop misconceptions through unguided approaches to learning. These misconceptions and unorganized bits of information may be difficult, if not impossible, to correct. The fact that the constructivist approach has been around for many decades without improvement in student achievement scores is also decreed (Kirschner, Sweller, & Clark, 2006).

Research has shown that students who are in a high quality, inquiry-based science program dramatically improve in other subject areas, such as writing and mathematics. One study found a 70% increase in students' writing scores who were in an inquiry based science classroom versus students who received traditional science instruction. Inquiry has also proven effective for students with language and learning disabilities (Amarah, Garrison, & Klentschy, 2002).

Despite its potential benefits, few can dispute the fact that this complex form of science instruction places more demands on both students and teachers. Although more emphasis is being placed on science instruction, many teachers do not have a clear definition of inquiry based science instruction. Some teachers question if their lessons are inquiry based, and if so, how much inquiry is needed in the science curriculum (Ohana, 2006)?

This goal of this study was to determine the frequency of inquiry based science instruction and its relationship to student achievement. It contributes to the field of education by determining what most hinders the use of inquiry-based instruction so that improvements may be implemented. This could lead to solutions that will aid teachers in incorporating more inquiry into their science lessons. It could also assist instructional leaders in improving their institution's science achievement.

Statement of the Problem

Through this study, the results of a written survey were used to determine the frequency with which teachers were using inquiry-based science instruction, and how this effects student achievement scores on the Mississippi State Science Assessment. It also determined what challenges teachers are facing with implementing inquiry-based science instruction, and if they felt adequately trained to overcome these challenges.

Research Questions

The following research questions were explored through this study:

1. Is there a relationship between the amounts of time spent using inquiry-based science instruction and student achievement?
2. What are teachers' perceptions of inquiry-based science instruction?

3. Do teachers feel adequately trained in using inquiry-based science instructional techniques?
4. What challenges most hinder the use of inquiry-based science instruction?

Research Hypothesis

This study tested the following hypothesis:

1. There is a relationship between the amount of time spent using inquiry-based science instruction and student achievement.

Definition of Terms

Constructivism - a learning theory based on the premise that humans gain additional knowledge and meaning through life experiences (Esler & Esler, 2001).

Inquiry-Based Science Instruction - A form of active learning that emphasizes questioning, data analysis, and critical thinking (National Research Council, 1996).

Mississippi State Science Assessment - Criterion-referenced, standardized science assessment administered annually to all 5^{th} and 8^{th} grade students in Mississippi (Mississippi Department of Education, 2004).

National Education Science Standards - Inquiry intensive guidelines for science instruction and assessment developed by the National Research Council (National Research Council, 1996).

Delimitations

This study was limited to schools in South Mississippi. It was also be limited to teachers in grades kindergarten through 8 due to the testing arrangement designated by the Mississippi Department of Education.

Assumptions

The researcher assumed the teachers being surveyed felt they could be honest with their answers and responded accordingly.

Justification

This study was performed to analyze the effects of time spent using inquiry based science instruction on student achievement as measured by the Mississippi State Science Assessment administered to all students in grades 5 and 8 in the State of Mississippi. With inquiry being a new focus of science teachers in Mississippi, some question the impact of its use on student achievement. The results of this study provided evidence of its effect.

This study also examined teachers’ perceptions of inquiry based science instruction. Specifically, the importance teachers placed on inquiry-based instruction, what inhibits its use, and whether more professional development is needed. Educational leaders could use the results to develop improvements and solutions that will enable inquiry to be implemented more effectively into classroom instruction. This study provided documented research to assist them in their decisions.

CHAPTER II

REVIEW OF LITERATURE

What is Inquiry Based Science Instruction?

Inquiry based science instruction was pioneered by German chemists in the 1880s who referred to it as the “laboratory method” of instruction. Although it has changed over the years, this marked the birth of the scientific method. The practice found its way into American universities where it was believed to revolutionize education. High schools, who were attempting to emulate universities, soon adopted inquiry-based instruction, and it has since trickled down to the elementary level curriculum (Windschitl, Dvornich, Ryken, Tudor, Koehler, 2007).

In 1996, the National Research Council published the *National Education Science Standards* in order to “guide our nation to a scientifically literate society” (p. 3). The standards form the basis for many states’ science curriculums and are strongly supported by the National Science Teachers Association. The standards are heavily focused on teaching science through inquiry and assert that inquiry is central to science learning (National Research Council, 1996).

> When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by

> combining scientific knowledge with reasoning and thinking skills (National Research Council, 1996, p. 2).

The key to inquiry based learning is to have the students answer one or more research questions through data analysis. The research question and data can be generated and gathered by the students or provided by the teacher. The data can be physical or observed (Bell, Smetana, Binns, 2005).

Inquiry-based instruction frequently uses or closely follows the scientific method. First, the teacher usually presents the students with an observation, fact, or problem. Next, the students then form hypotheses and make predictions about the situation. Then, they test their hypothesis through experimentation and collecting and recording data. Finally, the results and data are analyzed and students are asked to draw conclusions (Marzano, 2007).

One important aspect of inquiry instruction is citing evidence and drawing conclusions. These conclusions are often shared with other groups of students for their consideration. This process allows students to develop higher-order thinking skills as they defend their findings to their classmates. Investigations can be repeated to refine findings and increase understanding until a common consensus can be reached among the class (Palincsar, Collins, Cutter, Magnusson, 2001).

Types of Inquiry Based Science Instruction

Scientific inquiry can take a variety of forms, as there is no universal research method in the world of science. This allows inquiry to be adjusted to each unique situation in which it is applied. Inquiry instruction can be performed on an individual basis, but it most often takes place in pairs or small groups. This practice enhances the classroom community and appeals to many different learning styles (Pyle, 2008).

Pyle (2008) categorizes inquiry into four levels, each with increased complexity, which teachers must consider when planning instruction. The categories range from the most simple level one, in which students are confirming already known information, to the most complex, level four, in which students are generating questions, implementing testing measures, and drawing conclusions. Students should progress gradually from a lower level of inquiry to a higher level throughout the year (Pyle, 2008).

Structured Inquiry

In structured or directed inquiry, students follow specific directions to arrive at a conclusion. This is the simplest form of inquiry instruction and is sometimes referred to as “cookbook” inquiry. Because students are not authentically engaged in inquiry, some educators do not consider structured inquiry a true form of inquiry. However, this is a great beginning for students or teachers who are new to using inquiry-teaching methods. It also allows the teacher to model inquiry techniques that students can use as the amount of inquiry is gradually increased (Martin-Hansen, 2002).

Guided Inquiry

Guided inquiry instruction is the most frequently used form of inquiry based science instruction. In guided inquiry instruction, students are presented with one or more guiding questions to answer by performing experiments or activities. Often one broad conceptual question is presented, with several smaller questions leading to a conclusion in order to help guide students' explorations and thought processes. The inquiry often proceeds in cycles of investigation concurrently or over several days. Each cycle may have several phases such as engage, investigate, explain, and report. Ideally, the investigations are authentic and allow students to develop a deep understanding of science concepts through higher-order thinking (Palincsar, Collins, Cutter, & Magnusson, 2001).

In guided inquiry, the teacher develops investigations for the students by choosing a central question to be answered. The students then help the teacher decide how to best answer the question and proceed with the investigation. Guided inquiry is often used as a progression to open or coupled inquiry as it teaches the students the inquiry process (Martin-Hansen, 2002).

Open or Full Inquiry

Open or full inquiry is the most complex form of inquiry instruction. It is a student centered approach that requires the students to formulate a question, design and implement an investigation, and justify the results. Full inquiry is most commonly used for science fair projects. Because of its complexity and time intensive nature, full inquiry is not frequently used in most classrooms. However, full inquiry has the greatest effect on student learning as it requires very high levels of thinking (Martin-Hansen, 2002).

Coupled Inquiry

Coupled inquiry is a combination of guided inquiry and open inquiry. The teacher begins by selecting a question based on specific content that is to be covered. The teacher may present the students with an experiment of observation or scientific phenomenon. After setting the topic and path students are to take, a more open inquiry investigation begins in which students decide how to investigate and answer the original question and topic. After reaching an explanation, students must justify and explain their results to the class (Martin-Hansen, 2002).

Coupled inquiry is effective because it allows the teacher to ensure that specific science concepts are being explored, as mandated by school and state curriculum, yet it still allows for the high levels of thinking to occur that are characteristic of an open inquiry investigation. This also allows students to connect abstract science concepts to their concrete experiences (Martin-Hansen, L., 2002).

