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THE EFFECT OF INQUIRY-BASED INSTRUCTION ON STUDENTS’ PARTICIPATION AND ATTITUDES IN A THIRD GRADE SCIENCE CLASSROOM

by

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Education in Science 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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ABSTRACT

The National Science Education Standards (1996) support inquiry-based instruction. According to the National Science Education Standards (National Research Council, 1996, p. 122 & 145). When children or scientists inquire into the natural world they: ask questions, plan investigations and collect relevant data, and organize and analyze collected data. The purpose of this study was to investigate the effects of inquiry-based instruction on third-grade students’ attitudes and participation in an elementary science classroom. Students were encouraged to ask and answer their own questions.

In this study, analysis of data gathered form: pre and post survey, student journals, teacher field notes, and student interviews were triangulated to provide the support for findings reported in this study. Findings showed that inquiry-based science experiences positively affected students’ attitudes in science and their participation. In addition, students worked collaboratively, made connections to other experiences, and demonstrated confidence in their ability to ask and answer their own questions through inquiry-based experiences.
This book is dedicated to my friends and family. I want to thank them for being my source of support and strength. They believed in me and cheered for me all the way.

I especially want to thank Laurie who never doubted the fact that I could do this, and kept me going with her support and encouraging words.
ACKNOWLEDGMENTS

I would like to say thank you to all the children who participated in my study, without you this study has no purpose. They allowed me to take a closer look at my teaching so I could become a better teacher. I would like to express my appreciation to all the UCF professors who helped me along my journey. To my advisor Dr. Jeanpierre and my cohort group who believed in me, and gave me many words of encouragement. What a wonderful group of people. To my colleagues Pam and Cindy who would not let me give up when things got tough. Finally, to my sister, brother, and Mom and Dad, you have made me the person I am today. I love you all.
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LIST OF ACRONYMS/ABBREVIATIONS

LEP  Limited English Pupil
TOSRA  Test of Science-Related Attitudes
SCIIS  The Science Curriculum Improvement Study
SLD  Specific Learning Disability
Throughout my teaching career, I have found that motivating students and keeping their interest in science has been a challenge. I first started teaching in 1989 when emphasis on “hands-on science” was on the rise. However, I was not always pleased with the level of engagement or challenges I received from my students. My prime directive as a teacher has been to find ways of making my students successful contributors to a rapidly changing world, and to be able to solve difficult problems. The National Science Education Standards (1996) have developed new science models for teachers to integrate inquiry-based instruction into their science curriculum. New frameworks in recent school reforms call for higher standards in teaching successful reasoning and problem solving involves everyday life and produces lifelong learners. I want my students to be able to question their surroundings, search for answers, and come up with solutions on their own. These areas can be addressed through a collaborative inquiry-based curriculum. An interactive atmosphere in which students and teachers are posing problems and questions for further investigation which stem from the students’ experiences, interests, and needs. I have always played the role of a facilitator of learning as opposed to simply a provider of information. I have continued to create an atmosphere where students may use as many resources necessary to construct connections between their learning and the observations of others.

**Rationale**

Inquiry-based instruction is not a new phenomenon to education. It had its start in the 1950s, particularly in science education. During this time, the space race with the Soviet Union was
increasing the necessity for the development of a more intense science curriculum. “If a single word had to be chosen to describe the goals of science educators that began in the late 1950s, it would have to be inquiry” (Haury, 1993 p. 4). “After the Russian’s launch of the Sputnik satellite in 1957, further development in inquiry-based curriculum occurred” (National Research Council, 1996, p. 17). During this time, children had a reason and a purpose to engage in science exploration. I have chosen the inquiry-based instruction, the major facilitator of the constructivist philosophy, to provide my students with the purpose to engage in science. This approach is taken in the hopes that within each student scientific questions are encouraged and attitudes towards science are improved.

Just as inquiry-based learning has been a departure from the more traditional teaching methods, constructivism is a departure as well. The traditional philosophies surrounding the cognitive abilities of students have been challenged by the more modern constructivism. Instead of simply trying to control the behavioral environment and promote the sterile, objective absorption of material, constructivist believe that “determining truth requires a value judgment on the part of the individual” (Alkove, 1992, p. 12).

A constructivist classroom involves the process of questioning, exploring and reflecting, by allowing students to construct their own understanding and knowledge of the world through experiences. It is essential for students to reflect on these experiences and assimilate useful information to create personal knowledge. The Constructivism approach includes an esteemed community of advocates and authors such as Dewey, Vygotsky, and Piaget. “Only by getting involved in the construction of knowledge, by transferring ideas and opinion into beliefs through inquiry, does one ever get knowledge of the method of knowing” (Dewey, 1910, p. 17). In *Science as Subject-Matter and as Method*, Dewey (1910) stated that “text-books and lecture are
not enough; that the students must have laboratory exercises” (p. 4). I believe Charles R. Pearce brought out Dewey’s philosophy best in his book *Nurturing Inquiry*. “Pearce reiterates that the primary goal of an inquiry-based curriculum is to facilitate a child’s ability to think autonomously, conducting processes internally.

Pearce (1999) stated, “Children are authentically motivated to do science for one basic reason; to find out!” (p. xi). If this is so, then why is there a need to motivate students to engage science? Students need instruction that encourages exploration. Inquiry-based instruction offers students opportunities to seek out answers. Inquiry will lead them down paths that may result in having to backtrack, search in new places, and ask other questions. In other words, an inquiry-based curriculum will treat students as if they are truly scientists. Pearce (1999) explains the teacher’s role as being a vital tool in motivating our students.

As teachers, it is important to maintain a sense of wonder about the world around us. Teachers should share enthusiasm for discovery and model the joy in exploring. Teachers need to validate children’s questions and guide them to seek out answers (p.139).

I have examined how my practices affect my students’ motivation toward science. I have integrated a more student initiated, inquiry approach to my teaching style and explore its effects on my students’ perspective and attitude toward science.

**Significance of the Study**

Inquiry-based instruction has been included in science curriculum across the nation. In recent years, many American schools have incorporated inquiry into their lessons. Many states have
passed mandates to contain inquiry-based instruction in schools. Inquiry and the National Science Education Standards (2000) take a strong stand supporting student involvement in an active process of inquiry. They describe the following process skills for grades K-4: (a) ask questions about objects, organisms, and events in your environment, (b) plan and conduct a simple investigation, (c) Communicate investigations and explanations (p. 19). Carlson, Humphrey, and Reinhardt suggested recommendations teachers could use in the search for an approach to inquiry-based instruction in their science program:

1) Use your daily classroom experiences to learn about your students’ thinking and abilities and the impact of your teaching strategies.

2) Reflect on what you most value in teaching and learning. Explore how these core beliefs align with national and local teaching and learning standards, and how they clarify a vision to drive your instruction.

3) Seek opportunities to collaborate, explore new idea, and share experiences and share experiences dilemmas with colleagues.

4) Build administrative support by sharing your experience of the benefits of classroom-based professional development (Carlson, Humphrey, & Reinhardt, 2003, p. 108).

Bonnstetter (1994) believed schools should be engaged in an inquiry-based teaching program for the following three reasons. First, to develop a framework of yearlong and short-term goals for students. Second, to select science content and adapt and design curricula to meet the interests, knowledge, understanding abilities, and experiences of students. Third, to select teaching and assessment strategies that supports the development of student understanding and nurture a community of science learners.
**Purpose of Study**

The purpose of this study was to investigate how inquiry-based instruction affected students’ participation and attitude toward science. The ultimate objective was to recognize and implement changes in the classroom curriculum that stimulated student interest while creating relevancy in each student’s life. Macleod and Moseley concluded that, “As with science itself, perhaps learning science proceeds not by the testing of one theory against the data, but by first making an imaginative leap which enables a new way of thinking about a problem to take place” (p. 81). The questions, and subsequent answers, of this study are designed to reach the goal of better guiding students in creating a higher interest and understanding of science.

**Research Questions**

The following research questions will be addressed in this study:

**Research Question 1:**

How does inquiry-based instruction affect student attitude toward science?

**Research Question 2:**

How does and inquiry –based curriculum affect students’ participation?

**Research Question 3:**

Can students develop confidence in asking their own questions in inquiry-based lessons?
Definition of Terms

Constructivism

A theory of knowledge used to explain how we know what we know. Teaching and learning that draws on a range of teaching practices including inquiry-based learning, cooperative learning, and project-based approaches. Constructivism involves the process of questioning, exploring, and reflecting. This theory says that learners should construct their own understanding and knowledge of the world through varied experiences. By reflecting on these experiences, students assimilate useful information and create personal knowledge (Lorsbach, A. W., Tobin, K., 1997).

Inquiry

Multifaceted activity that involves making observations; posing questions; explorations and other sources of information to see what is already known. (National Science Education Standards, 2003) Inquiry refers to the means scientists use to study nature and formulate explanations of what they observe. Students are engaged as they pursue increased understanding of science. (Anderson, 2001).

Inquiry-based instruction

Inquiry-based instruction involves an active process that implies physical and mental activity. “Hands-on active” activities are not enough, students also must have “minds-on” experiences. Science detaching must involve students in inquiry-oriented investigations in which they interact with their teachers and peers. Students establish connections between
their current knowledge of science and the scientific knowledge found in many sources.

(Lorsbach, A. W., Tobin, K., 1997).

**Student Motivation:**

A student’s desire to participate in the learning process. There are qualitative and quantitative factors that yield positive results in the students’ aptitude and interest.

