The Effects Of The Teacher's Use Of Guided Inquiry In The Fifth Grade Classroom

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THE EFFECTS OF THE TEACHER’S USE OF GUIDED INQUIRY IN THE FIFTH GRADE CLASSROOM

by

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B.A., University of Central Florida, 1984

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Education in the Department of Teaching and Learning Principles in the College of Education at the University of Central Florida Orlando, Florida

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This study investigated the effects of the teacher’s use of guided inquiry in a fifth grade science classroom. Inquiry is supported by the National Research Council (2000), and indicates that all students should develop the abilities necessary to do scientific inquiry and develop understandings about scientific inquiry (p.21). This study was a qualitative action research design, focusing on seventeen students and their responses to a guided inquiry method of science instruction on Matter, Energy and Motion, and Earth and Space. An analysis of students’ performance and students’ attitudes about science in the classroom was conducted about each unit of instruction. The 5-E model of guided inquiry was used to elicit meaningful understandings while completing the units of Matter, Energy and Motion, and Earth and Space. Students worked in cooperative groups to support lab activities, which required each member to participate in the investigations, projects, and presentations. Students kept journals, recorded their findings, and wrote responses about their thoughts and feelings on the activities in which they were engaged.

Students’ attitudes were affected positively by the use of guided inquiry in learning science. Students’ performance for lab activities was also positive and was supported by students’ responses in journals, teacher observations, and performance tasks. This study supports guided inquiry in the science classroom for improving students’ attitudes and students’ performance during classroom activities.
This research compilation is dedicated to my family for enduring my craziness and my many senior moments of forgetfulness. I thank them all for their continuous support and love for me.
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I want to acknowledge Michelle Kerr Davis Kelley, Ph.D. for enlightening my stagnate soul to new sources of engaging strategies to get students hooked into learning. This, in turn, brought a deep soul searching and a yearning for more ways to engage my students in the classroom.

I also want to acknowledge Roxanne Paulsen as being a mentor to me for introducing mathematics’ strategies in order to guide my students into a true learning for mathematics. Mrs. Paulsen encouraged and supported all of the teachers at our school to get all the information that you could get your hands on, because it would help you find a link to help each student learn. Every one learns differently and students should start with what they know; this was a constant reminder during workshops with Mrs. Paulsen.

Last, but by far least, I want to acknowledge Bobby Jeanpierre, Ph. D. with the Martin Lockheed Academy at the University of Central Florida and all the professors at the University of Central Florida for their undying dedication. Dr. Jeanpierre always took my thesis to heart and nurtured me as if I was her only student. I gratefully appreciate every time she read and reread each chapter of my work and gave in depth critiques, even when I got the “eyes dropped.” I am grateful that our paths crossed at this time in my life and I believe that I am, and will be, a better teacher because of her insight and nurturing.
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FCAT: Florida Comprehensive Assessment Test

ESOL: English Speakers of Other Language
CHAPTER ONE: INTRODUCTION

“He that questioneth much shall learn much, and content much; but especially if he apply his question to the skill of the person who he asketh; for he shall give them occasion to please themselves in speaking and himself shall continually gather knowledge…”

Sir Francis Bacon (1561-1626)

For many years, I taught the subjects of science and mathematics in a traditional manner. Traditional teaching for me included introducing the subject, assigning students to read the pages within the specified chapters, instructing the students to answer the questions at the end of the chapter and administering the posttest. From my experience, this method of instruction did little to encourage the students to seek additional information and did not encourage them to ask their own questions.

While co-teaching a class with a colleague, it became even more apparent to me that I needed to facilitate the process of students pursuing topics in more depth. The insights gained from these co-teaching experiences made me question my own instructional techniques. I wanted to know: “How can I change my teaching methods in order to engage students to pursue a journey of lifelong learning?”

One way to help students continue the journey for knowledge was to teach them how to question effectively. In order to help students learn effective questioning strategies, I needed to learn effective questioning strategies, too.

As I watched and listened to my students interact during cooperative group work, I became acutely aware that the students were not transferring skills being introduced during the initial whole class instruction. During some teacher-student conferences, I realized most students had only a superficial level of knowledge, and therefore the
discussions within their groups and the questions entertained by them were factual, low on Bloom’s Taxonomy for intermediate students.

This self-questioning and observation led to a reassessment of my instruction methods. I wanted my students to take what they learned in the classroom and relate it to their life. Learning and living should be intertwined. In order to support my students in becoming lifelong learners, I had to change the focus of my teaching methods.

After reflecting on my teaching practices, I also thought of other occupations I had prior to teaching and quickly realized that they were no longer options that interested me. I believed that my present career was rewarding and was making a difference in students’ lives. In order to continue making a difference in students’ lives, I needed to find strategies to help them think beyond the facts.

The purpose for conducting this action research was to examine the effects guided inquiry had on students in my fifth grade classroom. It was important to this researcher to examine how guided inquiry related to students’ learning to question themselves, their peers, and teachers as they acquired the skills necessary to become life-long learners. Students should be encouraged to develop their own questions and questioning strategies.

Purpose of the Study

The purpose of this study was to examine the effects of the teacher’s use of guided inquiry instruction, particularly, as it pertained to the teaching of science in my fifth grade classroom.

Question #1: How did the use of guided inquiry affect students’ academic performances in science?
Rationale for the Study

The focus of this research was to improve the use of guided inquiry instruction in science. When I began taking courses to earn my master’s degree in elementary education, I realized that posing questions to students was a viable area for student learning, of which, I needed to research more. According to John Dewey (1910), learning is a science that needs to be questioned and explored daily. One of the many beliefs Dewey had was “that science teaching has suffered because science has been so frequently presented just as so much ready-made knowledge, so much subject-matter of fact and law, rather than as the effective method of inquiry into any subject-matter” (p.124). I believe students make connections when they can apply knowledge learned in the classroom to experiences outside the classroom.

Mark St. John (1998), founder and President of Inverness Research Associates in Inverness, California, also believes that a journey of lifelong learning comes by way of questioning. He worked continually with a subcommittee on research to improve the quality of education in districts and states across the country. Mark St. John (1998) asked the question, “How does inquiry affect us every day?” He then says, “Asking questions, and then pursuing our interest to extend our awareness of the world around us, is the essence of lifelong learning” (p.109). St. John also stated “… to use inquiry in order to answer a question, students need to become good at knowing what they do not know”
Therefore, teachers must become good at knowing what they do not know in order to facilitate a good questioning environment.

St. John related that a person could expand their knowledge by recognizing what they do not know and needed to become fearless in going beyond that boundary. He stated, “…pressing and probing until you find the place where there’s a contradiction, or where you encounter something you cannot understand or explain. This process is called “looking for trouble” and is not something we often value in the classroom” (p.111). St. John maintains children are rarely taught anything useful in examining what they do not know. Yet, this is the essence of how they might learn to find things out for themselves, and become authors of their own knowledge (1998). St. John (1998) asked the question, “How does inquiry affect us every day?”

The inquiry approach to teaching students provides multiple opportunities for teachers to facilitate questioning as well as providing the students the invaluable opportunity to question themselves. Enabling students with experiences in the classroom so that they make connections that extend into their daily lives is an important part of their education in order to ascertain learning for a lifetime. According to the NRC (2000), “They (students) must experience inquiry directly to gain a deep understanding of its characteristics” (p. 14).

John Dewey was one of the first critics of the perspective of gaining knowledge through direct instruction. Dewey believed that schools were focusing too much on the teaching and learning of factual information, and not enough on the scientific method (NRC, 2000). Referring to the scientific method, Dewey said, “is the only authentic means at our command for getting at the significance of our everyday experiences of the
world in which we live” (1938, p. 111). According to Dow (2000), Dewey believed that teaching children through inquiry allowed them to learn from direct experience and develop their natural curiosity. Dewey also believed that organizing learning in the processes of science would allow teachers and students to integrate information across other subject areas through the development of disciplined habits of mind (Dow, 2000).

Students’ attitudes towards science play a large role in their academic performance in this area. Research continues to demonstrate that science teachers need to motivate students to pursue science careers to promote job interest and growth in future research. “If students are to compete in the professional job market, they will most likely need to know the sciences that undergird these positions” (Scherer, 2004, p.1). Science is around us everyday, and there is no getting away from it.

The National Research Council coordinated the development of the Standards, which are described by the NRC as:

The National Science Education Standards are designed to guide our nation toward a scientifically literate society. Founded in exemplary practice and research, the Standards describe a vision of the scientifically literate person and present criteria for science education that will allow that vision to become reality (p.11).

Mark St. John (1998) asked the question, “How does inquiry affect us every day?” He then says, “Asking questions, and then pursuing our interest to extend our awareness of the world around us, is the essence of lifelong learning” (p.109).

Adams and Hamm (1998) indicate that today in classrooms, inquiry-oriented teaching strategies in the elementary science classroom afford children the opportunity to
experience and explore science as it relates to their personal lives. Emphasis has shifted away from memorization of facts to the development of thinking skills, cooperative learning, and working in teams. Research supports that children learn best through personal experience and by connecting new information to what they already know (Caine & Caine, 1994; Hinrichsen & Jarrett, 1999; Sprenger, 1999; Wolfe, 2001).

According to Lederman and Morrell (1998), students generally showed optimism toward school. Even though, students, in general, had a positive attitude towards school, their interest in science was less positive (p.5). Yet, according to Lederman and Morrell (1998), “There is no evidence that attempts to improve students’ attitudes toward school should affect students’ attitudes toward classroom science” (p.50). According to Siegel and Ranney (2003), a summary by McComas (1996), and Piburn and Baker (1993), has shown that positive attitudes towards science declined as students reach high school (p.759). Positive attitudes toward science is enhanced by inquiry-based learning than those in conventional science classroom (Johnson, Wardlow, & Franklin, 1997; Butta, 1998; Chang & Mao, 1999; Frederick & Shaw, 1999; Berg, Bergendahl & Lundberg, 2003).

Shepardson and Pizzini (1993) conducted a study to determine the effect of instructional approaches on student attitude. Of the 287 seventh and eighth grade students surveyed, most found the inquiry (problem solving-based) type of instruction fun compared to traditional laboratory or lecture-worksheet approaches.

According to Simpson (1991), “All one has to do is watch a group of students to tell if they are interested and motivated to learn.” Simpson also states research has generated new data that the learning of science in influenced by the way children feel
about science. Because attitudes are so closely tied to achievement, it is difficult to separate the two. Much of the research on inquiry-based learning and teaching study both students’ attitudes toward and achievement in science.