Philosophy Behind Inquiry-Based Science

Inquiry-based science instruction is largely centered on the theory of constructivism. Constructivism is a learning theory based on the premise that humans gain additional knowledge and meaning through life experiences. When the theory of constructivism is applied to an educational setting, it is believed that the teacher must assume the role of a facilitator of knowledge and the student must take an active, rather than passive, role in his or her own learning. This shift from teacher to facilitator can be difficult for some teachers (Esler & Esler, 2001).

The constructivist theory is based on the works of Piaget, Dewey, Vygotsky, and others. Jean Piaget theorized that individuals construct new meaning from their experiences through accommodation and assimilation. John

Dewey believed human development occurs when people are confronted with real world situations to solve. He believed that the best activities are those that engage the learner in problems that have real world value. Vygotsky believed that teachers should act as mentors to guide students through their own zone of proximal development and that each child develops at his or her own pace (Esler & Esler, 2001).

Others believe that inquiry-based instruction and the constructivist theory are not the best way to educate students. Some point to the fact that inquiry-based learning theories have been around for decades and there has been little improvement in student achievement scores. Kirschner, Sweller, & Clark (2006) state:

> Even for students with considerable prior knowledge, strong guidance while learning is most often found to be equally effective as unguided approaches. Not only is unguided instruction normally less effective, there is also evidence that it may have negative results when students acquire misconceptions or incomplete or disorganized knowledge. (p. 84)

Proponents of inquiry-based instruction claim that criticism should not be placed on the method itself, but rather on how teachers implement it. Many teachers are unfamiliar with inquiry-based instruction or are reluctant to try something new. Teachers also face time constrains, a lack of professional development, and a lack of resources (Esler & Esler, 2001).

Based on the constructivist theory, the National Research Commission developed a set of standards and assessment processes for K-12 science programs in 1996. The National Science Education Standards provide a set of goals for students, teachers, and administrators. The standards are organized into six categories:

- Standards for science teaching;
- Standards for professional development for science teachers;
- Standards for assessment of science education;
- Standards for science content;
- Standards for science education programs; and
- Standards for science education systems.

Teaching science as inquiry is discussed in standard one, standards for science teaching, and is considered an essential component of high quality professional development. The standards have been used by many states, including Mississippi, to develop their science curriculum and develop standardized assessments (Esler & Esler, 2001).

Why Is Inquiry-Based Instruction Needed?

The competitiveness and educational ranking of United States students with other world counterparts has been a focus of the educational realm for the past 20 years. The United States is in direct competition with other countries to develop the technologies of tomorrow. As the quantity and quality of scientists being educated in foreign countries is steadily increasing, a well-educated workforce is essential for the United States to remain the leader of the free world because our students must be able to outpace international students (Gordon, 2007).

Unfortunately, many sources indicate that the United States is losing ground to our international counterparts. Recent reports from the National Assessment of Educational Progress (NAEP) continue to show United States students faring poorly in science, and other subjects, when compared to students from other developed countries. NAEP ranks students into one of three categories: basic, proficient, and advanced. Students from across the United States are assessed in grades 4, 8, and 12. The science scores of U.S. students in grades 4 and 8 did not change between 1996 and 2000 while grade 12 scores declined. Only about one-third of students scored at or above the proficient level in 2000 (Gordon, 2007).

Is Inquiry Based Science Instruction Effective?

Children are naturally inquisitive and therefore, science taught though inquiry is highly effective. Too often, however, teachers focus heavily on teaching scientific facts rather than allowing students to explore the world around them. Elementary science instruction should be more about allowing students to investigate their surroundings in order to conceptualize their world and less about right or wrong answers (Martin, Sigur, & Schmidt, 2005).

The National Science Education Standards suggest that students in all science courses should engage in scientific inquiry in order to develop higher order critical thinking and reasoning skills. Research has shown that students who are in a high-quality science program dramatically improve in writing and mathematics also. One study found a 70% increase in students' writing scores who were in an inquiry based science classroom versus students who received traditional science instruction (Amarah, Garrison, & Klentschy, 2002).

In addition to increasing language, math, social studies, and writing skills, Eisler and Eisler (2001) connect the following benefits to inquiry-based science programs:

- Enhances the I.Q. scores;
- Increases listening skills;
- Develops logical thinking;
- Enhances student curiosity; and
- Improves students' attitude toward school, science, and learning. (p. 7)

Booth (2001) designed an experiment in which students were divided into two groups with one group completing an inquiry-based lab and the other completing a traditional, systematic "cookbook" type lab. The objectives for each lab were the same. After completing the labs, the students were given a short assessment. To the surprise of the instructors, the group completing the inquiry-based lab had an average quiz score of 55% while the other group had an average quiz score of 62%.

Despite having anticipated that the quiz scores of the inquiry-based group would be significantly higher, Booth (2001) acknowledged that the students were used to performing the "cookbook" style labs and not inquiry-based labs. He also noted that many students complained of having to "think" during the inquiry-based labs. Therefore, he believes that higher levels of thinking occurred in the inquiry-based group. He also notes that he overheard many in-depth conversations among students during the inquiry-based lab experiment (Booth, 2001).

Booth (2001) also surveyed the students participating in his experiment to discover if they felt they had learned more by completing the inquiry-based lab as opposed to the traditional lab exercise. The results indicated that 57% of students felt they had learned more, while 43% felt they had not learned more by completing the inquiry-based experiment. The survey also asked the students if they would prefer more inquiry-based labs as opposed to traditional labs with the following results: 46% stated yes; 36% stated no; 12% stated some of the time; and 6% stated that they did not care. Due to the high level of student interest and enthusiasm about inquiry-based labs, Booth concluded that they were worth investigating further (Booth, 2001).

The third phase of Booth's (2001) experiment sought to determine how often teachers at his school used inquiry-based labs. The teachers completed a brief questionnaire with the following results: none said *almost always*, three said *often*, two responded *not very often*, eight chose *sometimes*, and one said *never*. The teachers were also asked if they felt their students learned more by completing inquiry-based labs; 86% responded *yes*. Many teachers complained of a lack of time to implement inquiry-based labs into their instruction. Others did not believe that students would learn content needed to successfully complete the state science exams by completing inquiry-based labs. Booth (2001) notes, however, that the vast majority of his colleagues strongly support inquiry-based learning and feel that it should become more common in the future as it will greatly benefit students it the long run.

There is no doubt that inquiry-based instruction is more complex than traditional science classroom instruction as students are required to gain a deeper understanding of science concepts. One might conclude that students with learning and mental disabilities would not be very successful in an inquiry-based classroom, however, research on inquiry-based learning suggests otherwise. Studies suggest that inquiry based science instruction is also beneficial to students with disabilities (Palincsar et al., 2001).

Mastropieri, Scruggs, Boon, and Carter (2001) have studied the benefits of a constructivist approach to science instruction for several years. They report that, despite a great increase in support for inquiry based science instruction, many educators do not consider the dramatic positive effects it can have on students with disabilities. After studying students with mental disabilities and mild retardation for two years in an inquiry based science classroom, researchers found a remarkable increase in cognitive processes, the ability to manipulate materials, and the ability to draw precise inferences and conclusions (Mastropieri, Scruggs, Boon, & Carter, 2001).

Much like regular education students, students with disabilities initially required intensive coaching from teachers. Over time, the amount of direct coaching was decreased as student learning continued to increase. This study found that students who actively reasoned through science content with inquiry-based instruction outperformed students who received traditional direct instruction in both recall and comprehension (Mastropieri et al., 2001).

A classroom of middle school students with mental and behavioral disabilities was also studied. The students performed much better on units that included inquiry based activities as compared to units that consisted of traditional textbook and workbook instruction. Similar studies have been replicated in a number of different classroom environments with positive outcomes being reported for students with disabilities in each situation as inquiry based activities were introduced (Mastropieri et al., 2001).

In a recent study, 75 elementary students were selected to examine the effects of inquiry based science instruction on comprehension. Of the 75 students, 24 were regular education students with the remainder having varying degrees of common mental disabilities, such as mental retardation and autism. The students' math and reading achievement scores were used as predictors with the disabled students performing far below the regular education students on standardized tests (Mastropieri et al., 2001).

The students completed an active inquiry based science lesson regarding the buoyancy of oil in water by working one-on-one with one of the researchers. Before beginning the experiment, the students first predicted what they thought would happen. The researchers guided the students through the experiment using a script, all students were asked the same three questions, and student responses were recorded verbatim to eliminate any error in the procedure (Mastropieri et al., 2001).