**TOSRA: Test of Science-Related Attitudes**

A science-related test co-authored by Barry J. Fraser and The Educational Testing Service that measures a student’s interest toward towards the science class. The results are placed on a Cartesian graph and analyzed (Fraser, 1977).

**Overview**

As an educator for thirteen years, I have noticed a decline in the student interest concerning scientific inquiry. The need for a coherent, decisive classroom curriculum, that has the students’ development as the main focus, is becoming more necessary as the sciences expand. There has been a greater emphasis placed on the necessity of technology, rather than engaging the deductive thought processes that shape science and utilize technology as a tool. As the classrooms become more and more eclectic in students’ cultures and needs, it is relevant that a curriculum should be just as eclectic and effective; hence the importance of the inquiry-based approach. Dewey believed a child is best prepared for the demands of responsible membership within the democratic community. The more that the communities of educators support the
students, the more the students are to be motivated and have their queries answered. Alkove and 
MCcarty (1992) wrote that, “the constructivist teacher often allows students to assume 
ownership of a subject by challenging them to articulate their personal goals for learning in that 
area” (p. 20). Therefore, this study is yet another necessary component in the analysis of inquiry-
based effectiveness experienced as a curriculum. The essential requirements of motivating 
students using inquire-based instruction were examined from data sources collected. Chapters 3, 
4 & 5 were concluded by linking the results in my study to research from relevant literature in 
chapter 2.
CHAPTER TWO: LITERATURE REVIEW

Introduction

“After long study and discussion under the guidance of an experienced teacher, a spark may suddenly leap, as it were, from mind to mind, and the light of understanding so kindled will then feed itself.”

-Plato

Research shows that inquiry-based instruction develops reasoning skills and heightens students’ motivation toward science (Carin & Bass, 2001; Kyle, Bonnstetter, & Gadsden, 1988; Marx, Blumenfeld, Krajcik & Soloway, 1997; Damnjanovic, 1999). “Within the context of teaching standards, inquiry is defined as a pedagogical method combining higher order questioning with student-centered discussion and discovery of central concepts through laboratory activities” (National Research Council, 1996, p. 18). The National Science Education Standards (NSES) and the Benchmarks for Science Literacy “recommend inquiry as the most desired and effective way for students to learn methods of doing science while they also learn to understand, apply, and retain scientific knowledge” (Leonard, Penick, & Douglas, 2002, p. 36). Recognizing the need to implement changes in my classroom curriculum that will engender student interest and become relevant to their lives, leads me to ask: What happens when students are actively involved in helping create their science curriculum through inquiry?
Novak (1979) debates as to whether students are best taught using the discovery teaching approach. For example, in a direct approach like lecturing, teachers tend to rely on textbooks to guide their instruction. Teachers who believe in direct instruction feel that students will not be able to discover scientific knowledge for themselves.

However, in a constructivist classroom students are allowed to explore their ideas through discovery. In summary of their findings, Carin & Bass, (2001) have shown that inquiry approach instruction develops reasoning skills through students’ investigations. A constructivist classroom draws out student curiosities, and allows students to take an active role in making discoveries in their world. As a result, students become motivated to designing experiments, investigate phenomena, and construct meaning from data and observation.

**History of Inquiry-Based Instruction**

The educator Joseph Schwab (National Research Council, 2000) argued that science should be viewed as conceptual structures that were revised as the result of new evidence. Joseph Schwab also recommended that science teachers look first into the laboratory and use these experiences to lead rather than follow the classroom phase of science teaching (p.15). Schwab’s perceptions on inquiry may have been considered profound in the twentieth century, but the topic of inquiry is not a new phenomenon to education. Over twenty-five hundred years ago Confucius believed that every person should strive for the continual development of self until excellence is achieved (Henson, 2003, p.7). Two hundred years later, about 386 BC, Plato had formed the Academy to counter the traditional teachings of the
Sophists. The Sophists taught rhetoric, self-expression and persuasion. Plato, however, believed that the main focus of study should be on mathematics, logic and philosophical discussion (p.5). This then became the first of many battles between the different foundations concerning the educational format.

Over two millennia later, education and its philosophical dichotomy re-surfaced after being lost in the European political shuffle. In the seventeenth century it was John Locke that introduced “experimental education”- the idea that one learns through experience. (Henson, 2003). In John Lockes’ An Essay Concerning Human Understanding, he responded to the question concerning where the mind gets its understanding: “To this I answer in one word, experience” (p.7). Another two hundred years passed before European educators Pestalozzi, Hegel, Herbart, and Froebel designed and popularized experienced-based, learner-centered curricula (p.5).

The beginning of the twentieth century brought with it a large quantity of advancements, particularly in education. One of the most influential educational reformists was John Dewey (1859-1952). John Dewey, an avid supporter of inquiry in education, was a visionary thinker in philosophy, education and social art. John Dewey’s educational ideology was considered progressive and ahead of his time. He argued that learning comes from so much more than lectures and reading out of textbooks. He believed that science is most productive in social environment. Dewey’s description of acquiring knowledge would fit right in with constructivist’s ideas.

Dewey professed that each child had psychological and social dimensions that, when explored and understood, would help the child succeed in the realms of education and community. The focus was to be placed on the child’s capacities, interests, and habits.
Dewey also recognized that the developing life of a child was a process of continual renewal and a series of ongoing experiments. These ideas Dewey believed provided form and structure of his educational setting. Dewey (1916) believed that the only way a child would develop to its potential was in a social setting.

Dewey’s view of a learner-centered education embraced the idea that education should be both problem-based and fun (Henson, 2003, p.10). Dewey believed that the experiences of each learner must come from within each learner and each experience should leave each student motivated. Also, the solving of each problem must lead to new, related questions about the topic (p. 10). Dewey stated that, “Unless a given experience leads out into a field of previously unfamiliar no problems arise, while problems are the stimulus to thinking” (P.10).

Jean Piaget is considered as the leader of constructivism development. He believes regardless of the science concept being taught, students were able to organize their thinking processes into a series of discoveries that led to understanding. Jean Piaget called this method schemes. (Jean Piaget: Genetic Epistemology, 1968, p.2) Schemes are building blocks that help one organize actions and thoughts of certain concepts, and to adapt them into an environment. A large amount of his research has been applied to education, even though he was not an educator. His background was in cognitive psychology. “In 1955, Piaget established the Center for Genetic Epistemology. Epistemology is the development of knowledge. He found that “knowledge is a constant construction of structures or schemes, with every experience reinforcing, revising, or replacing existing structures.” (Driver & Easley, p. 70).
Piaget was the most frequently cited author in the 1950s and 1960s in the movement for an improved course of study in child development and the learning process (Wadsworth 1996, p. 2). This is due to his three types of psychological theories. These are three major streams of psychological and educational thinking, each forming a theoretical position resting on a different set of assumptions (p.2). Each suggests different ways of “educating” a child. They are known as romanticism-maturationism, cultural transmission-behaviorism, and progressivism-cognitive development. A brief summary is sufficient for the purpose of this study (p.2).

According to Piaget, the first, romanticism-maturationism is essentially the claim that environment is only important only as it affects development by providing the necessary nourishment the growing organism needs (Wadsworth, 1996). Second, cultural transmission-behaviorism states that the job of education is the direct transmission of bodies of information, skills and the values of the culture of the child. This model suggests that the child can only learn through direct instruction; the teacher must teach the child. Finally, progressivism-cognitive development is an interaction viewpoint. Mental development is seen as the product of the interaction of the organism (the child) and the environment (p.4).

These radical shifts in the traditional educational format had been met with many obstacles. It was to be some years later, in a time of national necessity, which the ideas and philosophy of inquiry-based learning were to take hold. It had its advent in the 1950s, particularly in science education (Henson, 2003, p. 10). During this time, the Space Race with the Soviet Union was pushing for the increased development of a more intense science curriculum: “If a single word had to be chosen to describe the goals of science educators
during the 30-year period that began in the late 1950s, it would have to be inquiry” (Haury, 1993, p.4).

Although, descriptions vary from highly structured, teacher guided inquiry, where teachers control the questioning and outcomes, to the free rein inquiry where structure is minimal, a definition for inquiry could be agreed upon. Inquiry is the seeking of knowledge and understanding to fulfill a learner’s curiosity.

   In its essence, then, inquiry-oriented teaching engages students in investigations to satisfy curiosities, with curiosities being satisfied when individuals have constructed mental frameworks that adequately explain their experiences. (Haury, 1993, p.62)

   Advances in cognitive research and developmental psychology have developed an understanding of how children convey new information with what they already know in connection with personal experiences. Charles Pearce (1999) describes this as critical for students to develop self-esteem and self-empowerment. The National Science Education Standards (1996) have developed new science models for teachers to integrate inquiry-based instruction into their science curriculum. New frameworks in recent school reforms call for higher standards in teaching students successful reasoning and problem solving, which involves everyday life and produces lifelong learners.

   If a curriculum is truly learning-centered, then that curriculum is based on inquiry and search for questions that are significant in our lives, whether we are adults or children. Without inquiry, a sense of purpose and meaning is lost, and learning is reduced to gaining bits and pieces of information and covering topics of study. (Short, K., & Armstrong, J.,
Once again, it is John Schwab that suggested that teachers should present science as inquiry and that students should use inquiry to learn science subject matter (p. 15).