Researchers have shown that there is a positive correlation between hands-on or inquiry-based instruction and student achievement (Bay, Staver, Bryan & Hale, 1992; Butta, 1998; Ruby, 2001). Bay et al. (1992) carried out a study to determine the effectiveness of direct achievement. The study included children with and without learning disabilities (LD). Although the students without LD outperformed those with LD, overall results concluded that the students who received the discovery teaching approach did better than those receiving direction instruction.

Summary

The goal of this research was to examine my instructional practices using guided inquiry and how their use affected my students’ academic performance and attitudes in a science classroom. The change from direct teacher instructional practices, where students were to read and answer questions with little or no discussion with peers or from the teacher during science, to a teacher guided inquiry practice was used in order to study the affect it had on students’ attitudes and academic performances during science instruction.

Definitions

Action Research: “An invitation to learn, a means to tackle tough questions that face us individually and collectively as teachers, and a method for questioning our daily taken for-granted assumptions as a way to find hope for the future” (Mills, 2000, p. v).
Attitude: A mental position with regard to a fact or state; a feeling or emotion toward a fact or state; an organismic state of readiness to respond in a characteristic way to a stimulus (as an object, concept, or situation). (Merriam Webster Dictionary)

English Speakers of Other Languages (ESOL): Students whose first language is a language other than English (Florida Department of Education, 2004).

Gifted Learners: The State of Florida defines gifted individuals as those who have superior intellectual development and are capable of high performance (Seminole County Public Schools, 2003).

Five-E Model: This is an established planning method in science education and it is consistent with contemporary theories about how individuals learn. It consists of five stages: engage, explore, explain, expand, and evaluate (Lorsbach, 2004).

Florida Comprehensive Assessment Test (FCAT): criterion-referenced and norm-referenced assessment designed to measure how well students are learning the skills and competencies outlined in the Sunshine State Standards for reading, math, science, and writing (Florida Department of Education, 2004).

Guided-inquiry: An inquiry activity where the teacher provides only the materials and problem to investigate, and students devise their own procedure to solve the problem (Colburn, 2000).

Higher-order-thinking: The synthesis level from Bloom’s Taxonomy (1956). Bloom developed a taxonomy of educational objectives based on a increasing level of cognitive
processes. The levels are knowledge, comprehension, application, analysis, synthesis, and evaluation.

Inquiry and Inquiry-Based: Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already know; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results (National Research Council, 2000).

Rubric: A rubric is a carefully designed ratings chart that is drawn up jointly by teacher and/or students. Along one side of the rubric are listed the criteria that the teacher and students decide are the most important ideas to be mastered in the lesson. Across the top of the rubric are listed the rankings that will be used to assess how well students understand each of those criterion. The rubric also indicates how much importance should be given to each criterion, based on its importance to the overall lesson. Within each ranking, there also may be numerical gradations, depending on whether a student performs on the higher or lower level of that category (Pate, P. E., Homestead, E., McGinnis, K., 1993).

Sunshine State Standards: A set of standards developed by the Florida Department of Education to provide a clear understanding of what skills and competencies Florida students should have in the subject areas of reading, mathematics, science, and social studies for grades K through 12 (Florida Department of Education, 2004).
Wait Time: This is sometimes called thinking time, referring either to the interval between teacher question and student response, or to the interval between student response and subsequent teacher question (Rowe, 1986).

Overview

The purpose of my study was to examine the effects of my instructional practices in the use of guided inquiry in the elementary science classroom. More specifically, I wanted to determine how my practice of guided inquiry during teaching affected my fifth grade students’ attitudes and academic performance in the science classroom.

In subsequent chapters, I discussed the methodology I used in the study, the outcome of my data, and a summary of my action research study which provided how guided inquiry was effective in students’ academic performances and students’ attitudes while in the science classroom.
CHAPTER TWO: LITERATURE REVIEW

Introduction

In my review of the literature, renowned researchers and philosophers support the use of guided inquiry to facilitate students’ learning. During the review, two themes emerged which were relevant to my study. One theme addresses the effect of guided inquiry strategies pertaining to students’ academic performance, while the other theme addresses the effect of guided inquiry on student attitudes within the science classroom.

Inquiry: Historical Theories

Encouraging students to question themselves by inquiry was derived from such early philosophers as Plato, and Socrates in 335 B. C. (Clegg, 1977). Plato wrote a dialog between Socrates and a young boy in the book, *Meno*, where Socrates continued questioning and answering in such fashion as to lead the boy in developing inferences and deductions from them. These inquiries and answers lead to hypotheses, such as, (“if this is so, then it must follow that…”) to test the knowledge in new situations.

One human trait, curiosity, has probably been around since the beginning of time. For many philosophers such as Socrates, Plato, and Aristotle (Dow, 2000; Callison, 1999), curiosity has been the drive for scientific inquiry. Some educators, prior to the 1900’s, believed that science was knowledge which students needed to access through direct instruction (NRC, 2000). According to Martin (1997), there was a three-fold problem when educators focused on specific information. The problem was this: the
sheer amount of scientific knowledge known today, the possibility of scientific knowledge becoming obsolete, and that scientific knowledge changes over time.

John Dewey was one of the first thinkers to criticize traditional teaching in the science classroom. Dewey believed that too much focus was on teaching of information, and not enough time was spent on the scientific method (NRC, 2000). The scientific method, Dewey said, “is the only authentic means at our command for getting at the significance of our everyday experiences of the world in which we live” (1938, p. 111). Dewey also believed that children should be taught using inquiry in order to allow students a direct experience and develop their natural curiosity (Dow, 2000). One other belief of Dewey’s was that organizing learning in the processes of science would allow integration of information across the curricula developing the discipline habits of the mind (Dow, 2000).

Guided Inquiry: The Effect on Students’ Attitudes and Academic Performance in Science

“‘Rose-colored glasses.’ ‘Half full or half empty?’ Such sayings remind us of the effect that one’s attitude can have on one’s experience” (Ranney, 1996). According to Ramsden (1998), interest in questions of attitudes toward science has decreased since each study gives the same results and nobody knows what to do to change the students’ attitudes.

Several researchers (Koballa, 1988; Simpson & Oliver, 1990; Shepardson and Pizznin, 1993) have indicated that generally students begin studying science with genuine positive attitudes, but in the middle and high school years, interest, and positive attitudes
decline. Another similar study Yager and Penick (1986) found that almost fifty percent of primary students enjoyed science; however, the percentages for middle and high school dropped close to twenty percent of the students still showing an interest in enrolling in science classes. “The more years our students enroll in science courses, the less they like it” (Yager and Penick, 1986, p. 360).

Koballa (1998) states:

The literature indicates that the affective domain related to science education is primarily concerned with attitudes related to science. The development of positive attitudes toward science has long been viewed as a legitimate goal of science education. Science curriculum developers have for some time sought to improve students’ attitudes toward science and scientists. Concern for student attitudes toward science has also risen with regard to the possibility of increasing enrollment in elective science courses by improving attitudes toward science among adolescents (p. 1).

One study by Scruggs and Mastropieri (1993) compared the effects of teaching science by using textbook-based lessons and inquiry-oriented approaches. Traditionally, textbook-based lessons have teacher demonstrations with teacher questioning for comprehension answers, while inquiry-oriented lessons give opportunities for students to explore and formulate their own questions. The study was conducted with a class of twenty-six junior high students (all students had learning disabilities). The teacher used both teaching approaches in the lessons. The students scored better on the inquiry lessons than they did on the textbook lessons. When the students were asked which type of lesson they enjoyed most, the majority said they enjoyed the inquiry-oriented approach.

In a longitudinal study conducted in Sweden where compulsory education for students to attend school between the ages of 7 and 16, Lindalh (2004) studied a group of students from the fifth grade through the ninth grade. The students had sixteen different
study programs in their secondary education from which to choose. If students want to
study science later at a university they must enroll in mathematics, biology, chemistry
and physics; however, less than 20% of the students chose to continue to the secondary
level of their education. Lindahl’s study states that the students have intentions to become
“something.” Lindahl believes the decision to become “something” for these students,
“depend on three determinants, attitudes of all kinds, duties or experienced demands from
the neighborhood, and self-efficacy which means the conviction to be able to succeed
with the action” (p.4) Questionnaires on interests and attitudes were given in each of the
years. Each student was interviewed chatting about his or her answers on the
questionnaire, and then at the end of each interview the students were asked to explain an
everyday phenomenon, which was selected from the curriculum. For grades five, seven,
and nine the students were asked the same questions regarding the season, rain and light
with hope they could relate and transfer more information each year. The questionnaires
and interviews were used in order to get to know the students more personally. The
questionnaires involved all the students’ subjects. Two of the questions on the
questionnaires were: “How good do you think you are at the following subjects?” and
“How interested are you to learn more in the following subjects?” in grades 5, 6, 7, 8, and
9. Overall, the students felt most interested in school and felt they were better
academically, in Grade 5. Comparing the sexes, the girls believed that in Grade 9 and
Grade 5, they were just as good, but they were not as interested in science any more. The
boys believed they were just as interested in Grade 9 as in Grade 5, but did not believe
they were as good in science any more. Lindahl (2004) was not surprised that as the girls
got older the fact that their interests dropped in science, that was nothing new, but the
interesting part was that the boys were also negative (p. 8). The students gradually had less and less hands-on experiences in the upper grades and begin to become disappointed in science. The students believed “that all of a sudden science got serious” and it was not fun anymore. Lindahl writes, according to Shrigley (1990), “this can be the beginning of a negative spiral between attitudes and behavior which can be difficult to break” (p.9).

The inquiry approach to teaching students provides multiple opportunities for teachers to facilitate questioning as well as providing the students the invaluable opportunity to question themselves. Enabling students with experiences in the classroom so that they make connections that extend into their daily lives is an important part of their education in order to ascertain learning for a lifetime.


Inquiry is an approach to teaching that stimulates curiosity by teaching children how to observe very closely, encourages children to take more than a quick look, provides adequate materials for exploration, and makes it safe for students to ask questions and to take risks…Equally important, teachers need to inquire into their own teaching methods…constantly reflecting on their own teaching.

Summary

Bacon, Dewey, St. Mark John, Wilen and many more were dedicated to teaching for understanding in classrooms throughout the world. They were steadfast in their beliefs that teachers were responsible for instrumental ways to relay the curricula to their students. Giving the students the information and having them regurgitate it back was not in their way of thinking. Having students learn from their teachers how to question the questions was the way they felt understanding happens. The literature review has shown that effective teacher questioning is important for students’ attitudes and academic performance in science.
In the following chapter, the methodology used in my study was discussed. A design of this action research was provided and an explanation of how the collected data were analyzed. The findings of the data were applied to the research questions on the effect of teachers’ questioning strategies pertaining to students’ academic performance, and the effect of teacher questioning on student attitudes in the science classroom.
CHAPTER THREE: METHODS

The purpose and design of this study was to determine if my teacher questioning affected students’ attitudes and academic performances in my fifth grade elementary classroom during science instruction. In this chapter, I described the school setting and the procedures implemented to incorporate teacher questioning into my everyday teaching practices. The instruments for data collection were identified. The chapter culminated with explanations for analyzing the collected data and how conclusion were supported.