The results were analyzed using Pearson r. It was found that achievement on standardized math and reading test scores were not predictive of learning in this activity. Instead, IQ appeared to be the strongest predictor of learning outcomes. Disabled students with IQs above 80 performed similar to regular education students with an average IQ. Disabled students with an IQ of less than 80 performed much lower than the other two groups (Mastropieri et al., 2001).

The current inclusion trend of placing students with mental disabilities in regular education classrooms can cause concern for educators who frequently do not know how to accommodate these students' needs. The findings in this study suggest that most mentally disabled students can perform at or near the same cognitive levels as regular education students when constructivist approaches, such as inquiry based science, are implemented into classroom instruction (Mastropieri et al., 2001).

The number of students for whom English is a second language being educated in our schools has doubled in the past decade and continues to climb to new levels. This has brought a new challenge to the education field in all subject areas including science. These culturally and economically diverse students are at a great disadvantage, as they must learn content and a new language concurrently. Traditional instructional strategies assume that English proficiency is a prerequisite to content knowledge. Incorporating a constructivist approach to learning, such as inquiry, allows English language learners to move past the language barrier and gain conceptual knowledge in the subject matter. This increases the interest and motivation of English language learners, which can lead to higher achievement, greater confidence, and lower dropout rates (Gibbons, 2008).

Imperial Valley School District in Southern California began an initiative to increase student achievement on the state science assessment. In this district, 81.5% of students are Latino and English is a second language for 46.7% of all students. Like many educators, the district believed that the language barrier could be overcome with the use of interactive inquiry-based science lessons. Called VIPS (Valley Imperial Project in Science), the school district developed a kit based science curriculum centered on inquiry based activities (Amarah, Garrison, & Klentschy, 2002).

Several years after implementing VIPS, a study was conducted to determine the impact of the program on English language learners. Students were divided into groups based on the number of years they had spent in the program and their level of English proficiency. The results showed that the longer students in all categories were involved in the program, the higher their level of achievement on standardized state science assessments. Students in grade 6 also saw a proportionate increase in standardized writing, reading, and math assessment scores in relation to the number of years spent in the VIPS program (Amarah et al., 2002).

Inquiry-based science instruction allows English language learners to discover the English language in context. The process of inquiry requires students to describe, hypothesize, and explain scientific content while linking language to objects, processes, and naturally occurring events. Students can use various forms of communication, such as writing, speaking, and using tables or graphs, to explicate their findings. Therefore, students are learning both science concepts and the English language concurrently. English language learners do not have to master English before they can learn science. Integrating science and language also promotes higher order thinking skills (Stoddart, Pinal, Latzke, & Canaday, 2002).

Implementing Inquiry-Based Science Instruction

The National Science Education Standards (1996) provide the following six standards (A-F) for teaching science through inquiry:

- Standard A: Teachers of science plan an inquiry-based science program for their students;
- Standard B: Teachers of science guide and facilitate learning;
- Standard C: Teachers of science engage in ongoing assessment of their teaching and of student learning;
- Standard D: Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science;
- Standard E: Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to learning science; and
- Standard F: Teachers of science actively participate in the ongoing planning and development of the school science program.

(pp. 30-51)

The council thoroughly describes each standard with examples given on effectively implementing them into classroom instruction. They are designed to apply to all students equally and provide criteria for educational science reform. The council cautions that the teaching standards are just one component of the larger science educational arena and that it will take changes in all areas to bring about better science education for our students (National Research Council, 1996).

Fradd, Lee, Sutman, and Saxton (2002) found that the key to increasing inquiry-based instruction is better professional development and support for teachers. They also state that, frequently, good activities are thought to be inquiry based, but actually are not. They hope to enable teachers to implement some level of inquiry into their instruction with varying levels of guidance (Fradd, Lee, Sutman, & Saxton, 2002).

In an effort to demystify the process, they developed a matrix dividing inquiry into six categories: questioning, planning, implementing, concluding, reporting, and applying. The use of these six categories determines the level (1-7) of inquiry. The students take more control of the activity as they progress through the six categories and seven levels, while the teacher becomes less of the focus and more of a facilitator. The more students are involved, the more inquiry is taking place, and thus students take control of their own learning process, requiring higher order thinking skills (Fradd et al., 2002).

Often educators question if an activity is an inquiry based activity or not and if so, how much? Esler and Esler (2001) state:

> to recognize teaching by inquiry, ask yourself two questions: Are the children required to go beyond the given information to gain new insights? Are the children problem solving—looking for answers or generalizations original to them? If the answer to both questions is yes, then regardless of the activity, the class can be said to be involved in an inquiry lesson. (p. 36)

To better help teachers design and classify inquiry-based lessons, Esler and Esler (2001) categorize learning activities into one of three categories: the rational approach, the discovery approach, and the experimental approach. All three approaches can be adapted to fit any grade level and science competency (Esler & Esler, 2001).

In the rational approach to science instruction, the teacher will present a phenomenon to students using manipulatives through a demonstration or hands-on activity. These are activities, also known as discrepant events, serve to get the students' attention and motivate learning. The teacher then guides the students through a series of questions to explain the event until the students arrive at a scientific explanation, thus explaining a science concept (Esler & Esler, 2001).

The key to successfully implementing an inquiry activity using the rational approach is questioning. The teacher must ask questions that guide students toward the desired conceptual understanding without giving away answers. The teacher must also allow sufficient wait time for student responses. The more frequently this approach is used in a classroom, the more comfortable and responsive students will become, as they understand their role in the learning process (Esler & Esler, 2001).

In a discovery approach to science inquiry, the teacher provides the students with materials and offers no instructions other than safety guidelines and how to handle the materials with care. Each student or group of students may investigate different problems as they learn at their own pace. The teacher moves about the room acting as an advisor to the students, helping them organize their thoughts, and probing them to answer conceptual questions about their investigation (Esler & Esler, 2001).

When no guidance is given, this approach is referred to as pure discovery. Some teachers may initially use guided discovery in which they ask general questions as the students are working to steer them in the correct direction without limiting their freedom. The amount of time and resources available and the level of students often determine the use and effectiveness of discovery inquiry (Esler & Esler, 2001).

Some teachers are hesitant to implement discover inquiry because they fear losing control of classroom discipline. While there is certain to be noise and movement, most students can be trained in working through discovery inquiry. It is best to start by assigning each group member a role in the group and reviewing rules and procedures during the first few experiences (Esler & Esler, 2001).

It is best to end discovery inquiry lessons by allowing the students or groups of students to share their findings with the class. They should also explain how they arrived at their conclusion. This can be guided with questions from the teacher. This process also benefits children's' social and language skills (Esler & Esler, 2001).

The third approach to inquiry instruction is the experimental approach. In this approach the teacher or the students develops a hypothesis and performs experiments to discover its accuracy. This method closely follows the work of actual scientists as experimentation should follow a plan (Esler & Esler, 2001).

It is important to select a topic or problem that is interesting to the students to increase motivation. After developing a hypothesis, this approach closely follows the scientific method as students test hypotheses, control variables, experiment, control and interpret data, and draw conclusions. It is also common to share the results of student findings with the class (Esler & Esler, 2001).

Another technique suggested for teachers new to implementing inquiry-based lessons is to use the scaffolding technique. This technique incrementally applies various levels of inquiry to each lesson to fit the needs of the students and teacher. This helps the classroom culture transition gradually from highly structured and teacher centered to less structure with student directed inquiry (Eick, Meadows, & Balkcom, 2005).

The scaffolding technique divides inquiry into four levels, each with increasing levels of student directed inquiry. In level one, the teacher directs the students' inquiry through questioning and supplying data. This allows the students to practice interpreting real data in order to evaluate its meaning. In level two, the teacher provides a scientific demonstration with a focusing question. Students are then asked to explain why the phenomenon occurred using science concepts. Students may also be asked to record or analyze data related to the phenomenon in order to justify their explanation. This final step reinforces critical thinking skills and connects science facts with evidence (Eick et al., 2005).

Level three of the scaffolding technique couples teacher led demonstrations with student explanations. The teacher should begin with a demonstration and then ask the students to research scientific literature in order to explain the phenomenon. Students are then asked to test their explanations using science materials. Next, students share their findings with the class and justify their explanation. This requires students to evaluate scientific explanations by connecting them to scientific knowledge. It also allows them to assume the role of a scientist (Eick et al., 2005).

The fourth level of the scaffolding technique is completely student led. Students develop the question(s) to be answered, methods for exploring them, and generate data for analysis. This high critical thinking level requires students to communicate and justify their explanations. Although very challenging, this level of inquiry requires extra time to complete and therefore is often never reached in the classroom. The most common type of level four inquiries is science fair projects. It is reported that students who have had experience with inquiry in classroom activities are more successful in science fair competitions (Eick et al., 2005).