**Risk Is Too High**

Equally challenging is the fact that the objectives of inquiry-based science are not set in stone and cannot be easily evaluated (Marx, et al., 1997). Costenson and Lawson state, “risk is too high” as the number five reason for not using inquiry-teaching methods (p, 154). Surveyed teachers stated that their administrators would not understand what was going on in their classrooms if they did not follow the textbook. Teachers also fear that poor student performance on standardized tests would be a reflection of their method of instruction. Therefore, possible consequences from administrators outweigh the benefits of attempting inquiry-based science instruction for many teachers.

Standardized testing controls much of the curriculum being taught in schools today. Teachers are under tremendous pressure to prepare students to perform well on these assessments. The *No child Left Behind Act* (2001) is President George W. Bush’s educational reform plan that sets the standards of schools today. All students are mandated to take standardized tests. Students who score below level in reading, writing and math often face retention. The pressures to perform well on tests have schools pulling out low performing students for extra tutoring, which often occur during Science and Social Studies. Usually this extra tutoring consists of lectures, and taking information right out of textbooks. As a result, many students are being denied discussions on higher order thinking related to science.

“Only by getting involved in the construction of knowledge, by transferring ideas and
opinion into beliefs through inquiry, does one ever get knowledge of the method of knowing” (Dewey, 1910, p. 17).

Additionally, school funding is often based on student performance, and in some cases teacher salary is based on student outcomes. Mistakenly, teachers who focus on providing facts for testing are overlooking research that states, “students exposed to inquiry-oriented, process-approach science perform better on measures of general science achievement, process skills, analytic skills and related skills such as language arts and mathematics” (Shymansky, Kyle & Alport, 1983). Marx and his colleagues concur, “rather than rely on standardized test that tap fragmented and decontextualized knowledge, the use of alternative assessments is encouraged” (1997, p.343). Based on this research, teacher’s negative attitude about inquiry-based science instruction may actually hinder student performance outcomes on standardized tests.

**Time and Energy**

A teacher’s attitude regarding the investment of time and energy is a major aspect in motivating student for inquiry-based science instruction. Costenson and Lawson (1986) list “time and energy” as the number one reason teachers do not use inquiry-based teaching methods in science education (p.151). An expository teacher who relies on textbooks and prepackaged materials to teach incurs minimal preparation time. On the contrary, teachers who use inquiry-based instruction invest a significant amount of time and effort obtaining a variety of resources that would interest students. Teachers who attempt inquiry instruction without the support of colleagues and administrators may become frustrated in the process.
“This [investment of time and energy] usually causes burn-out and a quick switch back to expository style [of teaching] (Costenson & Lawson, 1986, p.151). The time and energy required to prepare and conduct effective inquiry-based teaching can be overwhelming, however, beneficial inquiry may be necessary for continuing student interest in science.

Researcher’s recommendations for enacting inquiry-based teaching can be overwhelming. Marx, Blumenfeld, Krajcik, and Soloway (1997) are concern with lack of time as one of the challenges of inquiry-based instruction (p.47). Their focus is not the time required preparing for inquiry-based instruction, but the time required for exploring chosen inquiry topics. Student investigations and discussions take much longer than the traditional lecture and test form of science instruction. “Indepth exploration of ideas takes longer than the more familiar broad and superficial survey of concepts” (Marx et al., 1997, p. 347). In their recommendations, Marx et al. suggest that “allocation of time and technical resources also will affect whether these innovations are sustained” (1997, p. 354). The amount of time and energy for successful inquiry teaching is an investment for connecting children to the world of science, as well as creating future scientists

**Developing Teaching Procedures**

Current science education reform approaches, stresses active learning by students. A useful beginning step toward enhancing the ability of scientists to work with teachers and schools is to promote basic understanding of the issues by all participants (Moreno, 1999. p. 569). Scientists, teachers, school administrators, and parents all need to recognize the contributions each of them make by utilizing a common language. This language involves
words such as “assessment”, “cooperative learning” and “inquiry”. The use of common language is the first step in developing a collaborative effort between scientists and schools. Scientifically literate people, according to the NRC Standards and the American Association for the Advancement of Science (AAAS) Benchmarks, are able to experience the richness and excitement of knowing about and understanding the natural world (Bodzin K., & Beerer, A, 2003, p. 29). Also, scientific literacy is often recognized as the knowledge of significant science subject matter, the ability to apply that knowledge and understandings in everyday situations, and an understanding of the characteristics of science and its interactions with society and personal life (p.39). The National Science Education Standards recognizes that inquiry-based instruction holds significant promise for developing scientifically literate students.

The term “inquiry” is used in the NRC Standards (2000) not only to refer to teaching methods in which students construct their own knowledge by doing, but also to designate specific characteristics of scientific processes that students should be able to understand. Thus, the standards for inquiry-based instruction include the development of abilities and understanding. This can be through identifying questions, designing and conducting investigations and using technology and mathematics.

The processes directed at implementing a standard inquiry-based science curriculum are a continual challenge. This challenge is greatest where elementary teachers are concerned, because most are not science specialists. Aside from time being a limiting function, there are other factors that influence science teaching in elementary school classrooms:

- Teacher perception of the importance of science in an elementary curriculum
Limited content knowledge held by elementary teachers

Limited experience through formal coursework in participating in and presenting hands-on science

Lack of administrative support for the teaching of science (Abell & Roth, 1992).

Teachers who implement inquiry in the classroom must understand precisely what scientific inquiry is and they must become skilled in inquiry teaching techniques. (Costenson, K, and Lawson, A, 1986, p.153.) Procedures have been developed to aid teachers in implementing an inquiry-based curriculum. Two common inquiry approaches that are being used extensively are “learning cycle” and “cooperative learning”. These approaches, however diverse they may seem, are all rooted in the philosophy surrounding constructivism.

Learning cycle is a laboratory-based teaching procedure based upon Piagetian theory of learning. (Cavallo, Miller, Saunders, 2002, p. 27). The learning cycle teaching procedure consists of three phases designed to facilitate mental functioning: (1) exploration, (2) concept invention/term introduction, and (3) concept application (p. 27). During these investigations, the learner is engaged in hands-on investigations geared towards a specific experiment. The teacher’s purpose is to guide the students towards the proper experiences and encourage the students learning processes. Through discourse with peers and the teacher, students make meaning of their observations and experiments, and articulate their understandings of the concept (p.27)

Another inquiry-based approach that an instructor may also implement is called cooperative learning. According to Johnson & Johnson (1989), cooperation is “working
together to accomplish shared goals. The cooperative learning approach centralizes inquiry activities around multiple student interactions. (p.2) The more effective inquiry-based science curricula are organized around student group studies. This approach encourages the individual to become responsible for tasks, whether it be concerned with content and/or definition. Inquiry-based approach is believed to bring more important benefits to students, including enhanced individual learning, greater retention of knowledge, improve development of skills and more opportunities for students with a wide range of abilities to make important contributions to the group. The cooperative learning approach is a clear reflection of Dewey’s demand for a stimulating social setting that encourages communication and cooperation. Dewey writes:

To formulate requires getting outside of [the experience], seeing it as another would see it, considering what points of contact it has with the life of another so that it may be got into such form that he can appreciate its meaning… One has to assimilate, imaginatively, something of another’s experience in order to tell him intelligently of one’s own experience… A man really living alone (alone mentally as well as physically) would have little or no occasion to reflect upon his past experiences to extract its net meaning. (Rodgers, 2002, p. 53).

In 1988, Kyle, Bonnstetter, and Gadsen implemented a study that measured elementary students’ and teachers’ attitudes toward science process-approach teaching vs. traditional science classes. The Science Curriculum Improvement Study (SCIIS) was the science process-approach used in this study. One goal of the study was to measure “how do the attitudes toward science of teachers who have received in-service education and who have
taught one year of SCIIS compare to the attitudes of teachers who teach non-SCIIS classes and who have not received any in-service education? (Kyle, Bonnstetter, & Gadsen, 1988, p.106). In-service education was provided to both teachers and principals in the SCIIS schools. Teachers received two days of intense instruction and were brought back two months later to discuss project progress and concerns. Additional in-service opportunities were provided during subsequent summers to provide teachers with new science content and teaching strategies. The final survey showed surprisingly little discrepancy between SCIIS teachers’ and non-SCIIS teachers’ attitudes about science. The study stated, “SCIIS and non-SCIIS teachers possess similar, often negative, perceptions of science” (Kyle et al., 1988, p. 110).

Although teacher attitudes were virtually unaffected by the science process-approach training, the student attitudes about science, via inquiry, improved dramatically. The “attitudes of students who have experienced one year of an inquiry-oriented, process-approach curriculum were enhanced greatly when compared to students in textbook-oriented science classes” (Kyle et al., 1988, p.110). The fact that students’ attitudes greatly increased with process-approach science teaching was the motivation teachers needed to continue to use inquiry teaching methods in the classroom. Therefore, teacher attitudes about inquiry teaching were ultimately influenced by the changing attitudes of their students.

Several researchers discovered inquiry-based instruction in science affects students’ motivation and interest in learning due to relevant experiences to real life experiences. Damnjanovic (1999) study of the effectiveness of inquiry activities has been shown to enhance some students’ interest in science, as well as motivation to continue studying science.
Inquiry-based instruction is valuable because it connects personal experiences that are relevant to students that may effect their future goals.