Design of Study

Action research was the methodology used in this study. Geoffrey E. Mills (2000), explained action research:

Action research is an invitation to learn, a means to tackle tough questions that face us individually and collectively as teachers, and a method for questioning our daily taken-for-granted assumptions as a way to find hope for the future (p. v).

I began collecting research information in the fall of 2003. Prior to beginning the study, I obtained approval from the Institutional Review Board from the University of Central Florida (see Appendix A). I asked my principal for her permission to conduct my action research study in my classroom for the 2003-2004 school year. I also received approval from the district office to conduct my action research study with my fifth grade elementary students for the 2003-2004 school year.
Students’ attitudes were assessed using a pre- and post-attitude survey, teacher observations of students’ participation, and student journal entries. The students’ academic performances throughout the study were assessed using data collected from several sources. Among these sources were lists student journal entries, teacher-made rubrics, student projects, a posttest of general science knowledge by Harcourt Publishers, and student grades for the grading period.

Setting

School setting

This study was conducted at an elementary school located in an urban central Florida city (population approximately 23,000). The student population was made up from the following ethnic backgrounds: 69.2% White; 18.6% Hispanic; 8.1% Black; 2.5% Asian; and 1.6% Multi-racial. There were approximately 18.1% of 840 students on free or reduced lunches. The school housed Pre-Kindergarten (students enrolled in Pre-Kindergarten at this school were language, speech, or physically deficient) through Fifth Grade. Students who spoke another language other than English were provided LEP classes (Limited English Proficient) along with full time and inclusion classes for both Specific Learning Disability (SLD) students and Emotionally Impaired (EI) students. The setting for this research included, but was not limited to, the 5th grade classroom of 17 students, the computer lab, and the school’s media center throughout the study. The students’ use of the computer lab and the media center were sources for the students’ to research information for class projects.
The school was named an “A+” school by the Florida Department of Education for performances on the FCAT (Florida Comprehensive Achievement Test). The FCAT is Florida’s grading system to determine whether the students are making yearly gains in the subject areas of Reading, Writing, Mathematics, and Science according to the Sunshine State Standards, developed by the Florida Department of Education (FDE), (Florida Department of Education, 2003). The schools receive a monetary subsidy along with the status of being an “A+” school. Florida’s curriculum, instruction, and assessments were subjected to alignment to the Sunshine State Standards. Each academic subject area had specific developmental levels for mastery and were benchmarked for each standard. The Standards were written to inform teachers of what the students should be able to do in order to progress to the next grade level. The Standards also hold administrators and teachers responsible for students’ continuing academic achievement. The school grades were based on percentages of gains made by the students from the prior year’s test in the subjects of Reading, Writing, and Mathematics. Science is not included in the school grade percent for monetary subsidies, at the moment; however, state standards for Science are on the FCAT for monitoring and the scores are shown for academic performance to the district and state, as well as to the parents.

There were seven fifth grade classrooms in this school. Four of the classrooms were in an area called a pod, which is divided by permanent partitions into four quadrants. One classroom was located in a portable building near the main building, and two classrooms were located on what was known as the ‘patio area’. The patio classrooms are connected to the main part of the school building in an L-shape, and are divided by a wall of half cloth partition and half brick (side by side). The divider stopped
at a brick column leaving open a four-foot walk area for fire safety regulations. This study was conducted in one of the patio classrooms.

Classroom Setting

This study was conducted with my fifth grade classroom of seventeen students. Of the seventeen students, one student qualified for the Specific Learning Disabilities (SLD) program, for writing and mathematics. In order for students to qualify for this program they are given a psychological screening to determine an intelligence quota (IQ) and a subject area score. The student must have a substantial processing deficit between the IQ and the subject area and the standard deviation may be no more than 15 points for 10 and 11 year old students. Another student in this class qualified for LEP (Limited English Proficiency). Students qualifying for LEP must take an English proficiency district’s handbook. One other student qualified for the Gifted program. Qualification for the Gifted program is based on an intelligence quota (IQ) score, which must be above the average (100) IQ, and other criteria as specified in the county handbook (Seminole County Public Schools, 2003).

Science was taught for approximately 45 minutes each day, three to four days a week, Monday through Thursday. Friday was designated for gifted classes for fifth graders and no new material could be introduced on the days gifted students were out of the main classroom (Seminole County Public Schools, 2003). There were seventeen students in my classroom that participated in this study. Of the seventeen students in this study, six were boys and eleven were girls. Thirteen of these students participating in the study were of Caucasian descent and four were of Hispanic descent. A parental consent
and child assent form (see Appendix: C) was completed by participating students and their parents, as required from the Internal Review Board of the University of Central Florida and the Seminole County Public School Board. Seventy percent of the students were from middle to high-income families, while thirty percent of the students came from low-income families and were on the free or reduced lunch program.

Procedure

Forty-five minutes of science instruction was given approximately four days a week. The study was conducted over a period of twelve weeks, giving four weeks to each unit. The topics of study for this research were on units of Earth and Space, Matter, and Energy and Motion. Curriculum for the topics was used from the district’s adopted text, Harcourt Science (2000). The Sunshine State Standards for Science that guided my study were from Strand A: The Nature of Matter, Strand C: Energy and Motion, and Strand E: Earth and Space, and Strand H: The Nature of Science. The benchmarks used in this study were:

SC.A.1.2.1: The student determines that the properties of materials (e.g., density and volume) can be compared and measured (e.g., using rulers, balances, and thermometers).
SC.A.1.2.2.: The student knows that common materials (e.g., water) can be changed from one state to another by heating and cooling.
SC.A.1.2.3.: The student knows that the weight of an object always equals the sum of its parts.
SC.A.1.2.4.: The student knows that different materials are made by physically combining substances and that different objects can be made by combining different materials.
SC.A.2.2.1.: The student knows that materials may be made of parts too small to be seen without magnification.
SC.B.1.2.2.: The student recognizes various forms of energy (e.g., heat, light, and electricity).
SC.B.1.2.3.: The student knows that most things that emit light also emit heat.
SC.C.1.2.1: The student understands that the motion of an object can be described and measured.
SC.C.2.2.: The student knows that an object may move in a straight line at a constant speed, speed up, slow down, or change direction dependent on net force acting on the object.
SC.C.2.2.3: The student knows that the more massive an object is the less effect a given force has.
SC.C.2.2.4: The student knows that the motion of an object is determined by the overall effect of all of the forces acting on the object.
SC.E.1.2.1.: The student knows that the tilt of the Earth on its own axis as it rotates and revolves around the Sun causes changes in season, length of day, and energy available.
SC.E.1.2.3.: The student knows that the Sun is a star and that its energy can be captured or concentrated to generate heat and light for work on Earth.
SC.H.1.2.2.: The student knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results.
SC.H.1.2.3.: The student knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

The data used to show evidence in the understanding of the curriculum were selected from the district, adopted text, Harcourt Science (2000), Mathematics and Science Professional Development (2001), teacher made rubrics adapted from RubiStar, a teacher friendly Internet site for making rubrics, and tests from the district adopted science series, Harcourt Science. The Harcourt series includes texts, workbooks for each student, videos for experiments, and resource materials for the teacher. The Harcourt (2000) chapter objectives, which align with the Sunshine State Standards, are:

### Matter:

1. Recognize that matter is anything that has mass and takes up space.
2. Conclude that an object’s physical properties remain constant and can be used to identify it.
3. Compare and classify matter according to its physical state.
4. Recognize that heat is responsible for changes in the state of matter.
5. Identify melting and boiling points as constant temperatures at which substances change state.
Energy and Motion:

1. Describe what forces are and what they do.
2. Explain how the forces of friction, magnetism, and gravity act in our everyday lives.
3. Describe balanced and unbalanced forces.
4. Define acceleration.
5. Calculate net force when more than one force acts on an object.
6. Evaluate the impact of research and technology on scientific thought, society, and the environment.
7. Identify careers related to science.

Earth and Space:

1. Recognize the time-and-space relationships of the sun-Earth-moon system.
2. Describe lunar and solar eclipses.
3. Identify telescopes, satellites, and space probes as instruments scientists use to study the solar system.
4. Connect chapter concepts with the history of science.
5. Connect chapter concepts with the contributions of scientists.
6. Conduct a simple experiment using selected equipment.
7. Evaluate information to construct reasonable explanations from direct evidence.

Description of Classroom Instruction

Science instruction in the classroom was integrated with language arts and/or mathematics. Students wrote in their journals recording data they discovered during lab activities, wrote reflections on what they learned from projects and presentations, and wrote suggestions of how projects could be improved.

The Matter unit was presented using the method of guided-inquiry instruction by implementing the “5E Model” approach. The directors of Biological Sciences Curriculum Study (BSCS) developed this strategic teaching model for inquiry instruction in the 1980s. Five steps are involved in this instructional approach, they are: engage, exploration, explain, elaborate, and evaluate.
The “engage” step is to get the students interested in the instruction being presented. In the study of Matter the students were engaged by getting their curiosities stirred by allowing gum chewing in school. The students were asked to weigh the gum in the wrappers first, write down the weight, and then they were asked: “What will happen to the gum after you have chewed it for two minutes?” The students wrote in their journals their hypotheses.

The “explore” step was next and the students chewed their gum continuously for two minutes. The gum was placed in the original wrapper, weighed their gum again, and recorded their data. Questions were raised from many students as to why the chewed gum weighed less than it did in the beginning.

The “explain” step had students starting to make connections with the experiences they encountered during the experiment of chewing gum in the classroom. The students were communicating among themselves with the teacher being the facilitator. Many of the students began reading the label on the gum wrapper to investigate the ingredients in the gum.

In the “elaborate” step, the students began making connections about the concepts learned during the experiment of chewing the gum. During this step, the students realized that something had to ‘disappear’ from the gum in order for it to weigh less after it was chewed. They had many ideas and suggestions for possible variables. Some students believed that the saliva was different in each person and some questioned whether everyone chewed as hard or as long. They were not sure just how, but something made a change in the chewed gum, because all the “chewed” weights were not the same.
The “evaluate” step occurs throughout the entire gum lesson by the continually collecting data. The students made charts comparing gum weights within their groups wrote down their theories about the changes found in their journals. During the “evaluate” step is where any misconceptions about the experiment were addressed.