In order to teach inquiry-based science effectively, teachers must possess science content skills, assessment skills, and the ability to guide students through their own learning processes. Collaboration among teachers has proven to be an effective method of obtaining these skills, and therefore improving science instruction. Administrators can support collaboration among faculty by developing professional development groups in which science teachers are allotted time to meet with colleagues to share ideas, lessons, and best practices techniques (Anderson, 2002).

Challenges to Implementing Inquiry-Based Instruction

Although inquiry is a relatively new addition to the Mississippi science curriculum, the *National Science Education Standards* have called for increased inquiry instruction for over a decade (National Research Council, 1996). Still, studies show that many have little knowledge of what inquiry instruction is, are reluctant to implement it into their classrooms, and are inadequately prepared in both science content and experiences to effectively implement inquiry-based instruction into their practice. The main reason cited for a lack of inquiry-based learning is that it is often neglected in teacher college programs, receives little professional development, and is not stressed or supported by administrators (Johnson, 2006).

Content

Teaching through inquiry science instruction is not only more challenging for the students, but also for the teacher. Teachers must be able to create or find the type of powerful and meaningful activities that will keep students engaged and ensure learning. They must also be very familiar with the content themselves and be able to identify their students' thought processes. Finally, teachers must assess student progress and ensure that they are progressing towards the goals and objectives of the curriculum (Palincsar et al., 2001).

Research shows that a teacher's content and pedagogical knowledge has a tremendous impact on teaching practice and classroom culture. Because inquiry based teaching requires higher levels of pedagogical knowledge, some teachers may find it difficult to implement into their classrooms. Most teachers, especially at the elementary level where a foundation of science concepts is built, are not science majors because teacher-training programs focus on best teaching practices in all subject areas. This limits their pedagogical content knowledge in science and forces some to learn to cope instead of teach effectively. Therefore, teachers with a high level of pedagogical background knowledge are more likely to implement inquiry-based instruction more effectively (Johnson, 2006).

Although typically thought of as a science skill, inquiry can be integrated into other content areas of the curriculum. Marzano, Pickering and Pollock (2001) suggest using inquiry to guide students through mathematical concepts or even the use of literary devices. Marzano, Pickering & Pollock (2001) offer the following outline could be used to engage students in inquiry:

1. Describe an observation.
2. Use theories or rules to explain the observation.

3. Develop a hypothesis to explain what would happen if the theories or rules were applied to the observation.
4. Experiment to test the hypothesis by applying the theory or rule to the observation.
5. Explain the results of the experiment including the accuracy of the hypothesis.

Time

Teaching through inquiry can be very time consuming. Often these time consuming but effective teaching techniques are acknowledged but not practiced due to time constraints. After observing several classrooms of varying achievement levels throughout Arizona, Manly (2008) concludes the following:

> Faced with a standardized test–oriented climate in many schools, it is hard to have the courage, conscience, and character to stand up to school administrators and fight for sharing what we know are the best pedagogical practices (inquiry) for preparing children for their future as science-savvy citizens. (p. 36)

Administrative Support

Another barrier to implementing inquiry-based instruction is a lack of school and/or district level support and leadership. Schools that value science and support reform are difficult to find. Many schools also do not provide the resources and preparation time required for effective inquiry-based instruction. Effective science instruction requires a plethora of educational resources such as scales, consumable supplies, curriculum materials, and other equipment.

Teachers often go without these vital resources. These issues lead to frustrated teachers and ultimately affect student achievement (Johnson, 2006).

Teacher Culture

One of the most difficult hindrances to change is teacher culture. Teacher beliefs about how students learn best are a key factor in the type of instructional practices implemented. Inquiry-based learning conflicts with many traditional forms of instruction in which the teacher and a textbook are the sole providers of information. Some teachers may feel that their students do not have the cognitive or social ability for inquiry based learning. Others believe that drill and practice are the most effective teaching methods because that is what has always been done or that is how they learned in school (Johnson, 2006).

Another common misconception about inquiry-based learning is that it will not adequately prepare students for the next grade level. Standardized state assessments cause some teachers to completely focus on preparing for the next school year or the next state test. They may fear that implementing new instructional techniques will cause preparation to suffer (Johnson, 2006).

Professional Development

Several reasons for not implementing inquiry based science instruction are frequently given. At the top of the list of reasons teachers often do not use inquiry are confusion about the meaning of inquiry, a belief that only high-achieving students are capable of inquiry, and inquiry-based activities being too difficult to manage. However, the most frequent deterrent of inquiry-based instruction is a lack of effective professional development (Colburn, 2000).

The *National Science Education Standards* (National Research Council, 1996) provides guidance on professional development for science teachers. The standards are designed as criteria for judging the quality of professional development programs. The standards premise that professional development should be an ongoing, lifelong process for all teachers (National Research Council, 1996).

There are four (A-D) standards for professional development of science teachers:

- Standard A: Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry;
- Standard B: Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching;
- Standard C: Professional development for teachers of science requires building understanding and ability for lifelong learning; and
- Standard D: Professional development programs for teachers of science must be coherent and integrated. (National Research Council, 1996, pp. 59-70)

In general, there are far fewer professional development opportunities on inquiry based science instruction available as compared to other instructional techniques. Often, professional development that is offered is not highly effective.

Research shows that professional development of less than 80 hours is not effective in creating a change in teaching practices. The amount of time spent in professional development courses is directly related to the use of new instructional techniques in the classroom. Effective professional development also requires multiple opportunities to acquire new skills. One-day workshops often do not address teacher needs (Johnson, 2006).

If our students are to perform at higher levels of thinking, as mandated by state and national standards, then professional development is the key to achieving those goals. Without effective training, many teachers are not equipped to teach at these higher levels because they learned to teach in a time when memorization of facts was emphasized. Many studies have been conducted to determine the essential characteristics of effective professional development. Several studies suggest that the duration of professional development experiences is directly related to the amount of teacher change. However, other studies suggest that professional development that focuses on specific science content is more effective in improving students' conceptual understanding and achievement (Garet, Porter, Desimone, Birman, & Yoon, 2001).

A study was conducted that focused on the aspects of best practice in professional development. These included form, duration, content, and active learning opportunities. The results of this study indicate that sustained and intensive professional development has a greater impact than shorter sessions of professional development as reported by teachers. They also report that professional development that focuses on hands-on activities and content is more likely to produce results (Garet et al., 2001).

One resource of professional development can be collaborating local universities with K-12 schools. The Texas Christian University at Fort Worth designed a program of inquiry based professional development courses for local teachers. They began by asking teachers what kinds of professional development would benefit them most. The teachers overwhelmingly indicated that short, topic specific workshops were the most beneficial as opposed to lengthy, time-consuming workshops (Kelly & Weiss, 2005).

The university designed their program around these requests and now offers 18 to 36 workshops each year. Just as requested by teachers, the workshops last approximately two hours and focus on various science topics. In the workshops, teachers act as the students by performing inquiry based science lessons. This method of professional development allows the teachers to experience firsthand the thinking processes that each activity requires of their students. In a follow up survey, 76% of teachers who participated in the workshops said they had carried workshop content into their own classrooms (Kelly & Weiss, 2005).

Conclusion

Well-structured and effective inquiry instruction requires time, professional development, and support. However, the benefits include higher achievement in all subject areas, increased higher-order thinking skills, and increased attitudes towards science and learning. There are many other ways to teach science, however inquiry forms an important foundation for science learning (Ohana, 2006).

CHAPTER III

METHODOLOGY

Overview

For this study, the researcher surveyed 204 teachers at 33 schools in four school districts located along the Mississippi Gulf Coast. The purpose of this study is to determine the relationship between the amounts of time spent using inquiry-based science instruction and student achievement as measured by scores on the Mississippi State Science Assessment. This study also determined teacher perceptions of inquiry-based science instruction. In addition, this study identified challenges teachers face when implementing inquiry-based science instruction and if they felt adequately trained in using this instructional technique.

Data was gathered using a written survey (Appendix A) created by the researcher. The surveys included a cover letter (Appendix B) with instructions for the participants. Superintendent approval (Appendix C) was requested prior to distribution, as was permission from The University of Southern Mississippi Institutional Review Board (Appendix D). The researcher distributed the surveys and cover letters with instructions to return completed surveys to each school's secretary. The surveys required approximately ten minutes to complete and were collected by the researcher approximately one week after distribution. The data from the surveys was then analyzed to determine results.

Research Design

The dependent variables in this study are each school's average score on the Mississippi State Science Assessment administered in March 2010. The independent variables are each school's average amount of time spent using inquiry-based science instruction as indicated by teacher responses on the written survey.