In conclusion, negative teacher attitudes about inquiry-based science instruction may translate into a more traditional, expository style of teaching. When presented with the positive effects of inquiry-based teaching, conscientious teachers may make an effort to change their procedures. In their argument for more inquiry-based teaching, Costenson & Lawson (1986) offer a recommendation for every negative perception given by teachers.

Science teachers must be committed to facilitating the empowerment of their students. Using a refinement of McLaren’s (1989) definition, empowerment is the process by which students learn to critically use science knowledge that is outside their immediate experiences to broaden their understanding of science, themselves, the world, and to realize the prospects for reforming the accepted assumptions about the way people should live in a scientifically diverse culture.

Prospective teachers need to experience science more as inquiry and less as didactic, passive lectures followed by confirmatory labs. They need to see science in action and experience science themselves. Instructors in pre-service science teacher preparation programs need to model the same behaviors they expect their students to demonstrate in the classroom (Kyle, Bonnstetter, & Gadsen, 1988).

Teachers must seek out professionals with similar pedagogy and work together to save time and energy as they implement inquiry-based instruction. According to Danmjanovíc, (1999) teachers who become members of professional organizations that support inquiry-based teaching in order to foster new and improved teaching habits and receive opportunities for discussing teacher and student discomfort. It is the teacher’s responsibility to inform
administrators of the benefits of inquiry-based instruction in efforts to reduce the risk of declining interest in the sciences; whether by the student or the instructor. These cooperative working behaviors enable the teacher to earn support, respect and encouragement from administrators. Also, to ensure total commitment to the program, these cooperative behaviors should be established with parents, community leaders and higher education relationships. Teachers must seek out the inquiry-based development programs that offer continuous support for inquiry-based science instruction. Positive changes in teacher attitudes will alternately draw out positive attitudes from the students in science.

The information amassed in this review has shed much light upon the topic of inquiry-based instruction. However, many questions and dilemmas arise due to the fact that inquiry-based instruction is still in its infancy. Even though there are over two hundred years of support and another hundred years of intense investigation and data collection, and ever growing support, there remains little cohesion among the leaders of the inquiry-based philosophy. An optimistic appraisal of the situation, whether by this analysis or others, stems from the almost infinite possibilities concerning the implementation of inquiry-based instruction in the classroom.

John Locke had conceptualized the idea of a learner-centered education in the seventeenth century, and at the end of the twentieth century we find this view defined by the contemporaries McCombs and Whistler (1997, p. 9) as:

The perspective that couples a focus on individual learners (their heredity, experience, perspectives, backgrounds, talents, interest, and needs) with a focus on learning (the best available knowledge about learning and how it occurs and
about teaching practices that are most effective in promoting the highest level of
motivation, learning, and achievement for all learners.

Children have wonderful experiences using the inquiry-based instruction if given the
chance. Inquiry-based science works well with elementary aged students. Teachers need
to be willing to become a learner along with the students, and to experience firsthand the
insecurities our students live with every day. Teachers often need to be reminded that the
process, not only the product, is the goal for the students and for themselves. Change and
progress within the inquiry-based curriculum will come slowly. To better understand the
possibilities of inquiry-based instruction affecting student attitudes, it was necessary to
engage the same strategies discussed here within. The methods employed to collect and
evaluate the data concerning inquiry were designed around the inquiry-based approach.
This method to method approach was a prime example of cyclic learning and the endless
possibilities concerning inquiry. Inquiry-based instruction along with patience may help
develop life-long learners, which in turn leads to responsible citizen in the future.

Chapter Three, Methodology, identified the process I used to collect my research data. I
explain the instruments used to collect data, describe the participants of the study and
methods of collecting data. This chapter examined the steps taken to pull together and
analyze data that reflects inquiry-based instruction and how it affects student motivation.
The purpose of this study was to better understand how, in my classroom, inquiry-based instruction affected my students’ participation and attitude towards science. In the fifteen years that I have been an educator, I have constantly developed curriculum that engaged the inquiry-based principles, but even though I have felt that the results were positive, I did not have data to support their conclusions. This in-depth study used qualitative and quantitative methods to collect and analyze the data. The data were collected from using multiple sources: science attitude test, student journals, teacher field notes, and student interviews; to best reveal the themes and pattern within the data.

**Design of Study**

For this study to explicitly describe and give a rationale of the research design, I decided to utilize school-based action research. *Educational Research: Competencies for Analysis and Application*, defined the methodology of action research. It defined action research as a involvement of teachers identifying a topic or problem to study, collecting and analyzing information to solve or understand a teaching problem, or to help understand aspects of their practice (2003, p. 262). With the action research approach, I was able to properly assess and evaluate the direct relationship between the students and myself. Good action research integrates theory, practice, and meaningful applications of search results (Gay, Airasian, 2003). Action research is used to find and solve one or more educators’ problem in their own institution (p. 14).
The other key reason that action research was an optimum approach of the data being collected was from a qualitative perspective. Since it was necessary to describe and answer questions concerning content and perspectives, qualitative research was a must. Qualitative research can answer questions and illuminate issues that cannot be addressed by quantitative methods (p. 163). Even though quantitative data was present, only the qualitative research was rooted in the foundations of sociology, anthropology, and psychology, which rely on verbal and interpretive descriptions. Although qualitative and quantitative methods are used in action research, it is clear that in action research qualitative methods are used the most (p. 262).

Action research, as described by Kurt Lewin, is a three-step spiral process of (1) planning that involves reconnaissance; (2) taking action; and (3) fact-finding the results of the action (Lewin, 1947). Lewin also states that action research is the process by which practitioners attempt to study their problems scientifically in order to guide, correct, and evaluate their decisions and actions. (p.143).

This study of inquiry-based instruction- methods and results- required a qualitative approach. However, by just simply facilitating the qualitative approach was not enough. The use of triangulation, which is the use of multiple methods, data collection, and data sources to help create cohesion between multiple sources, was the corner stone in generating a clear and concise understanding of the resulting data a priori.
Setting

The focus of this action research is my third grade classroom of twenty 8 and 9 year olds. There are three gifted students, three students labeled learning disabled, two students labeled LEP (Language Enriched Public), and the remaining 12 fall into their average range as determined by past classroom performance and test scores. The classroom demographic included 8 Caucasian, 8 Hispanic, 3 Asian, and 3 Black. Science was taught for approximately forty-five minutes per day.

The researcher selected the school where she is presently working, to participate in the study. The school was located in a pre-kindergarten through fifth grade elementary community public school. It is located on the east side of Orange County. The current demographics indicate that 49% of the children are Caucasian, 32% Hispanic, 11% African-American, 5%, and 3% other. Approximately 48% of the students receive free or reduced lunches. About 20% of the population are upper-middle class or even wealthy. Hence the student population is diverse socio-economically, culturally and academically. The school serves about 124 (9%) exceptional education students and roughly 116 (14%) students in the ESOL program.

Procedures

My action research study consisted of four data collection methods: pre and post attitude survey, student reflective journals, audio and video taped interviews, and teacher field notes.

To begin the research, it was necessary to conduct a survey (Appendix D) to collect the current attitudes and feelings of each student towards science and instruction. Students took a pre and post attitude survey. The surveys measured student’s attitude towards science or more
specifically inquiry used in the classroom. Each survey was given at the beginning and end of the research.

A modified copy of the Test of Science-Related Attitudes (TOSRA) was used as the science survey. Dr Barry Fraser of Macquarie University developed and used the instrument around the world to measure students’ attitudes toward science since 1981. TOSRA was shorten and modified with the permission of Dr. Fraser for the use of elementary age students. (Appendix D).

In compliance with the TORSA Handbook, the unmodified TOSRA scales using the unmodified version had consistency reliability using the Cronbach coefficient. The values for 7-10 ranged from .64 to .93 on the TOSRA, 1981.

During the period of the study, journals were used for the student’s reactions while working on the inquiry-based assignments. Also, student journals were maintained throughout the study to document their experiences and attitudes in science class. Discussions about what they have written in their journals were shared in their groups. Discussions were used to clarify the students’ understanding of science concepts, attitudes toward inquiry-based learning, and changes in science process skills.

The qualitative data were collected by way of student journals, interviews, teacher field notes, and evaluation surveys. The evaluation survey (Appendix D) was the most determinant tool in understanding the changes in student attitudes toward inquiry-based learning and instruction. The objective was to focus on the students’ feelings towards science.

The curriculums used in this study were matter, force, and the laws concerning the relationship between the two. The experiments were chosen based on the alignment to satisfy the National Standards and Florida Sunshine State Standards. To best facilitate the potential of
inquiry-based instruction, a multitude of methods were initiated. The decision for this was that physics provides concepts that are relevant and more tangible than some of the other sciences.

Four inquiry-based lessons were chosen for this studies duration. The lessons were as follows:

- **Turning Milk into Homemade Moo Glue:** This lab activity challenged students to separate Casein from whole milk. Within the experiment, students were to derive a better understanding of the relationship between acids and bases and the chemical interactions between both. This inquiry-based assignment, formed and directed by the teacher. The students were to utilize the tools and chemicals necessary for separation and isolation of the Casein. This was a hands-on activity, a challenge for deductive reasoning, and an assertion for drawing reasonable conclusions. Afterwards, there was time allotted towards classroom discussions concerning the experiment and the students’ attitudes assisted in the inquiry-based evaluation.