The class instruction for the Energy and Motion study engaged the students by group lab activities from a MSPD, Mathematics and Science Professional Development (2001), workshop. This instructional lesson in Energy and Motions also was taught using guided-inquiry. The students were divided into groups of four or five students and each group was given a center activity card. Each card gave the items needed for the activity along with a set of questions for predictions before experimenting. Their predictions were written in their journals alongside the center name, such as: ‘Toy Car’ – Directions: Explore a toy car with a pull-tab using a meter tape to measure the distance it travels. Predictions: 1. How far do you predict the car will travel when you pull the tab and release it; and 2. What is the average distance the car can travel? Then, on the back of the card, it read: ‘Toy Car’ – 1. What were some predictions you made; 2. What were some observations you made; 3. What kinds of measurements did you use; and 4. What are some questions you have? In this lab activity, students had eight separate center cards (see Appendix: D) for investigation in this unit of study.

The computer lab and the media center were used to create PowerPoint presentations. For example, in the study of Earth and Space, the students first conducted research about different jobs held by astronauts in order to create a PowerPoint presentation. Then, in the computer lab and media center students continued to research on the World Wide Web for statistics on assigned astronauts. During the computer lab
visitations the students completed a graphic organizer called a storyboard (see Appendix: E). The students used the storyboards as a visual for the brainstorming and final information that was placed in their presentations.

Data Collection Methods

This study’s data collection methods included a variety of sources including students’ performance and attitudinal information along with self-reflections through teacher observations. The data collection methods throughout the twelve-week study included: student journals, surveys, posttests, projects and presentations, and lab activities. Students were given a district, text adopted performance task exam, while rubrics were used to assess projects and presentations, also used were, selected journal entries as part of the assessment in the three topics studied. I observed and participated as a facilitator to the students throughout group activities and class discussions prompting with questions as necessary to keep the topic flow throughout the activities.

Instruments of Data Collection

The data had to have validity and reliability. “Attention to the three important concepts of validity, reliability, and generalization will help the teacher researchers ensure the quality of their work” (Mills, 2003, p.77). Qualitative data were collected from student journaling, graphic organizers, classroom observations, and surveys.

The quantitative methods for data collection were: projects and presentations using rubrics, lab activities, students’ pre and post attitude surveys, posttests, and performance task exam. The data were collected within the restraints of the classroom
and careful attention was given to insure that classroom activities did not coincide with data collection. Students and their parents signed forms of permission to be involved in this research. In the permission form (see Appendix: C), also stated that the students’ names would be confidential. Seventeen students and their parents agreed to the research.

Rubric

A teacher-made rubric was given to the students to help guide them in choosing useful information to include in their PowerPoint presentations on astronauts. The rubric (see Appendix: F) information was developed from RubiStar4teachers, an Internet-based rubric generator available online free of charge for teachers to create quality rubrics. Rubrics from the district, adopted teacher resources were also used to score student projects and performance task assessments.

Pre- and Post-Attitude Surveys

Pre and post attitude surveys were given to the students to find out how they were feeling about science in general. The surveys used can be found in Charles Pearce’s book, Nurturing Inquiry (1999, p. 10). An example of the survey can be found in Appendix H. This student survey was chosen as an appropriate attitude tool for this study because it had more of the questions that I wanted to know about my students than other attitude surveys previewed. I chose only those questions to analyze that directly related to students’ attitudes about this science study.
Post Tests

One of the posttests I used to measure a portion of the students’ knowledge was taken from the district, adopted text, (Harcourt Science, 2000). This test was chosen because it represented one of performance task rather than factual information (see Appendix I).

Lab Activities

During the study, students worked together when a need for discussion was present and during lab activities. They worked collectively during the activities and wrote their findings and summaries individually in their journals. The lab activities were procured from the Harcourt Science Teacher Resources, MSPD 2001 Force and Motion, and student workbooks. (See Appendix J)

Projects and Presentations

I used student-created projects and presentations as assessment tools because students had to use application and evaluation levels of learning in order to complete their assignments. The projects and presentations consisted of a timeline, a solar cooker that was used to cook a hotdog and a multimedia presentation using a PowerPoint presentation to share biographies on assigned astronaut. The rubric used for the PowerPoint presentation on astronauts was adapted from RubiStar (see Appendix E). Rubistar4teachers.org is on the Internet for teachers and students to create rubrics for any academic subject, project, or presentation. Rubrics were given to the students to guide
them in assembling and researching their projects and presentations. The design and rubric for the solar cooker was taken from the district, adopted text, Harcourt Teacher Resources.

**Student Journals**

Students used journals to keep records of brainstorming lists, record their findings on various lab activities for this study, write research sources, write explanations of what they had learned during presentations, and to write questions about an aspired thought while they were researching another topic. Students were introduced earlier in the year on correct ways to record data of lab activities in their journals.

**Teacher Data Collection**

The teacher’s data collection consisted of classroom observations of students’ activities during labs, behaviors, academic performances, and attitudes collected throughout this study. Keeping notes in the form of a journal or log is a valuable tool for keeping short narrative accounts of students’ performance in activities and class discussions during instruction (Shepardson and Britsch, 2001). The use of journaling is supported by the National Science Education Standards in Professional Development Standard C. Professional development activities should provide self-reflection with the use of various tools, including journals. (NRC, 2000). Notes were kept as I went to each student group observing and listening to dialog regarding the science content. This researcher noted student responses to teacher questions, student questioning, students’ activity during lab participation, and on task and off task behavior throughout the study.
Methods of Data Analysis

The focus of this action research study was to examine effective teacher questioning in the science classroom. The data needed to be precise and reliable. Therefore, multiple sources of data were collected in order to insure a triangulation of data sources and methods. Gall, Borg, and Gall (1996) wrote “Triangulation helps to eliminate biases that might result from relying exclusively on any one data-collection method, source, analyst, or theory” (p. 574). According to Mills (2003, p. 77), “attention to the three important concepts of validity, reliability, and generalization will help the teacher researchers ensure the quality of their work.”

Through the students’ surveys, responses were recorded to find information to support students’ attitudes toward science in the classroom. This survey was used to report the findings of the effect of students’ enthusiasm, and interest level in science. Data collected from the surveys, lab activities, teacher observations, and journal entries were complied to confirm the attitudes of students during guided inquiry in a science classroom were positive.

Validity of the quantitative data assessments was supported in the use of lab activities, district adopted tests, and performance tests that aligns with the objectives of the state’s Sunshine State Standards. Data from the rubric on projects and presentations, test grades, lab activity grades, and journal entry grades were compiled to present students’ academic performance that was significant to guided inquiry instruction.
Summary

Chapter three, Methods, presented the design of my study, my procedures used in the study, and the methods used for collecting data and data analysis. Detailed information about the setting of my study and data collection methods were documented. Is there an effect of teacher questioning on students’ attitudes and academic performances in the science classroom? Chapter Four, Data Analysis, presented interpretations of the data findings.
CHAPTER FOUR: DATA ANALYSIS

The purpose of the study was to examine the effect of the teacher’s use of guided inquiry in a fifth grade science classroom. In this study, my focus was centered on two questions: 1. How does the use of guided inquiry affect the students’ performance in the science classroom? and 2. How does the use of guided inquiry affect the students’ attitudes in the science classroom?

Seventeen of the enrolled twenty-three students in my fifth grade classroom participated in and completed multiple learning and assessment activities throughout the course of this study. Six parents would not return the notice of participation; therefore, those students were not part of the study. The six abstaining students’ were involved in all classroom activities and were not reprimanded in any way, nor were their grades negatively impacted. Their written conversations were not included, nor any part of the data collected in this study from these six abstaining students. Data were collected in a variety of assessments.

Prior to the beginning of this study, this researcher used a more “traditional” method of instruction. This method included accessing prior knowledge by asking students to recall what they knew about the unit to be studied, reading and answering textbook questions, watching teacher guided demonstrations and lab activities. Some students were chosen to help with the experiment, but rarely did all students have an opportunity to touch materials or make their own inquiry. As a result, often times, students’ behaviors were frequently off task and only students directly involved with the activity were willing participants in the question and answer part of the lab.
During this study of the effects of the teacher’s use of guided inquiry in a fifth grade science class, three topics were analyzed to assess students’ performance and students’ attitudes in science, Matter, Energy and Force, and Earth and Space. The data collected were triangulated. To triangulate the data collected for this study several sources were used: write-ups from lab activities, a posttest, student journal entries, a performance task, students’ projects, PowerPoint presentations, and teacher observations.

The analysis of the data collected from the students revealed several recurring themes in this study of guided inquiry instruction. The themes were: 1.) students were thinking critically, 2.) lab activities supported student academic performance, and 3.) science is fun.

**Students Thinking Critically**

The 5-E model of instruction was used for guided inquiry during lab activities for the study of Matter. Students’ dialogs were recorded by this researcher using the teacher observation form (see Appendix: H) during the class lab activities, students’ journal entries were also included in the data, along with a pre and post attitude survey. The introduction, or engagement, phase of the 5-E Model gave students a fun way to investigate and think critically about Matter. The students investigated the parts of a solid by observing and chewing bubble gum. The students were engaged as soon as they saw the gum in the teacher’s hands.
Lab Activities

The “explore” stage of the 5-E instruction model had the students weighing and recording the weights of their piece of gum, using balances with the wrapper on, and then recording the data in their journals before the chewing of the gum. Students chewed for a total of two minutes, removed the gum, placed it back into the wrapper, weighed the chewed gum, and recorded the weight. The results astonished the students; they could not understand why the chewed gum weighed less than the original weight. What was even more questionable to the students was that the weights were not exactly the same from student to student. Their observations led them to try and explain the phenomena.

The third stage of the 5-E model is “explain.” Many of the students were baffled at the recorded results. The differences in the chewed gum weights varied in small amounts. Students took apart their wrappers and weighed them separately to see if there was a difference in everyone’s papers, then added the weight of the gum back to the wrapper. They concluded that something about the gum had changed the final weight and that something was missing from the gum. Students had questions and ideas for this activity, some of them asked:

JR: Is this a trick? (This researcher assured the students it was not a trick.)

CB: Maybe some of us chewed harder than others.

BC: Maybe that stuff in peoples mouths is different.

AT: You mean saliva?

BC: Yeah.
Students' Attitude Survey

The students completed a pre and post survey (see Appendix: F) indicating their attitudes towards science in the classroom. A pre-survey was given before the guided inquiry lessons began indicating 5% of the students had strong attitudes that learning was boring and it appeared that 5% still thought learning was boring after the guided inquiry lessons were taught. Seventy-one percent of the students disagreed that learning was boring before guided inquiry lessons, however, after the guided inquiry lessons the percentage jumped to 95% of the students disagreeing that learning was boring. To this researcher, these percentages indicated that guided inquiry lessons are more interesting to students than traditionally taught lessons and students became engaged in the learning.