The data was also used to identify teacher perceptions of inquiry-based science instruction. Factors inhibiting the use of inquiry-based science instruction and the level of professional development teachers have received were also identified by the data.

Participants

The participants of this study were K-8 teachers at 33 schools in four different school districts located along the Mississippi Gulf Coast. School administrators distributed the cover letter and written survey to each participant. The participants were given approximately one week to complete the surveys and return them to their school secretary or other designated individual. The researcher then collect the surveys from each school.

Instrumentation

The written survey instrument consisted of twenty-four items. Seven items collected status and demographic data. One categorical item determined the amounts of time spent using inquiry-based science instruction. The remaining sixteen questions used a Likert scale ranging from 1 to 5 to determine the level of agreement or disagreement that each teacher had for each statement. A rating of 1 identified the teacher's *disagree* status while a rating of 5 identified statements in which the teacher held an *agree* status.

The instrument is divided into four subgroups. Question 8 identified the amounts of time that each teacher used inquiry-based science instruction. Questions 9, 14, 15, 18, 19, and 24 indicated each teacher's perception of inquiry-based science instruction. Factors hindering the use of inquiry-based science instruction were identified by questions 11, 12, 13, 16, 17, 22, and 23. Finally, professional development was addressed by questions 10, 20, and 21.

A panel of experts reviewed the written survey designed by the researcher. This panel included a science curriculum instructional strategist and three school administrators. Upon approval of the instrument, it was used to: (a) collect data in order to analyze the relationship between the amounts of time spent using inquiry-based science instruction and student achievements on the Mississippi State Science Assessment, teacher perceptions of inquiry-based science instruction; (b) determine teacher perceptions of inquiry-based science instruction; (c) identify factors that hinder the use of inquiry-based science instruction; and (d) determine if teachers felt adequately trained in using inquiry-based science instruction.

A pilot study was conducted with a group of teachers to identify any directions, questions, or answer choices that are unclear or misleading. Data collected from the pilot study was analyzed using a Cronbach's alpha analysis to determine the reliability of the instrument. A reliability score of .805 was reached, indicating appropriate reliability.

Each schools average amount of time spent using inquiry-based science instruction, as indicated by the average teacher response on the written questionnaire, was compared to the school's average score on the Mississippi State Science Assessment to determine a relationship between inquiry-based instruction and student achievement. The Mississippi State Science Assessments are criterion-referenced assessments administered in grades 5 and 8 each spring. A committee of Mississippi teachers chosen by the Mississippi Department of Education designed the assessments. They are completely aligned with the Mississippi Science Curriculum and allow fulfill the requirements of the No Child Left Behind Act. The data gathered from these assessments is used to improve student achievement and factor into each school's rating under Mississippi's School Accountability System (Mississippi Department of Education, 2004).

Procedures

After receiving each superintendent's approval and support through written communication, the researcher delivered the written surveys to each school's principal. The surveys contained a cover letter explaining the purpose of the study to the participants and thanking them for their voluntary participation. The cover letters also included instructions directing the participants to complete and return the surveys to their school secretary or other designated person within one week. Each survey was placed in a sealed envelope and remained anonymous.

After approximately one week, the researcher returned to each school to collect the surveys from the secretary. The data was then entered into SPSS and analyzed to determine results.

Data Analysis

After the organized collection of data, the researcher used SPSS to analyze the results of the teacher survey. Results from the participants were divided into two groups according to the grade level they teach, K-5 and 6-8.The Mississippi State Science Assessment is administered only to students in grades 5 and 8. The 5th grade assessment is cumulative of grades K-5, while the 8th grade assessment is cumulative of grades 6-8. Therefore, teacher responses from grades K-5 were analyzed with the 5th grade science assessment and teacher responses from grades 6-8 were analyzed with the 8th grade science assessment.

This quantitative study tested the following research questions and hypothesis:

1. Is there a relationship between the amounts of time spent using inquiry-based science instruction and student achievement?

Hypothesis: There is a relationship between the amount of time spent using inquiry-based science instruction and student achievement.

This hypothesis was explored through the use of a Spearman rho Correlation test. The purpose of this procedure was to analyze the relationship between the amounts of time spent using inquiry-based science instruction and student achievement on the Mississippi State Science Assessment using standardized test scores for the 2009-2010 school year. An alpha value of .05 was used.

The following questions were analyzed using frequency, mean, and standard deviation tables in SPSS to determine the number of teachers who agreed or disagreed with the statements concerning these research questions found on the survey instrument:

2. What are teachers’ perceptions of inquiry-based science instruction?
3. Do teachers feel adequately trained in using inquiry-based science instructional techniques?
4. What challenges most hinder the use of inquiry-based science instruction?

CHAPTER IV

ANALYSIS OF DATA

Introduction

This chapter provides descriptive, statistical and ancillary findings from the completed study. In order to complete the study, the researcher distributed approximately 400 surveys to K-8 science teachers in four school districts along the Mississippi Gulf Coast. Two-hundred four responded by completing the surveys, for a return rate of 51%. An introductory statement was included on the survey defining inquiry-based science instruction for the purpose of this study.

Descriptive Statistics

The group of participants included 160 elementary teachers in grades K-5 and 44 science teachers in grades 6-8. Participants included a majority of Caucasians. Females made up the majority of participants at 97.1%. The majority of participants were between the ages of 41-50 and had 5-10 years of experience.

Participants were employed at 30 schools along the Mississippi Gulf Coast. Being that the Mississippi Science Assessment is cumulative, but only administered in grades 5 and 8, schools consisting of only non-tested grade levels were included in data from the corresponding tested school. The majority of classes were between 21-25 students. See Table 1 for complete demographic information.

Table 1

Characteristics of Participants

Variable	n	%
Grade Level		
K	22	10.8
1	26	12.7
2	26	12.7
3	44	21.6
4	25	12.3
5	17	8.3
6	16	7.8
7	16	7.8
8	12	5.9
Race		
Caucasian	188	92.2
African American	12	5.9
Asian	1	0.5
Native American	2	1.0
Other	1	0.5
Class Size		
11-15	7	3.4

Table 1 (continued).

Variable	n	%
16-20	44	21.6
21-25	117	57.4
>25	36	17.6
Years of Experience		
<5	38	18.6
5-10	54	26.5
11-15	38	18.6
15-20	31	15.2
20-25	26	12.7
>25	17	8.3
Age		
21-30	32	15.7
31-40	63	30.9
41-50	66	32.4
>50	43	21.1

As part of this study, participants were asked how often they used inquiry-based science instruction in their classroom. The majority (33%) indicated they used inquiry at least once per week. This data was compared to scores from the

Mississippi Science Assessment to answer hypothesis 1. See Table 2 for complete data.

Table 2

Inquiry Usage

Variable	n	%
Daily	15	7.4
At least once a week	69	33.8
At least once a month	49	24.0
A few times a year	36	17.6
Rarely	24	11.8
Never	11	5.4

Following the demographics section, the participants were asked 11 questions on a Likert-type scale of 1-5, with 1 indicating disagreement with the statement, and 5 indicating agreement with the statement. These questions asked the participants about their perceptions regarding inquiry-based science instruction, factors that limited its usage in their classroom instruction, and professional development they may have received on inquiry-based science instruction. See Table 3 for frequencies regarding each of the 11 Likert-type questions on the survey instrument.

Table 3

Frequencies of Likert-Type Questions

Variable	n	%
Question 9–Inquiry is Important for Students		
Disagree	1	0.5
Somewhat Disagree	5	2.5
Neither Agree nor Disagree	21	10.3
Somewhat Agree	61	29.9
Agree	116	56.9
Question 10-Comfortable and Confident Implementing Inquiry		
Disagree	7	3.4
Somewhat Disagree	22	10.8
Neither Agree nor Disagree	35	17.2
Somewhat Agree	69	33.8
Agree	71	34.8
Question 11-Not Enough Materials for Inquiry		
Disagree	62	30.4
Somewhat Disagree	82	40.2
Neither Agree nor Disagree	22	10.8
Somewhat Agree	22	10.8
Agree	16	7.8

Table 3 (continued).

Variable	n	%
Question 12-Inquiry is Too Time Consuming		
Disagree	20	9.8
Somewhat Disagree	51	25.0
Neither Agree nor Disagree	64	31.4
Somewhat Agree	35	17.2
Agree	34	16.7
Question 13-Administrators Actively Support Using Inquiry		
Disagree	8	3.9
Somewhat Disagree	12	5.9
Neither Agree nor Disagree	69	33.8
Somewhat Agree	49	24.0
Agree	66	32.4
Question 14-Students Learn Best Through Inquiry		
Disagree	0	0
Somewhat Disagree	8	3.9
Neither Agree nor Disagree	53	26
Somewhat Agree	82	40.2
Agree	61	29.9

Table 3 (continued).