- **Paper Airplanes (Part I & II):** This lab activity engaged the students to use a variety of tools and methods necessary for science inquiry. The students applied measurement concepts, utilized scientific inquiry methods for field and lab work, and manipulated variables to improve the performance of the plane they had designed. The students were asked to first articulate what they already knew of the properties of motion; second the students had to make reasonable predictions based on the new information concerning motion and energy that the instructor had provided. The instructor guided the inquiry but the students recorded data, initiated, group task, manipulated variables, and compared data findings. The students had hands-on
experience and created productive relationships with other concerning self-motivation. The students were allowed to utilize classroom time for open discussions, which assisted in evaluating the effectiveness of an inquiry-based activity.

- **3-2-1 POP!**: This lab activity asked students to form scientific queries concerning Newton’s Laws of motion and the effects matter has on these principles. The students were challenged with the concepts of chemical interactions and reactions. The students had to understand that matter has observable, measurable properties, that motion can be described, measured and predicted, and realize the difference between qualitative and quantitative concepts. The instructor outlined the procedure while the students compiled data that ranged from before the experiment to the post-data collection stage. Once the activity was completed, the students were allowed time to discuss findings in an open forum.

- **Does It Add Up?** This lab activity centered around the concepts concerning the indivisibility of matter where mass and weight are concerned. The students had to form predictions and questions with the idea that the mass of an object is equal to the sum of its parts.
**Instruments**

My action research study consisted of four components: pre and post attitude assessment, informal video and audio recorded interviews, student journals and field notes.

**Pre/ Post Attitude Test**

TOSRA was developed by Dr. Fraser of Macquarie University and has been used around the world to measure students’ attitude toward science since 1981. With the permission of Dr. Fraser I used a modified copy for third grade students. The questions on the TOSRA are on a agree/disagree scale. The test was split into two sections and administered in two different days. The questions were read to the students.

(Appendix E).

In the TOSRA, there was administered a Pre-Science attitude test and a Post-Science attitude test. The improvements of students’ attitudes from the Pre- Science attitude test to the Post-Science attitude test are easily differentiated. The tests show how the 20 items in TOSRA are allocated whether each item is positive (+) or negative (-) with respect to scoring. For positive items responses SA, A, N, D, SD are scored 5,4,3,2,1, respectively. For negative items, responses SA, A, N, D, SD are scored 1,2,3,4,5, respectively. Omitted or invalidly answered items are given a score of 3.

**Interviews**

After each science unit, randomly selected students were interviewed. The process of Simple Random Sampling was use, random sampling defines the population, identifying each member
of the population, and selecting participants for the sample on a completely chance basis. (Gay, p. 104). Student names were written on a separate slip of paper and placed in a container. Selected slips from the container became the participants selected for the interviews. The interviews were administered with either a video or an audio recording.

**Field Notes & Student Journals**

Data collections were field notes taken to document all data acquired during this action research. These field notes reflected my teaching practices as well as students’ responses in their journals.

At the end of my study I administered post-attitude assessment. After collecting all the data, I reevaluated the video and audiotapes, as well as the student journals.

**Methods of Data Analysis**

Data that were collected throughout this study had to be analyzed in such a way that emerging patterns and themes could be recognized. The reduction process was implemented due to the high volume of data that was acquired. This procedure was designed to organize data, such that the patterns and themes are recognizable. Once the data were organized in this manner, forming conclusions were possible. However, the themes and patterns had to be made valid by way of triangulation so to ensure the most accurate of results.

Data collected in this study were primarily qualitative in nature. At the beginning of the study a survey was administered. This survey was the first necessary component in understanding the students’ original attitudes towards science and the students’ most understood science concepts.
The focus groups and reflection were the sources that provided the most insight. Since the data were completely qualitative it was necessary to re-read the data to find the emerging patterns. Once the supporting data began to reveal patterns, the results were collected and compiled onto 3x5 index cards. From the 3x5 cards, the results could be organized as needed.

Chapter Four contains a more descriptive narrative of the findings that emerged from this study. The data were organized to best utilize triangulation so to ensure the most valid conclusions. The patterns and themes that were noted but not described in the analysis are to be found in the “Other Conclusions” section of Chapter Five.
CHAPTER FOUR: FINDINGS

Introduction

This study was conducted in the fall of 2004 investigated how inquiry-based instruction affected students’ participation and attitudes towards science. The investigation also revealed how inquiry-based instruction affected students’ participation in inquiry-based processes. Action research was the primary mode of investigation. The advantage of action research is that it provides teachers with a philosophy and practice that allows them to systematically study the effects of their teaching on student learning. (Mills, p.4). My action research study questions were:

1. How did my practice of inquiry-based science affect the students’ attitudes?
2. How did an inquiry-based curriculum affect student participation?
3. Did students develop confidence in asking their own questions in an inquiry-based lesson?

Through multiple sources of data these questions were addressed. A useful tool used in the study was the TOSRA (Test of Science Related Attitudes). This survey was administered before and after the study. Also, student journals, video and audio recordings, and student interviews were essential to uncovered the themes focused on in this study. These multiple sources of data allowed for triangulation, which is an essential process in qualitative research and analysis.

The first theme focused on students’ attitudes towards inquiry-based science before and after the study. The quantitative measurements obtained with the TOSRA were clearly understood and
discernable. The analysis of the students’ attitudes was essential to making a decisive decision concerning the direct and indirect participation of students, whether positive or negative. The second theme observed was the effects inquiry-based learning had on the voluntary participation of each student. The students’ willingness to increase participation in inquiry-based science may support for the social and cultural significance inquiry can produce. Students documented their feelings, reactions and questions in their journals, and they were videoed and audio taped during instruction. The third prevalent theme, which emerged was related to how students’ confidence in asking question that interest them. The relationship between the students’ and the question/answer process, through inquiry, is cyclic and congruent with the results obtained by the TOSRA concerning attitude. While the student interviews procured the most conclusive data concerning the students’ ability to have their questions answered, other data sources, such as the teacher field notes, video and audiotapes, and student journals were essential for triangulation.

In reviewing the collected data, other important themes emerged. These themes included: confidence, collaborative group work and making connections. These themes were discussed in the later part of this chapter.

**How Inquiry-Based Science Affects Students’ Attitudes**

Students demonstrated a positive attitude towards inquiry-based experiences. As the students became more actively involved in the procedures, and as the students engaged in questioning, it appeared that their trepidation decreased as a whole. The data extrapolated from the TOSRA, the audiotapes and student journals support this claim.
When I reviewed all the data results, several themes emerged that related to students’ positive attitude toward inquiry-based instruction and participation. The consistent theme was a positive attitude toward inquiry-based instruction. The collection of data (TOSRA) revealed an increase in positive attitudes in science when compared to the pre and post-test.

The following related pre and post TORSA survey items represented students’ positive science attitudes. Also, it was an attempt to find out what attitude changes students had formed through their experiences.

<table>
<thead>
<tr>
<th>Student Response Options</th>
<th>% if students in pre survey</th>
<th>% of Students in post survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>55%</td>
<td>75%</td>
</tr>
<tr>
<td>Agree</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Not sure</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Disagree</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>15%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Mean = 1.35  St. Dv. = 0.67  n = 20

The post-test results increased for Question #11. The overwhelming majority of students looked forward to science lessons. Out of the twenty students surveyed the total “strongly agree and agree” were 90% on the post-test. For the over-all positive scores, there was a twenty-five percent increase concerning the students’ attitudes toward the statement “I look forward to science lesson.”

Interviews with students were done throughout the study after each lesson to reveal their opinions of inquiry-based science lessons. Findings emerged during the interviews that corresponded with the theme of science as a subject the students enjoyed. The students were
asked to express what their feelings were about science class and to give examples for their responses. The conclusion found that science was a subject the students enjoyed. The following statements were taken from their responses:

“When we learned about mass of a box of crayon having the same mass when taken apart. I liked science class that day.” “We finally got to motion; I like science because I can do experiments.”

“We worked on chemical changes. I liked science class because I understand how to do it.” “When we get to do experiments I always find out new things”

“I liked the time we went outside to shoot rockets to see what fuel will make it go higher.”

“I’m glad when we get to try things on our own. I really enjoy science class every day.”

“Science class is good because we get to use real things, and play with them to find out new things.”

“ I know how to get the answers to my questions, so science is easy for me.”

The statements reflect the overall agreement that the majority of the students liked the science classes, and that there were a variety of activities to make it interesting and enjoyable. Students positive comments related to the inquiry-based science lessons presented as part of this study.

Another statement that showed a positive increase in attitudes was “The material covered in science lessons is uninteresting”. This statement was in need of high disagreement to produce positive results concerning the students’ attitudes toward inquiry, and that is exactly what occurred. The next table will show the results to this statement.
Table 2: Question # 4 " The materials covered in science lessons is uninteresting."

<table>
<thead>
<tr>
<th>Student Response Options</th>
<th>% of students in pre survey</th>
<th>% of students in post survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>25%</td>
<td>15%</td>
</tr>
<tr>
<td>Agree</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Not Sure</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Disagree</td>
<td>30%</td>
<td>35%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>30%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Mean = 4.05  St. Dv. = 1.41  n = 20

The pre-test had five students (30%) “strongly agreed” and three students (15%) “not sure”. The post-test results had only three students (15%) “strongly agreed” and 0% “not sure.” The change was a twenty-five percent increase for students that found materials in science interesting.

Teacher field notes supported that the students found the inquiry-based science lessons interesting.

Examples from the teacher field notes recorded:

“Group 1 seems excited to use the spring scales to measure force.”

Student 1 states, “how cool it is to use film canisters to make rockets.”