According to the survey, it appeared that students believed they learned more when they worked in a group and shared ideas. In the pre-survey, 76% of the students agreed that they did learn more while working in a group and sharing ideas, and the percentage increased by 6% in the post survey. The surveys for group collaboration was good, however, this researcher found that the students’ attitudes about partner work was even more advantageous than group work. The pre-survey indicated that 94% of the students agreed that they understand more when they talk things over with a partner. This percentage dropped 6% during the post survey, but to this researcher, 88% of the students agreeing is evidence that students believed they learned more by having discussions about their learning.
Teacher Observations

After what appeared to be an extended amount of wait time, approximately three minutes, a few students were twisting the wrapper in their fingers, looking it over, and CZ said, “Could the weight have anything to do with the ingredients, she had difficulty pronouncing ingredients?” All the students began reading the label on their wrappers and started noticing that the ingredients were written on the wrapper along with a measurement. The groups made collective decisions that they had chewed out the sugars in the gum because the sweetness that was there in the beginning had disappeared in the majority of their experiments.

The “elaborate” stage is next after the explanation. This researcher brought the students back to some of their statements earlier on in the activity regarding the style of chewing and people’s saliva. The question for elaboration was, “Does it make a difference in how people chew the gum?” and “Is everyone’s saliva different?” The students had opinions on both of these questions. In a group discussion, this researcher recorded some of their responses on the teacher observation form. Some responses were:

Some people could chew faster and that would make the flavor go away quicker.

Some people were blowing bubbles, so I think that air caused a difference in how much theirs weighed at the end.

Maybe some did not chew at all, just pretended to chew.

Everyone eats different things, so maybe that liquid stuff, saliva, is not the same in our mouths.

Doesn’t stomach acids break down foods for our bodies? So maybe the saliva did the same thing with our gum.
This was an example of the students’ critical thinking that had begun during their discourse. In one of the survey statements, the students acknowledged that they learned better when they could discuss what they found with a partner. In the previous discussion, it appears the students believe they have some solutions to the phenomena.

*Journal Entries*

The final stage in the 5-E model is “evaluate.” In this stage, the students gave a reason for what they believed caused their findings. The student performance in this activity indicated that they agreed that something, whether in the chewing of the gum, or something in the mouth, such as the saliva, had made a definite change in the weight of the gum. Students were asked to give a written summary explaining why their gum weighed less, or why the gum’s weight did not change. Students gave their analysis of the gum lab by writing in their student journals. Listed are some of their entries:

BC: I think everybody’s gum was not the same size to begin with. And, then when we chewed it, it got smaller.

GM: Everyone’s gum weighed real close to the same. So, it had to be something that went out of the gum.

NA: When we read the ingredients on the wrapper, sugar was added to the gum, so that added to its weight. Then when we chewed it, the sugar must have dissolved and we swallowed it. That’s what I think.

AT: I think since the gum did not taste sweet anymore that we chewed the ingredients out of it, especially the sugar. Probably the acids in our mouths had something to do with all of it too.

CZ: Well, everyone was supposed to chew for the same amount of time, but I think some people didn’t chew all the time, so that’s why their gum still weighed almost the same.

CB: I know it had to do with the chewing.
RC: I think things started to come apart when we started chewing. Like when we chew our food it gets into little pieces and then we swallow it, but I didn’t swallow the gum.

HD: I agree with AT, I think it was acid that caused it. But I thought acid burns.

BT: My gum still tasted sweet and it weighed about the same.

This researcher observed that while the students enjoyed chewing gum during the matter lab activity, they used critical thinking skills during the group and class discussions. Students hypothesized about the possible changes in the gum, and they discussed their solutions with peers. Students engaged in critical thinking during their 5-E inquiry as they observed and then questioned the changes in their partner’s gum.

Lab Activities Support Student Academic Performance

In the Energy and Motion unit the 5-E Model of inquiry was used to engage students with activity cards. One side of the activity card had a material’s list, which asked for predictions, gave an idea for the students to investigate, or had the students make a question of their own about energy and motion. The opposite side of the card asked the students to explain what they learned after they had investigated while using the materials, such as marbles, meter sticks, wind-up cars, drip timers, a Slinky, tennis balls, and ball and jacks. The students were required to record their results in their student journals. Each activity card was set up similarly giving a description of the activity, suggested a prediction, and the follow-up questions. The students had eight different activities to explore. The lab activities taught during the Energy and Motion unit supported student question of observed phenomena and revealed their level of understanding of Energy and Motion concepts. Data were collected from lab activities.
along with students’ journals, teacher observations, and a performance task assessment (see Appendix: G). The curricula used for instruction of the unit were the district adopted text, Harcourt Science (2000), and activity cards from Mathematics and Science Profession Development (MSPD, 2001).

Lab Activities and Student Journal Entries

Two labs were conducted during the Energy and Motion unit. Both labs were introduced the same way using activity cards and follow-up questions (MSPD, 2001). The following activities were used during this unit for data collection:

1. Toy Cars: Explore the toy cars with the measuring tools provided.
2. Drip timer: Explore the drip timer by filling it with water and opening the valve until water drips out at a steady rate. Use the pie pan to catch drips.
3. Pendulums: Explore the pendulum as it swings.
4. Slinky: Explore a slinky as it moves down steps.
5. Tennis Ball: Drop a tennis ball into a container of water.
6. Ball and Jacks: Drop the ball and gather the jacks. Toss the ball in the air, and gather more jacks.

One of the activities in the Energy and Motion unit was the beanbag toss. The following directions were on the activity card for the students:

Beanbag Toss: Predict what will happen when you drop beanbag of differing masses from the same height. Hold two beanbags up and drop them at the same time. Predict what will happen when you toss beanbags of different masses at the boxes. Toss the beanbags at the boxes.

- How does mass affect what happens to the boxes?
- What kinds of forces are acting on the beanbags?
- What forces are acting on the boxes?

Examples of students’ journal responses were:

Student One:
Prediction: I think one bag will drop faster than the other.
Observation: The heavier bag fell faster than the lighter bag.
Question: Does the mass affect the boxes by knocking them down?
Student Two:
Prediction: I think that the bigger one (bag) will fall faster because it has more weight. Also, I think that the small beanbag will make it into the box because it (bag) has less weight.
Observation: When we throw the beanbags they hit the box with so much power that it knocks the boxes over.
Question: What if someone throws harder than I do, what will happen to the boxes then?

Student Three:
Prediction: I predict the heavier beanbag will fall faster because it has more weight.
Observation: Because the force that we throw the bag with, knocks the boxes over.
Question: If I threw a big paper wad at the boxes, would I be able to knock over one of the boxes?

Student Four:
Prediction: They won’t hit the ground at the same time. It (box) will also not fall.
Observation: My prediction was right, they didn’t drop at the same time and didn’t bounce.
No question.

Student Five:
No prediction.
Observation: What happened was when I threw the bags it felt like one was heavier and one was lighter.

The hammer activity card gave these directions:

Hammers: Use a small hammer and a big hammer to pound nails into a piece of wood.
- Describe the force of the small hammer.
- Describe the force of the big hammer.
- Explain the difference.

Students’ journals revealed:

Student Four:
Prediction: I predict the force of the hammer will push the nail into the wood.
Observation: The bigger hammer had more force than the little hammer because of gravity.
No question.

Student Five:
Prediction: None
Observation: The small hammer hammered faster than the big hammer.
No question or other observation.

Student Six:
Prediction: I predict the force of the hammer will push the nail in to the wood.
Observations: The force of the small hammer was not very much. The force of the big hammer was a lot greater and got the nail in faster. No question recorded.

Students were brought together at the end of each day’s lab to address any misconceptions and concerns regarding behaviors the students may have had, but important teacher and student talk about several activities as they happened was minimal. During the lab activities students worked cooperatively with each other, which gave a smoother transition to each activity.

Performance Task Assessment

A performance task (see Appendix G) was given to the students as an assessment in the study of Energy and Motion. The performance task, Mass in Motion, had students collect data to determine the association between mass and momentum. The students compared how far two different-sized marbles traveled on a flat surface after traveling down a channel. Each group of students presented their findings, explained their conclusions, and gave ideas as to what they inferred from their data collection. The students were scored using a rubric from the district, adopted text, Harcourt Science, 2001. The students were divided into five groups, four students in two groups and five students in three groups. Each group of students were given tape, three large marbles,
three small marbles, a piece of poster board, three books, and a meter stick. First, students had to create a track using the poster board. Specific instructions on how to fold the poster board and complete activities were on students’ handout of the performance task assessment.

Students worked eagerly in their groups to construct their ramps. All were focused and they were making predictions about the distance the marbles would travel before the ramp was finished. This researcher overheard students’ discussions regarding the height of the ramp; one student asked his group, “Why can’t we use more books to make our ramp taller?” One group thought that they should get out the balances and weigh the marbles because, some of them felt heavier than others did.

The students were assigned to compare the average distance traveled by the large marbles with the average distance traveled by the small marbles. The students recorded the results of the distances the large marbles traveled and then they recorded the distance the small marbles traveled. Trials for both the large marbles and the small marbles used the same procedures. The students’ conclusions were:

Group One: We needed a stop watch to time how fast the marbles went down the poster board. The bigger marbles rolled a long time, but not as fast as the little ones did.

Group Two: We found that the larger marbles rolled a longer distance than the smaller marbles. So, we think if an object is really big (mass) it will roll for a long time before it stops.

Group Three: The large marbles all stopped about the same place and so did the little ones, but the large marbles rolled a lot longer. We think that since the large marbles rolled longer then they must have more mass and it’s harder for something to stop that’s really big once it gets going.

Group Four: The large marbles had more mass than the little marbles. The little marbles came down the slope in the poster board a lot faster, but the large marbles rolled farther.
Group Five: We used four books and all our marbles came down real fast. The big ones rolled a lot farther.

The students were eager to assist each other in finding solutions to problems throughout the units. Through the teacher observations, students’ journal entries, and the performance test gave an indication of students learning of the designated objectives.

From the triangulated data, the researcher concluded that the Energy and Motion unit could use more time for students to investigate and have their group discussions. The students’ journal entries facilitated student developing the use of guided inquiry during lab activities that the students had some understanding about energy and motion. It was difficult to facilitate each group as closely as planned.

In the second unit, Earth and Space, the researcher used what Pearce class read-to-find, or researchable question inquiry. The data collected from the students for their understanding of Earth and Space unit were a timeline on the history of space, a PowerPoint presentation on astronauts, student made Solar Cookers, and student journal entries. Students were given a set of events in space history, instructed to research when the events took place, using the Internet and non-fiction references, and then place them correctly on a timeline. The students were to be creative while constructing their individual timelines.