Variable	n	%
Question 15-Inquiry Prepares Students for State Assessments		
Disagree	1	0.5
Somewhat Disagree	11	5.4
Neither Agree nor Disagree	72	35.3
Somewhat Agree	60	29.4
Agree	60	29.4
Question 16-Most Students are Cognitively & Socially Able to Learn through Inquiry		
Disagree	7	3.4
Somewhat Disagree	27	13.2
Neither Agree nor Disagree	39	19.1
Somewhat Agree	89	43.6
Agree	42	20.6
Question 17-Inquiry is Difficult to Manage		
Disagree	14	6.9
Somewhat Disagree	63	30.9
Neither Agree nor Disagree	56	27.5
Somewhat Agree	32	15.7
Agree	39	19.1

Table 3 (continued).

Variable	n	%
Question 18-I Enjoy Using Inquiry		
Disagree	2	1.0
Somewhat Disagree	8	3.9
Neither Agree nor Disagree	44	21.6
Somewhat Agree	81	39.7
Agree	69	33.8
Question 19-I Am Intimidated by Using Inquiry		
Disagree	4	2.0
Somewhat Disagree	32	15.7
Neither Agree nor Disagree	51	25.0
Somewhat Agree	48	23.5
Agree	69	33.8
Question 20-I Would Like More Professional Development on Using Inquiry		
Disagree	6	2.9
Somewhat Disagree	15	7.4
Neither Agree nor Disagree	41	20.1
Somewhat Agree	65	31.9
Agree	77	37.7

Table 3 (continued).

Variable	n	%
Question 21-I Have Attended Professional Development on Using Inquiry		
Disagree	85	41.7
Somewhat Disagree	21	10.3
Neither Agree nor Disagree	18	8.8
Somewhat Agree	30	14.7
Agree	50	24.5
Question 22-Collaborating with Peers Helps with Implementing Inquiry		
Disagree	15	7.4
Somewhat Disagree	9	4.4
Neither Agree nor Disagree	57	27.9
Somewhat Agree	59	28.9
Agree	64	31.4
Question 23-I Am Familiar with the Different Types and Levels of Inquiry		
Disagree	32	15.7
Somewhat Disagree	40	19.6
Neither Agree nor Disagree	33	16.2
Somewhat Agree	66	32.4
Agree	33	16.2

Table 3 (continued).

Variable	n	%
Question 24-Inquiry Can Benefit Students with Disabilities		
Disagree	2	1.0
Somewhat Disagree	2	1.0
Neither Agree nor Disagree	41	20.1
Somewhat Agree	71	34.8
Agree	88	43.1

A descriptive analysis was used to find the mean and standard deviation of each perception question on the survey. The results indicate that most participants enjoy using inquiry and feel that it benefits their students. A majority of participants also indicated they had not received professional development on using inquiry. Most indicated they would like more professional development on implementing this instruction technique. Table 4 displays descriptive information for each question.

Table 4

Descriptive Statistics for Likert-Scale Questions

Variable	Minimum	Maximum	Mean	SD
Question				
9-Importance	1.0	5.0	4.40	.81
10-Confident/Comfort	1.0	5.0	3.86	1.12
11-No Materials	1.0	5.0	3.75	1.22
12-Too Much Time	1.0	5.0	2.94	1.22
13-Admin. Support	1.0	5.0	3.75	1.09
14-Learn Best	2.0	5.0	3.96	.85
15-Prepares Students	1.0	5.0	3.82	.94
16-Able to Learn	1.0	5.0	3.65	1.06
17-Difficult to Manage	1.0	5.0	2.91	1.23
18-Enjoy Inquiry	1.0	5.0	4.01	.89
19-Intimidated by Inquiry	1.0	5.0	2.28	1.15
20-Need Prof. Dev.	1.0	5.0	3.94	1.07
21-Have Had Prof. Dev.	1.0	5.0	2.70	1.68
22-Collaboration	1.0	5.0	3.73	1.17
23- Types/Levels	1.0	5.0	3.14	1.34
24-Disabled Students	1.0	5.0	4.18	.86

A descriptive analysis was also used to determine the amount of time participants spend using inquiry-based science instruction. Table 5 displays this information.

Table 5

Descriptive Statistics for Inquiry Usage by Participants

Variable	n	Minimum	Maximum	Mean	SD
Inquiry	169	1.0	4.0	2.37	.918

A descriptive analysis was used to find the mean and standard deviation of test scores on the 2009-2010 Mississippi Science Assessment for each participating school. The results are grouped by grade level Table 6 displays this descriptive information.

Table 6

Mississippi Science Assessment

Variable	n	Minimum	Maximum	Mean	SD
K-5	169	551.00	557.00	562.89	6.09
6-8	35	855.00	868.00	861.31	3.38

Statistical Analysis

Hypothesis I

This hypothesis was explored through the use of a Spearman rho Correlation test to determine a relationship between the amounts of time spent using inquiry-based science instruction and student achievement as measured by the Mississippi State Science Assessment. In testing Hypothesis I, the Spearman rho Correlation found a significant positive relationship between the amounts of time spent using inquiry-based science instruction in grades K-8 and students achievement on the Mississippi State Science Assessment. Therefore, Hypothesis I was not rejected.

In order to test Hypothesis I, the researcher gathered the data from the surveys and organized it using SPSS for Windows, version 18. A Spearman rho Correlation test was used to determine a relationship between the amounts of time spent using inquiry-based instruction and student achievement scores on the Mississippi State Science Assessment.

Table 7 gives the results of the Spearman rho Correlation test for all grades K-8. Results were significant below the .05 level. With a positive correlation and a p-value of .042, there is a significant correlation between time spent using inquiry-based instruction and student scores.

Table 7

Spearman's rho Correlation Test-Time Spent Using Inquiry-Grades K-8

Variable (2-tailed)	N	Correlation Coefficient	Sig.
Standardized Test Scores	204	.156	.042

Data was also analyzed for the subgroups of grades K-5 and grades 6-8. Table 8 gives the results of the Spearman rho Correlation test for grades K-5. Results were significant below the .05 level. With a positive correlation and a p-value of .039, there is a significant correlation between time spent using inquiry-based instruction and student scores.

Table 8

Spearman's rho Correlation Test-Time Spent Using Inquiry-Grades K-5

Variable (2-tailed)	N	Correlation Coefficient	Sig.
Standardized Test Scores	160	.178	.039

Table 9 gives the results of the Spearman rho Correlation test for grades 6-8. Results were not significant at the .05 level. With a negative correlation and a p-value of .305, there is not a significant correlation between time spent using inquiry-based instruction and student scores at the 6-8 grade level.

Table 9

Spearman's rho Correlation Test-Time Spent Using Inquiry-Grades 6-8

Variable	N	Correlation Coefficient	Sig. (2-tailed)
Standardized Test Scores	35	-.179	.305

Ancillary Findings

Additional descriptive data was collected to determine teachers' perceptions of inquiry-based science instruction. Questions 9, 14, 15, 18, 19, and 24 measured teachers' perceptions of inquiry. Overall, teachers seemed to realize the importance of inquiry-based instruction in preparing their students for standardized science assessments and its ability to help students, including those with disabilities, grasp science concepts. About half of the participants were intimidated by using inquiry. Table 10 displays descriptive information for this group of questions.

Table 10

Teacher Perceptions of Inquiry

Variable	Minimum	Maximum	Mean	SD
Question				
9-Importance	1.0	5.0	4.40	.81
14-Learn Best	2.0	5.0	3.96	.85

Table 10 (continued).

Variable	Minimum	Maximum	Mean	SD
15-Prepares Students	1.0	5.0	3.82	.94
18-Enjoy Inquiry	1.0	5.0	4.01	.89
19-Intimidated by Inquiry	1.0	5.0	2.28	1.15
24-Disabled Students	1.0	5.0	4.18	.86

Questions 10, 20, and 21 targeted the level of professional development and understanding of inquiry of each participant. This data revealed that most teachers have not attended professional development sessions on inquiry-based instruction and were not familiar with the different types and levels of inquiry instruction. A majority of participants indicated that they would like to receive additional training on inquiry-based instructional methods. Table 11 provides descriptive data for these questions.