Student 2 states, “we were never allowed to work with messy stuff before in science class.”

Student 3 states, “I like knowing how to use everything so I can do my experiments right, so I can use many different things for my experiments.”
These field notes recorded revealed that the students enjoyed the inquiry-based science lessons. Their excitement to work with these lessons affected their attitudes and how they worked in their groups.

The other statement that revealed major improvements concerning attitudes toward inquiry-based science was, “I would enjoy school more if there were no science lessons.” The percent of disagreement among the students from the pre-test results and the post-test are, again, substantial.

<table>
<thead>
<tr>
<th>Student Response</th>
<th>% of students in pre survey</th>
<th>% of students in post survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Strongly Agree</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>2 Agree</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>3 Not Sure</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>4 Disagree</td>
<td>15%</td>
<td>25%</td>
</tr>
<tr>
<td>5 Strongly Disagree</td>
<td>40%</td>
<td>75%</td>
</tr>
</tbody>
</table>

Mean = 3.6  St. Dv. = 1.31  n = 20

The TOSRA pre-test results revealed that four students “strongly agreed” and two students that responded with “not sure”. The post-test result had no students “strongly agreeing”. Also, there were no students that logged “not sure”. A total of eleven students “disagreed” or “strongly disagree” on the pre-test, however, the number increased to eighteen on the post-test. This is a thirty-five percent increase of students that enjoyed school more with science lessons.

These survey results showed that the students did enjoy inquiry-based science. The patterns that emerged throughout the survey show that a high percentage of students’ positively increased towards science.
Further evidence to support students’ attitudes towards science was video and audio tape transcripts. Given that working in groups was very important in having a positive learning experience, data from four taped inquiry lessons were transcribed of students’ attitude as they worked with others. The video and audiotapes transcripts showed that most of the students appeared to enjoy the inquiry experience. The pattern that emerged throughout the data was that high percentage of students used positive expressions to show their feelings during the study.

The follow student responses were transcribed from the “Add It Up” inquiry lesson. The responses from students were derived from a series of questions asked by the teacher researcher. A sample question included, “How did you feel about the inquiry-based lesson, “Add it up.” Why? Seventeen out of twenty students responded with positive comments. Three of the students responded with comments that were unsure. Some positive comments included:

Student 10: “It felt great that we could get together and figure-out how to do it and what we did wrong.” “It’s very interesting to find things out.”

Student 2: “It felt pretty good…I felt real good that I could figure that an objects mass is the same when it is in pieces.”

Student 3: “We are doing science and learning new things every day, and that is something that I am good at.” “I love science.”

Student 5: “I feel very glad that we have experiments that we can find out things on our own.” “I liked it because it fun to search for answers other places and not just books.”

All of these students’ comments represent that they possessed a positive attitude and enjoyed doing the inquiry-based lessons.
Another source of data used to investigate student attitudes was student journal responses to inquiry lessons. Many journal entries correspond with what the students express in the transcripts. Figure 1 is an example:

Figure 1: Student entry on the lesson "Add It Up."
Figure 1 showed a typical journal response students made about their inquiry-based experiences. Students express a positive attitude when using inquiry-based instruction for the topic of Matter. The journals were essential to data triangulation. The “Add It Up” inquiry lesson was once again the focus in a student’s journal. After collecting the experiments results a student wrote:

“I liked it because it was fun and we really had to think about mass not changing when an object changes shape. We had to start all over again 3 times. We didn’t know if we were doing it right. But apparently we were!” [Sic]

These student comments showed that they enjoyed the inquiry-based lessons, had positive attitudes and had fun too. The triangulation of the data sources showed that students demonstrated positive attitudes during inquiry science experiences.

**Students Participation Through Inquiry**

A student’s ability or desire to work with others on a collaborative effort such as a science experiment is participation. The amount of enthusiasm or unwillingness presupposed by a student can be gauged by the attitudes before the inquiry lesson and the feelings that they exude after completing the science projects. The most revealing data collected was documented in students’ journals responses to the inquiry lessons. In the student journals, they not only kept close records of the experiment requirements, but also logged their feelings towards participation. They also gave feedback concerning each group-based inquiry assignment. There
were four inquiry-based science assignments that were taught and assessed. They were: Turning Milk into Homemade Moo Glue, Paper Airplanes, 3-2-1 Pop, Moo Glue, and Does It Add Up.

From the audiotape transcription data, a question posed the following to a student concerning their feelings towards participation during the Moo Glue assignment; the following are representative of student responses.

Ms. Arthur: Did you work well with your team?

Student 1: Yeah.

Ms Arthur: You think this because?

Student 1: Because we are a great team and we always stick together.

Another student was asked the same questions pertaining to the Moo Glue experiment:

Ms Arthur: Did you work well with your team?

Student 2: Yes

Ms Arthur: You think this because?

Student 2: We all got along and we all came up with the ideas. We all agreed how much we were going to put our hands in there and rub.

In another audio recording, a student was asked the same questions concerning the Add It Up lesson:

Ms Arthur: Did you work well with your team?

Student 3: Yes.

Ms Arthur: You think this because?

Student 3: we all came together and three minds is better then one.
The data collected in one student’s journal entry was not as positive as many others. On August thirty-first a student wrote about how participation in the “Add It Up” inquiry experiment was anything less than desirable:

Does matter add up?

I did not like it.

Student # 1 keeps making fun of me.

She is doing it right now.

And she called me a slow poke. [Sic]

During the researchers observation of the study group it was found that many students enjoyed combining the inquiry-based assignments. There were few instances where students did not function positively with each other, but with some guidance provided by the instructor the group settled and became more productive.

In summary, data from three different methods of data collection formed a consistent pattern. The data from TOSRA, student journals, and transcriptions were triangulated to reveal a common theme. The theme was that students interacted positively and cooperatively with each other during science inquiry-based instruction.

**Students’ Questions During Inquiry-Based Lessons**

A student’s ability to form questions and have the questions answered through inquiry appears to positively affect their confidence. The more questions answered, the more confidence they demonstrated. Four inquiry assignments, that have been mentioned were the basis for the study, revealed that most students reacted positively to inquiry-based lessons. Student explored
together and generated questions as a class. They were challenged to transform their questions into investigation plans.

In an interview, a student was asked about the questions that the group had formed about the Moo Glue inquiry assignment.

Ms Arthur: What was the question you all had?

Student 1: How do we make Moo Glue?

Ms Arthur: Did you answer your question?

Student 1: Yes.

Ms Arthur: You think this because?

Student 1: Because all of the stuff on the bottom was thick and it felt like glue.

Another student was asked the same question about the Moo Glue experiment:

Ms Arthur: What was the question you all had?

Student 2: I wanted to know how it would stick.

Ms Arthur: Did you answer your question?

Student 2: Yes

Ms Arthur: You think this because?

Student 2: because it stick pretty well. [Sic]

Ms Arthur: How do you know?

Student 2: remember when we stuck those pennies and the paperclips down…they stuck.

Even though the questions that students’ posed varied, the basis for the questions remained directly related to the experiment performed, and most students believed that they had answered their questions through the inquiry-based science lesson.
**Confidence**

Students gained confidence in asking questions and they were willing to take risks in sharing and pursuing answers. In the first few weeks of this study, students were unsure as to what questions were the “right” questions to ask. “Right” questions meaning that it would be acceptable for the teacher. Only 50% believed in seeking answers on their own. Rating as low “science learners,” which would make them uncomfortable with trusting their own ideas.

Table 4: Survey Results for Question # 16  "It is better to be told scientific facts than to find them out from experiments."

<table>
<thead>
<tr>
<th>Student Response Options</th>
<th>% of the students in pre survey</th>
<th>% of students in Post survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Agree</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Not Sure</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Disagree</td>
<td>10%</td>
<td>55%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>40%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Fortunately, at the end of the study 80% of the students had the confidence to ask questions and seek out answers using experiments.

After several frustrating days of journal writing, we had a class meeting to discuss their concerns and frustrations. One very astute young lady commented, “How can we know what is a good question when all teachers do is ask us questions?” “I’m afraid my questions will be wrong, or stupid, or silly.” That simple, but direct statement backs up what Short and Armstrong believed.
Because teachers (and school curriculum guides) have been the problem-posers, they have had to “motivate” students to examine their questions instead of letting students find and pursue their own. (Short & Armstrong, 1993, p. 184).

The problem was the students were trying to please me. At that point, I re-evaluated how our journals were constructed. I had to remind the students that journal writing was for their own reflections, and that they weren’t being graded. Also, their groups would help decide what questions to work on. This method proved successful, and produced some valuable questions for further research. The questions cut across all disciplines and were the springboard for further inquiry projects. To evaluate how the students felt about the use of journals, I asked what they thought. The majority of the students had positive comments concerning the use of these journals. I noted that 3 of the 4 negative responses came from “top” students. They felt the journals were a waste of time or found it difficult to think of questions.

Table 5: Positive Journal Responses

<table>
<thead>
<tr>
<th>Journal assignment</th>
<th>Number of students responding with positive comments out of the total number of journals collected</th>
<th>Percent of students responding with positive comments in their journals</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do you feel about journals in science?</td>
<td>16/20</td>
<td>80%</td>
</tr>
</tbody>
</table>

The following are examples of positive student responses written in journals about how they feel developing questions for an inquiry lesson.
Student C: “When I think of my own questions to research, it makes me feel Important.”