In addition to the research on the history of space, the students were assigned an astronaut to research. This information was presented in the form of a PowerPoint presentation to the students in the immediate classroom. Lab time was scheduled weekly in the school’s computer lab for their research and for completing a PowerPoint presentation. The computers in the classroom were also available for students to search
the World Wide Web for their information. In addition to the preceding computer lab and classroom time for researching on the Internet, the school’s media center was also available for research.

Students were to inform the audience of job descriptions of their astronauts and whether they were assigned to mission control, payload specialist, pilot, etc. After the completion of a brainstorming session to find out what they students knew about astronauts, their responses revealed that the students had little prior knowledge about astronauts and their job descriptions. The students appeared to have had the mind set that if you were part of the National Aeronautics Space Administration (NASA), you were automatically on the list to soar into space. This researcher felt students needed a stronger foundation of the jobs that supported NASA’s space bound astronauts. The students were given a rubric (see Appendix: E) to guide them so that they could present a successful PowerPoint presentation. A storyboard handout (see Appendix: D) was given to students in order to assist them in making a rough draft of the data and picture inserts they wanted to use for their presentations. The presentations were shared with their classmates in the computer lab because the room was larger; it had a 32-inch projection screen, and was more comfortable for viewing the final presentations. The presentations were colorful, full of animation, sound, and the content was accurate. The computers in the classroom were also available for students to search for information on the World Wide Web. This was the first multi-media project for most of the students. The information was sometimes straight from the web cite, even though the discussion of plagiarism was expounded upon in class by this researcher and from the computer lab instructor. Students’ written work, which had areas of concern (plagiarism) were circled and a
written explanation of why the information was not acceptable was placed on the copies of their presentations. This researcher believed that students need more instruction in applying appropriate researching and referencing skills. The data the students presented from their astronaut research indicated that they were beginning to grasp the concept that there was more to NASA than being the commander of a shuttle into space.

During the Earth and Space unit students asked a variety of questions. The objective of this activity was to promote students working together and seeking answers to questions that interested them. The following are example of students’ questions:

- Where did peers find a particular site on the World Wide Web for the astronaut presentation?
- Is there black foil we can use for the solar cooker?
- Where should we place the cooker so that it gets as much of the sun’s rays as possible?
- Where does this date go on the timeline for the space history?

The students assisted each other in finding solutions to questions. In order for students to work easily together this researcher felt the students needed a risk free environment to feel comfortable to ask questions and be able to discuss their projects openly with their teacher and their partners. Students were also observed asking analysis and evaluative questions, during some of the lab activities, and the students had a risk free learning environment in the science classroom.

Science is Fun

Students appeared to have fun in each facet of the guided inquiry units of Matter, Energy and Force, and Earth and Space. Data collected supported that the students had fun during the guided inquiry activities, in which they were engaged and was triangulated
using the following indicators: students’ journal entries, teacher observations, lab activities, and student made projects.

The students complained of sore cheeks after the gum lab during one of the Matter lab activities. However, this researcher wonders if the facial soreness was from just chewing gum for two consecutive minutes, or was the soreness from the continual smiling for two minutes while chewing.

During one of the labs for Energy and Force, students created and assembled solar cookers to cook hot dogs. This researcher observed students secretly creating and assembling their cookers using their bodies as barriers and giggling at their creations. The making of the cookers took more time than the allotted daily science block. The hot dogs were kept in the school’s refrigerator for a few days while the students and I watched and listened to the weather forecast for a bright sunny day. The chosen day for cooking started with bright clear skies, so the daily lesson plans were rearranged in order to allow adequate time for cooking the hot dogs. In our geographical area we have Daylight Savings Time, so the students thought it would be good to go outside to cook just before noon, as they believed this to be the hottest part of the day.

Unfortunately, clouds accumulated and blocked the sun’s rays. A few of the hot dogs received enough rays to become warm; they even got a little moisture on them. However, none of them cooked to the swelling look that hot dogs get after being thoroughly heated. The cooks, feeling disheartened by the lack of sun rays still evaluated the day as a fun learning day. The following are entries about the fun cooking day from their journals:

Pick a hotter day to cook. It was so fun.
Put more walls on the cardboard. If you close it, it will warm up faster.
(These partners made an oven.)

I think it was a little successful, because when I ate it, it tasted kind of cooked. If I ever do this again, I hope for it to get a little more cooked. I think me and my partner had a really good time doing it.

I think that we put a little bit more of the dull part of the foil than the shiny side. That’s where I think I mess up, and why my hot dog didn’t cook. It was fun being outside.

This was a fun experiment with solar energy. I liked it because we got to be creative and go outside. I think it failed because there wasn’t lots of sun, and when there was it lasted for a little amount of time. Solar energy is hard to collect, because it is protected by the ozone layer, and it has to reflect against something to land on the object you want heated.

It was fun, and I really tried hard to cook my dog. It’s cool.

Patience is needed to cook a hot dog with tin foil. I learned that you should try other ideas, not just the same one in a different spot. I learned that you should use your partner’s and your ideas and not brag when you’ve done something.

The 5-E Model of learning for guided inquiry suggested to this researcher by the data collected that students had fun in science while investigating and learning throughout the study. The students’ journal entries, lab activities, and teacher’s observations gave an indication that students enjoyed science in this fifth grade classroom.

Summary

The themes revealed for this study were: 1.) Students were thinking critically, 2.) Lab activities supported student academic performance, and 3.) Science is fun. The lab activities for Matter, Energy and Motion, and Earth and Space units presented data through the students’ journals, projects, and teacher observations gave support that
students thought critically throughout the units in science, that lab activities encouraged students’ engagement in the science classroom, and that students felt science was fun.

In chapter Five, I gave further elaborations on my use of guided inquiry on students’ performances and academic attitudes in the science classroom. Also, in chapter Five, is an overview of the review of research literature, limitations, assumptions, and recommendations for future research.
CHAPTER FIVE: CONCLUSION

The purpose of this study was to examine the effect of guided inquiry on students’ attitudes and academic performance in my fifth grade science classroom. The curricular units of study were Physical Science and Earth Science. The topics of study were Matter, Earth and Space, and Processes that Shape the Earth. The study was conducted over a period of twelve-weeks within my fifth grade classroom with seventeen students. Emerging themes from the collected data suggested that students think critically, lab activities support student academic performance, and that science is fun.

Conclusions

In this study, data were also analyzed using students’ projects, such as solar cookers, timelines, and PowerPoint presentations. The students’ projects revealed they had answered necessary questions needed in order to complete the assignments. The students used media resources and technology to successfully complete and present their research findings to the whole class. The guided-inquiry lab activities, field notes, students’ journals during this study did indicate that students enjoyed the hands-on experiences, and were engaged during the labs.

This researcher indicated that the interest level and attitudes toward the science classroom showed enthusiasm and excitement during lab activities using the teacher as a facilitator inserting questions (Frase, 1967), throughout the science instruction. According to Blosser (1979), “good questions” keep the classroom operating smoothly,
emphasizes a point, reinforces learning, checks retention, promotes discussion, and stimulates students’ thinking (p.3).

Assumptions

Several assumptions were made prior to conducting the study. One was that all students would give honest independent answers to all questions on the attitude survey. In addition, it was assumed all students would answer and discuss teacher questions, while in group discussions and lab activities, with sincere honest responses. Another assumption was that this researcher’s views about guided inquiry during instruction did not affect students’ attitudes.

Limitations

Several limitations may have affected this action research project. The length of time for each topic of instruction was limited to the district’s mandate for pacing the content. Specific units of study are required instruction before the FCAT is administered in the spring. If time had not been an issue for instruction, the researcher would have provided students with time to use the technology and complete investigation in the curriculum presented in order to tap their curiosities more and allow the students more freedom in finding their own answers to their questions.

Data collection in the learning environment was a possible limitation to this study. Only my perspective was recorded when collecting field notes on participation and on student and teacher questioning.
Another limitation was that some students lacked familiarity with some of the questions on the attitude survey. Too many students began asking how to pronounce words on the survey, which made this researcher question the range of the vocabulary of the survey; therefore, the questions were read aloud to all the students and wait time was given for them to circle their decisions. This, I believe could be a limitation because Gall, Borg, and Gall (1996) states, “Individuals with little or no information about the topic might express an opinion in order to conceal their ignorance, or because they feel social pressure to express a particular opinion” (p. 297).

This researcher also questions the use of the standard curriculum questions, and the readability level of the district, adopted tests for the science curricular. Three passages from the district adopted text for science were retyped and given a readability level test using Microsoft Word. The readability statistics provided by the Flesch-Kincaid Grade Level revealed reading levels for grades 6.7, 8.4, and a 9.1, all of which are above a fifth grade level for independent reading.

Lastly, students’ achievement level may have been a limitation in this study. Thirty percent of the students in this study had Academic Improvement Plans (AIP) in place for reading comprehension and for writing deficiencies. In order for a student to be placed on an AIP, they must be at least one grade level below the expectations for the grade they are enrolled; several of these students were one and two levels below the reading performance for the fifth grade level. Students reading performance level could have been a factor affecting the students’ academic performance during the guided-inquiry and questioning instruction.
Discussion

This researcher found that using guided inquiry during lab activities and class discussions may have possibly had a positive effect on the students’ attitudes during science, although students did not specifically write that they learned more from guided inquiry. In order for students to work easily together, this researcher felt that the students needed a risk free environment to feel comfortable to ask questions and be able to discuss their projects openly with their teacher and their partners. This researcher also believed the students had a risk free learning environment in the science classroom that allowed students a more relaxing, carefree and fun environment for learning. To this researcher the use of guided inquiry throughout lab activities and group discussions may have given students a catalyst for learning because, they were engaged in their own group discussions and individual questionings during the units of study.

The student attitude survey (see Appendix F) resulted in 72% of the students agreed that they enjoyed discussing what they had discovered in science and 82% of the students agreed that they learned more when working in a group and sharing ideas. Ninety-five percent of the students on the post survey indicated that learning science is not boring. The fact that the students liked discussing questions at all was encouraging to this researcher.

This researcher also discovered that no matter how trivial she believed the students’ comments and questions were their group discussions and questions were important to them. However, getting the students to express this importance fully in their journals was a difficult task, if not almost impossible. Many of the students’ journal entries listed the facts of the assignment and rarely did a student engage in writing a
descriptive paragraph with any substance relating to the science concept. One possibility for this could be that even though the students are subjected to an enormous amount of writing in the previous grade, they may not look at science as needing anything but the facts.