Table 11

Professional Development

Variable	Minimum	Maximum	Mean	SD
10-Confident/Comfort	1.0	5.0	3.86	1.12
20-Need Prof. Dev.	1.0	5.0	3.94	1.07
21-Have Had Prof. Dev.	1.0	5.0	2.70	1.68

Finally, questions 11, 12, 13, 16, 17, 22, and 23 gathered information on factors that most hinder the use of inquiry-based instruction. In general, teachers felt that their students were socially and cognitively able to learn through inquiry, and that collaborating with peers helped with implementing inquiry. Participants also indicated they received support from their school administrators, and time did not hinder the use of inquiry. However, participants indicated they did not have enough materials to effectively implement inquiry-based instructional activities in their classrooms. Table 12 provides descriptive data for these questions.

Table 12

Factors that Hinder Inquiry Usage

Variable	Minimum	Maximum	Mean	SD
11-No Materials	1.0	5.0	3.75	1.22
12-Too Much Time	1.0	5.0	2.94	1.22
13-Admin. Support	1.0	5.0	3.75	1.09
16-Able to Learn	1.0	5.0	3.65	1.06
17-Difficult to Manage	1.0	5.0	2.91	1.23
22-Collaboration	1.0	5.0	3.73	1.17
23- Types/Levels	1.0	5.0	3.14	1.34

CHAPTER V

SUMMARY

In this study, the researcher surveyed 204 teachers about their use of inquiry-based science instruction. The study's goal was to examine the relationship between the amount of time spent using inquiry-based instruction and student achievement as measured by the Mississippi State Science Assessment administered in grades 5 and 8. The survey also identified factors that hindered the use of inquiry instruction and teachers' perceptions of inquiry. Finally, the study identified the amount of professional development teachers had received on inquiry-based instruction.

Conclusions

The results of this study indicated a slightly positive relationship between the amounts of time spent using inquiry-based science instruction and student achievement. Using a scale of 1 to 4, with 1 being daily and 4 being never, teachers rated the frequency of their usage of inquiry-based instruction in their classrooms. A majority of teachers indicated they used inquiry-based instruction at least once per week in their classrooms.

Results from the study indicated a positive teacher perception of inquiry-based instruction. The majority of teachers indicated they enjoyed using inquiry in their classrooms. Teachers also believed that inquiry was important for their students' knowledge and helped prepare students for state standardized assessments. In addition to increasing language, math, social studies, and writing skills, Eisler and Eisler (2001) state that inquiry-based instruction also increases I.Q. scores, listening skills, logical thinking, student curiosity, and improved student attitude toward school, science, and learning. These findings support the related literature that inquiry-based instruction should be an integral part of all classroom instruction.

The most common factor hindering the use of inquiry-based instruction was a lack of materials. A large majority indicated they did not have the materials and resources necessary to conduct inquiry-based instruction in their classroom. This is especially true for elementary teachers who do not specialize in science and must share their limited school and personal funds for resources among all subject areas.

More than half of teachers indicated that inquiry-based instruction was too time consuming. A lack of time and materials support the findings of Palinscar et al. (2001) which state that teachers must be able to create or find the type of powerful and meaningful activities that will keep students engaged and ensure learning. They must also be very familiar with the content themselves and be able to identify their students' thought processes. Finally, teachers must assess student progress and ensure that they are progressing towards the goals and objectives of the curriculum. These tasks can be overwhelming.

Although the survey did not include any qualitative questions, several participants included written comments with their responses. One teacher stated that she would like to use inquiry more often but found it difficult because she only has 30 instructional minutes to devote to science. She also felt that science and history did not receive the time needed for proper instruction because too much time is focused on subjects areas tested on the Mississippi Curriculum Test 2 (MCT2).

Another respondent felt that her school district was too focused on students passing district level term exams and the state science test. She stated that she had taught science strictly through inquiry in another state but felt that the pace of the Mississippi Science curriculum was too fast to include enough inquiry activities. She therefore feels that students are being cheated out of a proper inquiry-based science education.

A lack of professional development on inquiry-based instructional techniques was also identified by the data. Only half of participants indicated they had received professional development on inquiry with a slight majority indicating they are familiar with the different types and levels of inquiry. A large majority of respondents indicated the desire for more professional development on implementing inquiry-based instruction.

These findings are also supported by the literature. Colburn (2000) found that the most frequent deterrent of inquiry-based instruction is a lack of effective professional development. Johnson (2006) states that, in general, there are far fewer professional development opportunities on inquiry based science instruction available as compared to other instructional techniques and often, professional development that is offered is not highly effective. The amount of time spent in professional development courses is directly related to the use of new instructional techniques in the classroom. Effective professional development also requires multiple opportunities to acquire new skills. One-day workshops often do not address teacher needs.

Limitations

One limitation of this study is the combination of the newness of inquiry being mandated in Mississippi and a lack of professional development. Although inquiry and Constructivist approaches to instruction have been established for many decades, it has only recently become a tested component of the Mississippi Science Curriculum and, for the first time in 2011, will be a factor in each school's Adequate Yearly Progress (AYP). This newness and a lack of professional development may have resulted in teachers being unfamiliar with using, or effectively using, inquiry in their classrooms. The data supports this limitation as a majority of respondents indicated a desire for professional development on using inquiry. Therefore, the results of question eight, which indicates the amount of time spent using inquiry, may have been positively misconstrued due to the unfamiliarity with inquiry and a lack of professional development on high-quality, inquiry-based instructional techniques.

Another limitation is that all participants are located along the Mississippi Gulf Coast. This area of the state historically has higher student achievement scores on standardized state assessments than other areas of the state. A larger study would be more representative of the status of inquiry-based science instruction in the State of Mississippi.

The final limitation to this study is that the researcher only gathered average Mississippi Science Assessment scores and compared them to average of amounts of time spent using inquiry for the participating schools. The researcher did not collect individual teachers' responses to compare with their individual students' scores. This could have limited the amount of information that could be drawn from analyzing individual teachers' amounts of time spent using inquiry and its effect on their students' achievement.

Recommendations for Policy or Practice

The researcher recommends more opportunities for high-quality professional development in using inquiry-based instructional strategies. There are currently very few opportunities available for teachers in the area studied. The new inquiry component to the Mississippi Science Curriculum was phased in over several school years. This would have been the perfect opportunity for high-quality professional development prior to switching over to the new curriculum completely. Professional development on inquiry instruction should also be mandated for administrators who will need this knowledge to assess the effectiveness of their instructional faculty.

The researcher also believes that more resources need to be devoted to science instruction in order for inquiry to be effectively implemented. Currently, math and language arts receive most funding and professional development due to MCT2 testing in those subject areas. State and local level educational leaders should shift more attention to improving science education in our schools.

Teachers must be given the tools needed in order to improve student achievement. It is the researcher's belief, supported by the results of this study, that additional knowledge through professional development and classroom resources are the keys to increasing student achievement and our educational rankings in science. The researcher believes this will improve over time, as science becomes a bigger factor in school accreditation ratings.

In conclusion, the researcher believes that most factors inhibiting the use of inquiry are beyond the control of the classroom teacher. It is the district and school administrators' responsibility to ensure that teachers are given the proper tools needed to be effective. This includes implementing an effective discipline plan, providing necessary materials, and offering professional development opportunities.

Recommendations for Future Research

Recommendations for future research include replicating this study after several years have passed with schools using the new inquiry-based Mississippi Science Curriculum. This would allow more time for teachers to become more knowledgeable about using inquiry effectively. More professional development opportunities may be available during this time which would also improve the usage and effectiveness of inquiry in our schools. In addition, the Mississippi Department of Education recently agreed to adopt the national Common Core Curriculum in the coming years. This will restructure the state science curriculum and will hopefully allow inquiry to be utilized more often.

The researcher would also recommend adding a qualitative component to a replication of this study. This would allow a better understanding of teacher perceptions of inquiry to be identified. It would also better indicate obstacles teachers face when using inquiry so that their occurrences may be reduced or eliminated.

APPENDIX A

PARTICPANT SURVEY

Preface:

For the purpose of this study, please consider the following guidelines while completing the survey. The National Science Education Standards define inquiry instruction as “involving students in a form of active learning that emphasizes questioning, data analysis, and critical thinking”. Inquiry-based science instruction can take many forms, but frequently closely follows the scientific method. Rather than being a passive absorber of knowledge, inquiry-based learning requires the student to be actively engaged in his/her own learning.

Inquiry learning is not just viewing a scientific demonstration or following a “cookbook” style science experiment. It requires the teacher to act as a facilitator of knowledge by guiding the students through their own levels of cognitive development and understanding.

Inquiry-Based Science Questionnaire

Directions: Please answer each of the following questions.