Student J: “I like to write my thoughts, it makes me think about question that I want to know about. About the stuff I care about.”

Student I: “I thought questions would be hard. They were when I first tried. Then it got easier, and I had some good ones everybody said.”

Student Q: I like it when I get to ask my own questions. Then I can find the answers to what is important to me.”

Student L: “I already know a lot of stuff. So, it’ hard to think of questions about more things.”

These reflections by the students revealed that most of them journal writing was a useful tool to help them communicate their questions and they felt confident in asking questions. These varied sources of data supported the finding that students believed they could create questions that were important for them to investigate.

**Collaborative Work**

My students gravitated toward collaborative research and projects, even when they started working individually. Many of the students were not accustomed to working with other students at the beginning of the study, and needed time and opportunities to learn cooperative work strategies. They viewed class work as needing to be individual tasks. At the beginning of the year, very few students liked working in groups. By the end of the study, the number of student
who liked or saw a benefit to group work had increased significantly. The examples below are typical changes in students’ responses in this study.

“I don’t like working in groups. They don’t listen to me and do work their way. Most of the time, I do all the work. All we do is fight.” (9/3/04)

“I learned to work in groups better than I could before. I learned from them that they sometimes help me know things I don’t know. They helped me find more answers. I could understand more.” (12/17/04)

During our first science unit, the students were exploring questions they had about chemical changes. After writing and sharing their questions for one week, they each chose one particular question of interest. When it was time to form inquiry groups based upon their questions, several students were reluctant to join a group. Not wishing to add undue stress to their desire to work independently, I allowed them to research their question alone, and prepare their own page for the class Matter book, “What’s the Matter”? These students would watch the working groups with interest. Two of the four reluctant students asked if they could work together. When approaching me, they stated, “The other groups have more work done than us. Can we work together, just the two of us” I noticed they both planned how the work load should be divided, and were thrilled when their information and presentation was completed.

Another especially interesting comment came from one of my SLD students during an end of the year video taped interview. I asked her to tell me if his ideas about working in groups had changed. The following was his reply.
At first I didn’t think I would like working with groups. I am always wrong and they all know it. Not many people like me or think I am smart. When we did the work with glue and my penny stuck to the paper it was me that figured out how to make the glue. That made me feel good because I did something right and they found out too. I think I work better in groups and can help other people do better too.

This array of students’ reaction to inquiry-based experiences provided support for the reported increases in participation and positive attitudes they demonstrated as the study progressed.

**Making Connections**

The fourth theme to be revealed was students making connections between previous life experiences and learning through inquiry. The use of student question established a framework from which my students made connections to their own experiences. The new knowledge acquired by the students was based upon their prior experiences with the various topics under exploration. Upon reflecting on the journals, I noticed that many times students would tell in what way a topic or question was important to them. It usually coincided with a previous experience.

From class observations, I noted that many times students would repeat the familiar before questioning what would happen next. For example, during our flight unit, the students were busy creating different types of paper airplanes to explore aerodynamics. All of the six groups would repeat the construction of their first few “planes” in exactly the same way. It wasn’t until two
“voices” questioned the addition or deletion of a feature that they all joined in and began the revision stage.

Whenever students are involved in experiences where they have choices, there is a greater likelihood that they will be able to make choices that allow them to connect with what they already know. (Harste, Short, & Burke, 1988)

**Continued Life Inquiry**

Inquiry did not end when activities or projects were concluded for this study. The searching for further questions continued well past the inquiry lessons. The inquiry-based experiences appeared to have propelled the students to continue their “wonderings.” It was interesting to see how inquiry affected students’ desire to know more. “As the content of investigations deepens, the students’ need to know grows, and their confidence to question and test expands. Questions become tools for both the asker and the asked” (Boyd, 1993)

During an exploration into the mechanics of ‘things,’” we started working with creating rockets. The water rockets call for the use of an air pump. Try as we could, the water rocket would not work. When we concluded the activity, a discussion arose about what could make it work. Several of my students received permission from their parents to take the materials home and try to change some of the features. One morning, a student dashed into the room full of excitement. In the palm of her hand she was carrying a washer and asked if she could show us how to improve our launcher. She told us, “the problem is the tube connected to the pump. My dad gave me this washer to put in the tube to help keep the air in the bottle.” The students were amazed that one little washer could make all the difference. Our initial exploration in water
rockets took a turn, but one that lead to further discoveries. I must agree with Short & Armstrong (1993), a successful inquiry classroom does not end with the answers, it continues with more questions.

**Conclusion**

The purpose of the research, *Inquiry-Based Instruction on Students’ Participation and Attitudes in a Third Grade Classroom*, was to investigate students’ attitudes and participation in science. Other themes that emerged were related to students’ confidence, collaborative group work, making connection, and continued life inquiry. The triangulation of multiple sources of data supported these themes.

The survey provided pre and post data on students’ attitudes toward science. At the beginning of the year only 47% of the students liked science and perceive themselves as good at science. By the end of the year, 100% of the students liked science and thought of themselves as good in science.

Journals were used as a framework for constructing questions and “getting their thoughts on paper.” They proved to be fertile ground for documenting growth in asking their own questions. As the students confidence grew their willingness to take risks appear to have increased, and they became more innovative in developing their own questions and research techniques. Also, the journals became documentation of connections students’ need between learning and life experiences, as well as, springboards for collaborative work.

The use of inquiry activities may also have facilitated students working collaboratively. The students stated that the use of inquiry activities made them think, and were better than using a
textbook. Jason’s statement is an example of many such comments: “I learned more this year doing the activities and experiments than I ever did before out of the book. It was hard but fun too. It made me want to learn science.”

Chapter Four, I presented my data and analysis. In Chapter Five I provided additional discussion of the themes presented in Chapter Four. In Chapter Five, I discussed recommendations and implications for future study.
CHAPTER FIVE: CONCLUSION

Introduction

The purpose of this study was to observe and record the effects that an inquiry-based science lesson had on a group of third grade students. This study involved twenty third grade students over a fourteen-week period. In order to measure the effect of inquiry-base instruction, four different data types were collected. The four data collections were: The pre and post survey test, student reflective journal, interviews, and teacher field notes.

The students were initiated into the study by taking the TOSRA pre-science attitude test. Throughout the process of data collection, the students were continually introduced to the concepts of an inquiry-based curriculum over-seen and administered by the teacher. The students’ daily assignments utilized specific tools and explanations concerning the process of inquiry. The group based experiments that engaged critical thinking and problem solving were the basis for the researcher’s observations. Near the end of the study, a post-test was administered which, was compared to the pre-test results. The data were then analyzed to find patterns and themes with respects to the research questions. Three themes that were directly related to the research were found when all of the data had been analyzed. The themes were: positive attitudes of students who used an inquiry-based science curriculum, students’ willingness to participate in science inquiry, and students being able to develop and answer their own questions.
Conclusions

Overall, the students’ attitudes toward inquiry-based science curriculum before the study was generally high, however, the final results were that the students’ attitudes had increased by at least thirteen percent. Most students had positive attitudes towards the inquiry process, but those that had difficulty understanding some concepts before and during the study had, for the most part, improved by the completion of the study.

Research Question #1

How does an inquiry-based science curriculum affect the students’ performance toward science?

The results of the study helped to show that the inquiry process produced improvements in the attitudes of the students. The qualitative data collection, that being the students’ journals and logs, allowed the student to reflect on the processes and strategies that allowed for a successful completion of each task. The students showed great enthusiasm for the “hands-on” experiments and enjoyed engaging each other to find the experimental results. The students did have some difficulty with proper planning and the distribution of task within the group; these are areas that could use more focus. These previously unknown factors were due to the fact that the researcher and the students were unfamiliar with all of the anomalies that the study produced, however, the results and conclusions from the study will help to provide insight into future studies concerning inquiry-based curriculum.
Research Question #2

How does an inquiry-based curriculum affect students’ participation?

The purpose of an inquiry-based approach was not only to help improve the attitudes of students, but to also increase students to participation during science. The students’ ability to successfully discuss their ideas greatly improved through the course of the study. The students found that the other perspectives available within the group, or even in the boundaries of the classroom, allowed for easier understanding the concepts based upon inquiry-based curriculum. The largest contributing factor to the students’ increased willingness to participate may have been their positive attitudes towards inquiry-based science curriculum.

Research Question #3

Can students develop confidence in asking their own questions in inquiry-based lessons?

This question was directly affected by the results of the subsequent primary themes. It was observable and understood through the data analyzed that as the students’ attitudes improved, and as the students’ willingness to participate increased, the students’ ability to have their questions answered increased. The main reason for this was that the procedures necessary to performing inquiry-based experiments helped to specifically define the students’ questions before, during and after the experiments. Also, as the students began to understand and use problem-solving techniques they distinguished between relevant question and those that are not. Generally, the students logged in the journals that the questions that were directed toward the experiments were answered, but also other questions arose; this being the basis for the scientific method.
**Discussion**

The goal of the inquiry-based science curriculum was to improve the attitudes and problem-solving skills of the students surveyed. The researcher believes that there are several reasons for the positive improvement in the students’ attitudes and abilities. The most important reason that an inquiry-based science curriculum produces such results is that the process of inquiry engages the students’ insatiable curiosity. Through hands-on experiments the questions posed by young students can also be integrated into the active imagination. The more traditional teaching formats, that simply give scientific fact, are less engaging and lose the interest of the student more rapidly. Inquiry, however, puts the students in the middle of the experiment and gives the student a sense of responsibility for the results. Event though the researcher tried varied experiments based on the inquiry approach, the students continued to show the same interest and enthusiasm for each experiment. The classroom environment and setting changed throughout the study, from apprehensive and lacking cohesion to active discussion and participation.