The solar cooker project was a project in which the guided inquiry did not go as well as this researcher had expected during the lab. Students were given aluminum foil, skewers, cardboard, black construction paper, and tape to use in constructing their cookers. The directions given to the students gave them a free reign in designing and constructing their cookers, however, the majority of the students kept asking for teacher assistance to build and design the cookers.

I cannot say for any certainty that the students’ academic performance was increased by the use of guided inquiry. However, the students’ class and group discussions that I observed indicated they were enjoying science, and according to the survey, the students believed they were learning more by working with groups and partners.

Recommendations

In my search to find equilibrium for teacher questioning in the science classroom, I have found that more research is needed on how I use questions, and make decisions about questions during guided inquiry.

My plan for my future science classrooms is to incorporate more guided inquiry into my science lessons. The directions from the science text were sometimes difficult for the students to read independently. This was one of the reasons this researcher felt it
necessary to allow students to work with partners and groups throughout the study. The reading level in this researcher’s classroom varied greatly. The reading range was from second grade to fifth grade and this researcher found that the students needed smaller groups, or individual, guidance in reading non-fiction text. I also plan to let students have more hands-on learning and guided-inquiry instruction using the teacher as a facilitator trying to stimulate students to question their questions in order to be productive and inquisitive learners, because during the study, I noticed students were engaged and enjoying the time spent during science class. The teacher still needs to be the facilitator and stimulus, when students need encouragement, because as teachers, I feel we have an obligation to be a guide for our students. My goal as a teacher is to teach for understanding in the science classroom, develop a sense of risk taking and create a community of learners who want to question the questions on the lifelong journey of learning.

Because of this study, my plan is to continue researching effective teaching strategies for my science classroom. Guided-inquiry, overall, worked well during the science lab activities and students were enthusiastic while interested in learning and sharing their ideas. My goal is to develop instructional plans that support the Florida Sunshine State Standards, and guided-inquiry with purposeful use of questions. My hope is to develop a classroom where teaching for understanding is the focus that will lead students to a life long journey of learning.
June 21, 2004

Mrs. Deborah Spiess
109 Shomate Drive
Longwood, FL 32750-3031

Dear Mrs. Spiess:

With reference to your protocol entitled, “The Effect of Teacher Questioning in Science Education,” I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur. Further, should there be a need to extend this protocol, a renewal form must be submitted for approval at least one month prior to the anniversary date of the most recent approval and is the responsibility of the investigator (UCI).

Should you have any questions, please do not hesitate to call me at 823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward, CIM
Institutional Review Board (IRB)

Copies: Dr. Bobby Jeannpierre
IRB File
June 17, 2003

To Whom It May Concern:

Deborah Spiess is currently a fifth grade teacher at Red Bug Elementary and has requested permission to conduct research with her classroom students. It is my understanding that the research will focus on Mrs. Spiess’s current teaching practices and questioning techniques. Through this research project she will examine current practices and develop conclusions that will improve the thinking skill of her students through teacher questioning. Mrs. Spiess has received my approval upon notification to parents.

Mrs. Spiess has also been instructed to contact Dr. Pimell’s office for district approval of the above request. Please feel free to contact me if necessary at 407-320-8350.

Sincerely,

Marian Cummings
Principal
September 22, 2003

Ms. Deborah Spiess
109 Shomate Drive
Longwood, FL 32750-3031

Dear Ms. Spiess:

I am in receipt of the proposal and supplemental information that you submitted for permission to conduct research in the Seminole County Public Schools. After review of these documents, it has been determined that you are granted permission to conduct the study described in these documents under the conditions described herein.

Each school principal has the authority to decide if he/she wishes to participate in your study or if it is appropriate to release any requested information. Therefore, your first order of business is to contact the principal(s) of the school(s) that you wish to involve in your research to explain your project and seek permission to conduct the research at that particular school.

You are expected to make appointments in advance to accommodate the administration and/or staff of the school for research time. Furthermore, any processing or comparison of data will be your responsibility and shall not impact our Testing Department.

Please forward a summary of your project to my office upon completion.

Good Luck!

Sincerely,

[Signature]

Ronald L. Pinnell, Ed.D.
Executive Director
Secondary Education
**Title of Research (topic):**
The Effect of Teacher Questioning in Science Education

**Statement of Problem or need to be addressed:**
The needs to be addressed are: how are my questioning practices working in the classroom and what do I need to do to improve my questioning strategies in order for students to have better attitudes towards Science, show improvement in academic performance in Science, and help students learn to use higher order questioning strategies for Science.

**Briefly describe what you would like to do:**
The purpose of the action research is to examine the effects of my questioning practices on students' academic performance and attitudes during science instruction. The use of questioning allows students the opportunity to investigate, explore and discover, using their own questions, curiosities and interests in a science classroom setting (Pearce, 1999, p.5).

**Briefly list measures to be taken and instruments to be used**
Include a copy of those instruments not in common use and any available technical support on these instruments.

The researcher is a teacher at Red Bug Elementary School in Seminole County, FL. This is a qualitative study of the researcher's practice as a teacher. The FL Sunshine State Standards for Science instruction will be addressed during class instruction. Data collected for the research will be from student surveys, student journals, student assessment, audio and video taping of the teacher during instruction, and the teacher's journal.

**Briefly describe subject groups participating in the research:**

<table>
<thead>
<tr>
<th>Grade level</th>
<th>Total #</th>
<th>Relevant Characteristics</th>
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<td>5</td>
<td>25</td>
<td>The participants in this research will include the teacher and the students assigned, by the administration of the school, to this teacher's class for the year 2003-2004. The school is located in the district of Seminole County in the State of FL. The ages of the students range from 9 to 12 years of age. No compensation will be given to the participants.</td>
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**How are participating subjects selected (randomly, matched, etc.):**
The participants in this research will include the teacher and the students assigned, by the administration of the school, to this teacher's class for the year 2003-2004.
# Research Permission Request

Seminole County Public Schools  
400 East Lake Mary Blvd  
Instructional Support Services Department  
Sanford, FL 32773  
407.320.0022

<table>
<thead>
<tr>
<th>School/Department Involvement (Indicate # of school sites by level)</th>
<th>School/Department Personnel Involved (e.g., teachers, administrators, guidance counselors, etc.)</th>
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<tr>
<td># of each school level</td>
<td>School or Department Name</td>
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<tr>
<td>1</td>
<td>Red Bug Elementary</td>
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</table>

School facilities needed (briefly list space, materials, equipment, etc. necessary for the proposed research—also list the purpose or use intended for each item listed)

<table>
<thead>
<tr>
<th>Item</th>
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</table>

Signature of Researcher: [Signature]

Please Print Name: Deborah S Spieca

Signature of Sponsor: [Signature]

Please Print Name: Bobby Jeampierre, Ph. D.

**ENCLOSURE CHECKLIST**

(One copy of each of the following must accompany this request)

- [ ] Completed research permission request form.
- [ ] An abstract of the research (3 page limit)
- [ ] Evidence of a review of the relevant literature and previous research.
- [ ] Instruments to be used.
- [ ] Procedures to be used to ensure confidentiality of subjects.
- [ ] Parental permission form and/or subject permission form.
Dear Ms. Spiess,
We have no objection to your using forms from "Nurturing Inquiry" as part of your research. Should you present a paper or thesis and wish to include the forms please be sure to acknowledge their source. Should you wish to commercially publish any of the forms you will need to re-apply for permission.

Sincerely,
Peggy Wishart
Permissions, Contracts, and Copyright Coordinator
Heinemann-Boynton/Cook

--------Original Message--------
From: Teach216@aol.com [mailto:Teach216@aol.com]
Sent: Monday, September 08, 2003 11:33 PM
To: permissions@heinemann.com
Subject: request to use information from books

Dear Sirs:
I respectfully request to use several of the forms in "Nurturing Inquiry," by Charles Pearce for my college research. I am researching teacher questioning strategies in the classroom and I believe several of the forms found in this book would be beneficial to me. Thank you for your time,
Deborah Spiess

**********************************************************************
This message is intended only for the use of the Addressee and may contain information that is PRIVILEGED and CONFIDENTIAL. If you are not the intended recipient, dissemination, distribution, and/or copying of this communication is prohibited. If you have received this communication in error, please erase all copies of the message and its attachments and notify us immediately.

Greenwood Heinemann Publishing

Greenwood MIS @ (203) 226-3571
Heinemann MIS @ (603) 431-7894
**********************************************************************
APPENDIX C: PARENTAL CONSENT FOR ACTION RESEARCH AND CHILD ASSENT FORM
September 29, 2003

Dear Parent/Guardian:

I am a graduate student at the University of Central Florida under the supervision of faculty member Dr. Bobby Je nanopierre conducting research on questioning strategies in the elementary classroom.

The purpose of this study is to examine the effects of my practice in the use of science as inquiry to promote students' understanding of environmental education. The results of this study may help other teachers better understand the use of science as inquiry in environmental education and allow them to design instructional practices accordingly.

These results may or may not directly help your child today, but may benefit future students. All of the students will participate in the inquiry process, but the research data of only those students with signed permission forms will be used in the data analysis and thesis report. With your permission, your child will be asked to respond to pre and post surveys to determine attitudes toward learning science in general and learning about the environment. The pre-survey will take place in September, and the post-survey will take place in December. The children will be asked to write their names on both surveys for matching purposes, their identity will be kept confidential to the extent provided by law. Names will be replaced with code numbers.

Results will only be reported in the form of group data. Participation or nonparticipation in this study will not affect the children’s grades or placement in any programs.

You and your child have the right to withdraw consent for your child’s participation at any time without consequence. There are no known risks or immediate benefits to the participants. No compensation is offered for participation.

Group results of this study will be available upon completion of this study at your request. If you have any questions about this research project, please contact me at (407) 320-8374, or my faculty supervisor, Dr. Bobby Je nanopierre at (407) 823-4930.

Questions or concerns about research participants' rights may be directed to the UCFIRB office, University of Central Florida Office of Research, Orlando Tech Center, 12443 Research Parkway, Suite 207, Orlando, FL 32826. The hours of operation are 8:00 AM until 5:00 PM, Monday through Friday except on University of Central Florida official holidays. The phone number is (407) 823-2901.

Sincerely,

[Signature]

Deborah S. Spiess
Assent:

Dear Students:

In addition to being your science teacher, I am also a graduate student at the University of Central Florida. This year, I will be completing a study on the effectiveness of my questioning practices while teaching the Science curriculum. I will ask you to keep a journal and complete surveys regarding your attitude of Science. I also will be video taping and audio taping some of our instructional lessons. The video and audio tapes will only be viewed by my college professor and me. The tapes are being made to that I can make improvements in my questioning practices in the classroom, which in turn will benefit both of us in our understanding of Science. Both the video and audio tapes will be secure and destroyed at the end of the project. I will not use any of your names in the project. I welcome your input at anytime during the project and participation will not affect your grade in this class.