1. Your Gender: ____ Male ____ Female
2. Average Class Size: ____ 11-15 ____ 16-20 ____21-25 ____>25
3. Grade level in which you taught during the 2009-2010 school year _____.
4. School at which you taught during the 2009-2010 school year. _________
5. Race: ____Caucasian ____African American ____Asian

   ____Native-American ____Hispanic ____Other
6. Number of Years of Experience: ____<5 ____5-10 ____11-15

   ____15-20 ____20-25 ____>25
7. Age: ____21-30 ____31-40 ____41-50 ____>50

8. How often to you use inquiry based science lessons in your classroom?

_____ Daily ____ At least once a week ____ At least once a month

____ A few times per school year ____ Rarely _____ Never

#	Question	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree
9	I feel that inquiry based science lessons are important for my students' achievement.	1	2	3	4	5
10	I feel comfortable and confident implementing inquiry in my science lessons.	1	2	3	4	5
11	I don't have enough science materials and resources available for inquiry science lessons.	1	2	3	4	5
12	Inquiry science instruction is too time consuming.	1	2	3	4	5
13	My school administrators actively support using inquiry science instruction.	1	2	3	4	5
14	My students learn science best through inquiry.	1	2	3	4	5
15	Inquiry science lessons prepare my students for state science assessments.	1	2	3	4	5
16	Most of my students are cognitively and socially able to learn science through inquiry.	1	2	3	4	5
17	Inquiry lessons are difficult for me to manage.	1	2	3	4	5
18	I enjoy using inquiry in my science lessons.	1	2	3	4	5
19	I am intimidated by teaching science through inquiry.	1	2	3	4	5
20	I would like more professional development on teaching science through inquiry.	1	2	3	4	5
21	I have attended professional development sessions on using inquiry based science methods.	1	2	3	4	5
22	Collaborating with my coworkers helps me with implementing inquiry science lessons.	1	2	3	4	5
23	I am familiar with the different types and levels of inquiry based science.	1	2	3	4	5
24	I believe that science inquiry can benefit students with disabilities.	1	2	3	4	5

APPENDIX B

COVER LETTER

Dear Educator,

I am currently pursuing my doctoral degree in Educational Leadership from the University of Southern Mississippi. As part of the requirements for this degree, I am conducting a research project that will enhance the field of education. As a science teacher, I am interested in the effect of inquiry-based instructional strategies on student achievement. Therefore, I am conducting a research project titled: The Effect of Inquiry Based Science Instruction on Student Achievement. To gather data for my research, I am asking for your participation in this study. This 24-item survey will take approximately 10 minutes and is completely anonymous. While your participation in this study is voluntary, it is critical to the success of the study. If you have questions at any time, you may email me at Michael.Suarez@BiloxiSchools.net.

Please place your completed survey in the sealed envelope provided, and return it to your school's secretary by January ____.

Thank you in advance,

Michael L. Suarez, Doctoral Candidate

APPENDIX C

SUPERINTENDENT PERMISSION LETTER

October 2, 2010

Dear Superintendent,

I am conducting research for my doctoral dissertation in Educational Leadership at The University of Southern Mississippi. I am conducting a study to determine the relationship between inquiry-based science instruction and student achievement on the Mississippi State Science Assessment.

I would appreciate it if you would grant me permission to send a written survey to each K-8 science teacher within your district. Once they receive the survey, they can voluntarily participate or elect not to participate. Please respond below with the appropriate choice, and send this letter back to me. I would greatly appreciate it if you could send it back within one week of receipt. If you have any questions or concerns, please feel free to contact me at (228) 669-2840, or contact my research advisor, Dr. David Lee, at . A self-addressed stamped envelope has been enclosed for you, as well as a copy of the survey instrument. Thank you in advance for your assistance in this research.

Sincerely,

Michael Suarez, Doctoral Candidate
Dr. David Lee, USM Research Advisor

______ YES, I am granting permission for my elementary schools to participate in this voluntary survey.

______ NO, I am not granting permission for my elementary schools to participate in this voluntary survey.

____
Signature of Superintendent

APPENDIX D

HUMAN SUBJECTS REVIEW COMMITTEE FORM

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.
  Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **10110803**
PROJECT TITLE**: The Relationship Between Inquiry-Based Science Instruction and Student Achievement**
PROPOSED PROJECT DATES**: 12/01/2010 to 05/30/2011**
PROJECT TYPE**: Dissertation**
PRINCIPAL INVESTIGATORS**: Michael L. Suarez**
COLLEGE/DIVISION: **College of Education & Psychology**
DEPARTMENT**: Educational Leadership & School Counseling**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION**: Expedited Review Approval**
PERIOD OF APPROVAL: **01/24/2011 to 01/23/2012**

Lawrence A. Hosman
Lawrence A. Hosman, Ph.D.
HSPRC Chair

1-25-2011
Date

REFERENCES

Amarah, O. M., Garrison, L., & Klentschy, M.P. (2002). Helping English learners increase achievemnt through inquiry-based instruction. *Bilingual Research Journal, 26(2)*, 213-239.

Anderson, R. (2002). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education, 13*(1), 1-12.

Bell, R., Smetana, L., & Binns, I. (2005). Simplifying inquiry instruction. *The Science Teacher, 72*(7), 30-33.

Booth, G. (2001). Is inquiry the answer? *Science Teacher, 68*(8), 57-59.

Colburn, A. (2000). An inquiry primer. *Science Scope, 23*(6), 42-44.

Eick, C., Meadows, L., & Balkcom, R. (2005). Breaking into inquiry: Scaffolding supports beginning efforts to implement inquiry in the classroom. *The Science Teacher, 72*(7), 49-53.

Esler, W., & Esler, M. (2001). *Teaching elementary science: A full spectrum approach.* Belmont, CA: Wadsworth.

Fradd, S. H., Lee, O., Sutman, F.X., & Saxton, M.K. (2002). Materials development promoting science inquiry with English language learners: A case study. *Bilingual Research Journal, 25*, 479-501.

Garet, M.S., Porter, A.C., Desimone, L., Birman, B.F., & Yoon, K.S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945.

Gibbons, B. (2008). Elementary preservice teachers' utilization of English language development instructional strategies in the teaching of science to English learners. *Multicultural Education, 15*(3), 50.

Gordon, B. (2007). U.S. competitiveness: The education imperative. *Issues in Science and Technology, 23*(3), 31.

Johnson, C. (2006). Effective professional development and change in practice: Barriers science teachers encounter and implications for reform. *School Science and Mathematics, 106*(3), 150.

Kelly, J., & Weiss, S. (2005). Methods and strategies: An institute for inquiry. *Science and Children, 42*(4), 45-47.

Kirschner, P., Sweller, J., & Clark, R. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discover, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75-86.

Manly, J. (2008). Let's fight for science inquiry. *Science and Children, 45*(8), 36-38.

Martin, D., Sigur, R., & Schmidt, E. (2005). Process-oriented inquiry-a constructivist approach to early childhood science education: Teaching teachers to do science. *Journal of Elementary Science Education, 17*(2), 13.

Martin-Hansen, L. (2002). Defining inquiry. *The Science Teacher, 69*(2), 34-37.

Marzano, R. (2007). *The art and science of teaching: A comprehensive framework for effective instruction.* Alexsandria, VA: The Association for Supervision and Curriculum Development.

Marzano, R., Pickering, D., & Pollock, J. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*. Alexandria, VA: Association for Supervision and Curriculum Development.

Mastropieri, M., Scruggs, T., Boon, R., & Carter, K. (2001). Correlates of inquiry learning in science. *Remedial and Special Education, 22*(3), 130.

Mississippi Department of Education (2004). *Elementary/middle grades science assessments*. Retrieved from http://www.mde.k12.ms.us/acad/osa/science.html

National Research Council. (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

Ohana, C. (2006). Defending inquiry. *Science and Children, 44*(1), 64-65.

Palincsar, A., Collins, S., Cutter, J., & Magnusson, K. (2001). Making science accessible to all: Results of a design experiment in inclusive classrooms. *Learning Disability Quarterly, 24*(1), 15.

Pyle, E. (2008). A model of inquiry for teaching earth science. *Journal of Science Education, 12*(2), 1-19.

Stoddart, T., Pinal, A., Latzke, M., & Canaday, D. (2002). Integrating inquiry science and language development for English language learners. *Journal of Research in Science Teaching, 39*(8), 664-687.

Windschitl, M., Dvornich, K., Ryken, A., Tudor, M., & Koehler, G. (2007). A comparative model of field inverstigations: Aligning school science inquiry with the practices of contemporary science. *School Science and Mathematics, 107*(1), 382