____ 1. I would like to participate in this study.

____ 2. I do not choose to participate in this study.

_________________________ Student’s signature  Date ____________________
I have read the procedure described above. I voluntarily give my consent for my child, ____________________, to participate in Deborah S. Spiess’ study of questioning strategies in the elementary classroom.

Parent/Guardian  Date

_____ I would like to receive a copy of the procedure description.

_____ I would not like to receive a copy of the procedure description.

2nd Parent/Guardian  Date
(Or Witness if no 2nd Parent/Guardian)
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
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<tbody>
<tr>
<td>Originality</td>
<td>Presentation shows considerable originality and inventiveness. The content and ideas are presented in a unique and interesting way.</td>
<td>Presentation shows some originality and inventiveness. The content and ideas are presented in an interesting way.</td>
<td>Presentation shows an attempt at originality and inventiveness on 1-2 cards.</td>
<td>Presentation is a rehash of other people's ideas and/or graphics and shows very little attempt at original thought.</td>
</tr>
<tr>
<td>Content - Accuracy</td>
<td>All content throughout the presentation is accurate. There are no factual errors.</td>
<td>Most of the content is accurate but there is one piece of information that might be inaccurate.</td>
<td>The content is generally accurate, but one piece of information is clearly flawed or inaccurate.</td>
<td>Content is typically confusing or contains more than one factual error.</td>
</tr>
<tr>
<td>Spelling and Grammar</td>
<td>Presentation has no misspellings or grammatical errors.</td>
<td>Presentation has 1-2 misspellings, but no grammatical errors.</td>
<td>Presentation has 1-2 grammatical errors but no misspellings.</td>
<td>Presentation has more than 2 grammatical and/or spelling errors.</td>
</tr>
<tr>
<td>Use of Graphics</td>
<td>All graphics are attractive (size and colors) and support the theme/content of the presentation.</td>
<td>A few graphics are not attractive but all support the theme/content of the presentation.</td>
<td>All graphics are attractive but a few do not seem to support the theme/content of the presentation.</td>
<td>Several graphics are unattractive AND detract from the content of the presentation.</td>
</tr>
<tr>
<td>Background</td>
<td>Background does not detract from text or other graphics. Choice of background is consistent from card to card and is appropriate for the topic.</td>
<td>Background does not detract from text or other graphics. Choice of background is consistent from card to card.</td>
<td>Background does not detract from text or other graphics.</td>
<td>Background makes it difficult to see text or competes with other graphics on the page.</td>
</tr>
<tr>
<td>Sequencing of Information</td>
<td>Information is organized in a clear, logical way. It is easy to anticipate the type of material that might be on the next card.</td>
<td>Most information is organized in a clear, logical way. One card or item of information seems out of place.</td>
<td>Some information is logically sequenced. An occasional card or item of information seems out of place.</td>
<td>There is no clear plan for the organization of information.</td>
</tr>
<tr>
<td>Sources</td>
<td>At least three (3) different sources were used in the research. Sources were listed in the presentation.</td>
<td>At least two (2) different sources were used in the research. Sources were listed in the presentation.</td>
<td>Some sources used in the research were identified and listed in the presentation.</td>
<td>No sources for the research were identified or listed in the presentation.</td>
</tr>
<tr>
<td>Required Number of slides</td>
<td>Exceeded the required number (4) of slides. All slides were used appropriately for this presentation.</td>
<td>Met the minimum (4) number of slides, and were appropriately used for this presentation.</td>
<td>Two (2) or three (3) slides were in the presentation.</td>
<td>No slides were presented.</td>
</tr>
</tbody>
</table>
**Teacher's Directions**

**Mass in Motion**

**Materials**
Performance Task sheet, three large marbles, three small marbles, piece of poster board, three or four books, tape, meterstick

**Time**
30 minutes

**Suggested Grouping**
groups of three or four

**Science Processes**
observing, comparing, identifying and controlling variables, gathering data, recording data, inferring, communicating

**Preparation Hints**
Place a set of marbles for each group in a plastic bag or envelope. Make sure sufficient space is available for the marbles to roll freely on the carpet or floor.

**Introduce the Task**
Explain to students that they will collect data to determine the relationship between mass and momentum. They will compare how far two different-sized marbles travel on a flat surface after traveling down a channel. Make sure students hold the marbles very still before releasing them and that the marbles are all released from the same point.

**Promote Discussion**
When students finish, have each group present its findings. Ask students to explain their conclusions. If any data seems incorrect, ask the students to determine what might have interfered with their data collection or recording.

---

**Scoring Rubric**

**Performance Indicators**

- Completes all steps in the experiment.
- Records in a table the distance each marble traveled.
- Calculates the average distance each size of marble traveled.
- Concludes that the larger marbles have greater mass, which increases momentum and causes the marbles to travel farther.

**Observations and Rubric Score**

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<td>3</td>
<td>2</td>
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</tbody>
</table>
APPENDIX F: ATTITUDE SURVEY
Table 1: Students’ Attitudes Towards Science in the Classroom

<table>
<thead>
<tr>
<th>Questions:</th>
<th>SA</th>
<th>A</th>
<th>D</th>
<th>SD</th>
<th>NO</th>
<th>M</th>
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<tbody>
<tr>
<td>Learning is boring.</td>
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<td>Pre</td>
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<td>24%</td>
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<td>Post</td>
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<td>35%</td>
<td>60%</td>
<td>0%</td>
<td>5.7</td>
<td>3.7</td>
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<td>I learn best by reading chapters and answering</td>
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<td>questions.</td>
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<td>3.5</td>
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<td>Post</td>
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<td>When I talk things over with my partner</td>
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<td>I understand more about what I am learning.</td>
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SA = Strongly Agree; A = Agree; D = Disagree; SD = Strongly Disagree; NO = No Opinion; M = Mean; sd = Standard Deviation; n = 17
APPENDIX G: PERFORMANCE TASK
You have already seen firsthand how mass and velocity affect momentum. Now you are going to investigate the relationship between mass and momentum. You and your small group will do this by comparing how far different-sized marbles roll after rolling down an inclined plane.

1. First, create a track for the marbles by folding the poster board in half lengthwise, so a V-shaped channel is formed. On a carpeted area, stack books to raise the height of one end of the channel to about 15–20 millimeters. Use tape to hold the channel in place. Arrange the books and channel so the marbles will run onto the carpet.

2. Carefully hold each marble in the track and release it without pushing. Start with the three large marbles. Measure the distance that each marble travels. Calculate the average distance traveled for the large marbles. Do the same for the small marbles. Record your results as a table on a separate sheet of paper.

3. Compare the average distance traveled by the large marbles with the average distance traveled by the small marbles. What is the relationship of mass to momentum? Write your conclusion in the space below.
# TEACHER OBSERVATION FORM

**TOPIC:** ________________  
**Date:** ______

<table>
<thead>
<tr>
<th>NAME</th>
<th>Participation 0-5</th>
<th>Tchr.Comments/Questions</th>
<th>Other</th>
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Matter and Its Properties

Part 1  Vocabulary

Use the letters of the terms in the Word Banks to complete the sentences.

<table>
<thead>
<tr>
<th>A gas</th>
<th>C liquid</th>
<th>E mass</th>
<th>G matter</th>
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</thead>
<tbody>
<tr>
<td>B solid</td>
<td>D volume</td>
<td>F weight</td>
<td>H solubility</td>
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All material that takes up space is called 1. ____. The amount of material in an object is called the object’s 2. ____. An object’s 3. ____ is the pull of gravity on the object.

All material takes the form of a solid, a liquid, or a gas. A 4. ____ has a definite volume but no definite shape. A 5. ____ does not have a definite volume or a definite shape. A 6. ____ has both definite volume and shape. You can measure the amount of space a solid object takes up, or the 7. ____ of a solid object, by placing the object in a graduated cylinder with water and measuring how much water is displaced. Sometimes the ability to be dissolved, or 8. ____, can be used to identify a substance.

<table>
<thead>
<tr>
<th>I condensation</th>
<th>K density</th>
<th>M evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>J physical properties</td>
<td>L reactivity</td>
<td>N combustibility</td>
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</table>

A liquid can change into a gas. This process is called 9. ____. A gas can also turn into a liquid. This reverse process is called 10. ____.

Other 11. ____ of substances, like color, size, and hardness, can be found without changing the substance into something else. You can divide the mass of an object by its volume to find the object’s 12. ____.

Chemical changes can turn substances into other substances. The ability of a substance to go through a chemical change is called 13. ____. The ability of a substance to burn is called 14. ____.
Part II  Science Concepts and Understanding

Write the letter of the best choice.

15. Which of the following is NOT a physical property?
   A color   B density   C solubility   D reactivity

16. When iron rusts, it no longer conducts electricity. This is because it —
   F changed chemically       H is in water
   G changed physically       J lost its luster

17. The density of an object is a —
   A combustible property   C chemical property
   B reactive property       D physical property

18. Weight is measured on a scale. Mass is measured on a —
   F thermometer           H barometer
   G balance                J scale

19. Changing the shape and amount of a substance does NOT change its —
   A volume   B density   C mass   D appearance

20. In which of the pictures below is a substance undergoing a chemical change?
   F I       G II       H III       J IV

   I         III
   II        IV
APPENDIX J: MSPD ACTIVITY CARDS
Center 1: Toy Cars

Explore the toy cars with the measuring tools provided.

- Observe and describe the motion of both types of cars.
- Make a prediction about the motion of the cars.
- Measure something about the motion of the cars.

Center 2: Drip timer

Explore the drip timer by filling it with water and opening the valve until water drips out at a steady rate. Use the pie pan to catch drips.

- Describe the motion of the water drops.
- Predict something about the drip timer.
- Make a measurement using the drip timer.

Center 3: Pendulums

Explore the pendulum as it swings.

- Observe the motion of the pendulum.
- Make a prediction about the motion of pendulum.
- Measure something about the motion of the pendulum.
FORCES
Learning Experiences

7. Slinky
Play with a slinky.
Describe how a slinky works.
Why can't a slinky go UPSTAIRS?
Would a slinky work on a circular staircase?
What factors might make a slinky move faster than another slinky?
Which factors are the most important?

8. Tennis Ball
Drop a tennis ball into a container of water.
What happens?
Why did the ball fall into the water?
What forces were acting on the ball when it fell?
What forces are acting on the ball in the water?
What forces are acting on the water?
LIST OF REFERENCES


from the National Science Foundation website, http://www.nsf.gov/pubs/2000/nsf99148/1cd/ch_1.htm