Another reason that the inquiry approach created improvements within the class was that the student could apply the scientific inquiry as a social setting as well. By the results produced by the data, students are more willing to become active in the inquiry process if the setting is socially designed and organized. Instead of traditional formats that create a sterile, inactive environment, the inquiry approach tasks students to interact with others thus increasing the students’ awareness of others perspectives. The researcher also noticed that as the bonds of communication that were formed within the experimental groups helped to improve the problem-solving skills of those involved.
As a teacher and researcher I plan to continue incorporating the inquiry approach into future students’ classrooms. The benefits of the inquiry-based science curriculum are far reaching and will play a primary roll in my personal teaching style and procedures. After observing the positive results of this study it is beneficial to continue the inquiry approach.

**Limitations**

Limitations noted in this study include:

- All subjects in the study were from one third grade classroom; therefore there may be limits on generalization.
- The attitude test, selected by the researcher, focused on the areas perceived as significant to the study.
- Study was interrupted due to hurricanes causing fourteen days of school closers.

**Assumptions**

There were several assumptions made in this action research study:

- All subjects responded to attitude instruments honestly and completely.
- The sample was representative of third grade level students at a public school.
- The subjects were able to understand English to interpret the tests.
- Teacher did not let her opinions on content integration influence interpretation of data.
**Recommendations**

For those teachers and researchers that are considering utilizing the inquiry-based approach to improve student attitudes and performance, I make the following recommendations. Collect data from older children who have had more experience with an inquiry-based science curriculum. The students’ that are just beginning to engage the inquiry approach may do so with some anxiety. The students’ problem solving techniques, especially at this grade-level, is somewhat foreign and unknown when they first begin to engage in the inquiry-based curriculum.

Student questions should be discussed with the teacher or team. The students’ questions and comments are an integral tool in allowing the teacher to better understand the cognitive abilities of each student, as well as noting the improvements of each student. Discussion in science should be the focus of inquiry. By doing this, students gain higher order cognitive skills that helps them see the links to search for answers. Verbalizing the problem also provides students with models to apply successful strategies.

Finally, if a teacher wants to make a difference in the performance of their students towards science, they themselves must be willing to change and adapt. The inquiry approach is very malleable and allows for a multitude of approaches, but it is essential that the teacher find creative ways to do so. Teachers must be prepared to change.
APPENDIX A:

UCF IRB CONSENT FORM
June 21, 2004

Ms. Debra Arthur  
Riverdale Elementary School  
11301 Lakanotosa Trail  
Orlando, FL 32817

Dear Ms. Arthur:

With reference to your protocol entitled, “The Affects of Inquiry-Based Instruction on Student Motivation to Learn Science,” I am enclosing for your records the approved, expedited document of the UCIRB 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 (UCF).

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  
Barbara Ward, CMT  
Institutional Review Board (IRB)

Copies: Dr. Bobby Jeannierre  
IRB File
APPENDIX B

PARENT CONSENT FORM
Parental Consent

August 2, 2004
Dear Parent/Guardian:

I am a graduate student at the University of Central Florida under the supervision of faculty member, Dr. Bobby Jeamperi, conducting research on ways that motivate students in science. The purpose of this research is to examine the effects of student attitudes while using inquiry-based instruction. The results of this study may help teachers better understand the effectiveness of inquiry-based instruction, and allow teachers design instructional practices accordingly.

Students in the study will receive the same instruction as students who do not participate. Students participating in the study will be interviewed and given a pre- and post science related attitude test. With your permission, your child will be videotaped or audio taped during instructional time. Although the children will write their names on their work for matching purposes, their identity will be kept confidential extent of provided by law. I will replace names with fictitious names. Results will be reported in the form of individual and group data. Participation or nonparticipation in this study will not affect the children’s grades or placement in any programs. All student data will be kept in a secure place by the researcher and upon completion of the study all videotape will be destroyed.

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 in March upon request. If you have any questions about this research project, please contact me at (407) 529-4373 or to faculty supervisor, Dr. Jeamperi, 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,

Debra Arthur

-------- I have read the procedure described above
-------- I voluntarily give my consent for my child, to participate in Debra Arthur’s research studying how inquiry-based instruction affects students’ motivation in science.

Parent/Guardian

-------- 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
(or Witness if no 2nd Parent/Guardian)

UCFIRB
APPROVED:
DATE 8/2/2004

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APPENDIX C

STUDENT ASSENT SCRIPT
Sample Child Assent Script

August 2, 2004

Dear Student,

My name is Ms. Arthur and I am a student at the University of Central Florida. I would like you to participate in science lessons and then ask you questions about the topic. I would like to videotape or audio tape the lessons and interviews. You may stop your participation at any time and you will not have to answer any questions you do not want to answer. Would you like to do this?

UCF IRB
APPROVED SPD
DATE 3 June 2004
APPENDIX D

TOSRA
TOSRA

TEST OF SCIENCE-RELATED ATTITUDES

Barry J. Fraser

DIRECTIONS

1 This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2 All answers should be given on the separate Answer Sheet. Please do not write on this booklet.

3 For each statement, draw a circle around
   SA if you STRONGLY AGREE with the statement;
   A if you AGREE with the statement;
   N if you are NOT SURE;
   D if you DISAGREE with the statement;
   SD if you STRONGLY DISAGREE with the statement.

Practice Item

0 It would be interesting to learn about basts.

Suppose that you AGREE with this statement, then you would circle A on your Answer Sheet, like this.

0 SA A N D SD

4 If you change your mind about an answer, cross it out and circle another one.

5 Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

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Australian Council for Educational Research
Test of Science-Related Attitudes

Answer Sheet

Name ________________________________
School _______________________________
Year/Class ____________________________

<table>
<thead>
<tr>
<th>Page 2</th>
<th>Page 3</th>
<th>Page 4</th>
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<tbody>
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<tr>
<td>STRONGLY</td>
<td>STRONGLY</td>
<td>STRONGLY</td>
</tr>
<tr>
<td>AGREE</td>
<td>DISAGREE</td>
<td>AGREE</td>
</tr>
<tr>
<td>NOT</td>
<td></td>
<td>NOT</td>
</tr>
<tr>
<td>SURE</td>
<td></td>
<td>SURE</td>
</tr>
<tr>
<td>DISAGREE</td>
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<td>DISAGREE</td>
</tr>
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1. SA A N D SD 29. SA A N D SD 50. SA A N D SD
2. SA A N D SD 30. SA A N D SD 51. SA A N D SD
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20. SA A N D SD 48. SA A N D SD 69. SA A N D SD
21. SA A N D SD 49. SA A N D SD 70. SA A N D SD

For Teacher Use Only

\[ S \quad N \quad 1 \quad A \quad E \quad L \quad C \]
From: Barry Fraser
Sent: Fri 7/9/2004 3:24 AM
To: Arthur, Debra
Subject: RE: TOSRA Test
Debbie

You have my permission to modify and use TOSRA.

I will need your postal address if you want me to send you comprehensive handbook and questionnaire.

Barry Fraser

From: Arthur, Debra
Sent: Thu 6/17/2004 12:46 PM
To: B.Frasrer@umc.edu
Subject: TOSRA Test

Dear Dr. Barry Fraser,

I am currently working on my Masters in Science and Math Education at Lockheed Martin/UCF Academy in Orlando, Florida. I would like to use your Test of Science-Related Attitudes in my Thesis. The topic of the Thesis is The Affects of Inquiry-Based Instruction on Student Motivation to Learn Science.

need to ask several questions:

1) Would you grant me permission to use the TOSRA in my study?

2) If I needed to Modify it (shorten it) would that also be acceptable?

3) Do you know if this test has ever been given to elementary age students?

4) Finally, I have not been able to find a copy. Could you let me know where I could locate a clean copy?

If you need more information from me, just let me know. I am impressed with the extensive use of the TOSRA at various education levels.

Thank you for your time,

Debbie Arthur

I

1. Scientists are just as interested in art and music as other people are.
2. It is better to ask the teacher the answer than to find it out by doing experiments.
3. I am unwilling to change my ideas when evidence shows that the ideas are poor.
4. The material covered in science lessons is uninteresting.
5. Listening to talk about science on the radio would be boring.
6. A job as a scientist would be interesting.
7. Science can help to make the world a better place in the future.
8. Few scientists are happily married.
9. I would prefer to do an experiment on a topic than to read about it in science magazines.
10. In science experiments, I report unexpected results as well as expected ones.
11. I look forward to science lessons.
12. I would enjoy visiting a science museum at the weekend.
13. I would dislike becoming a scientist because it needs too much education.
14. Money used on scientific projects is wasted.
15. If you meet a scientist, he would probably look like anyone else you might meet.
16. It is better to be told scientific facts than to find them out from experiments.
17. I dislike listening to other people’s opinions.
18. I would enjoy school more if there were no science lessons.
19. I dislike reading newspaper articles about science.
20. I would like to be a scientist when I leave school.
APPENDIX E

STUDENT REFLECTIVE JOURNALS
<table>
<thead>
<tr>
<th>Crayon Mass</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>white</td>
<td>9 g</td>
</tr>
<tr>
<td>mahogany</td>
<td>10 g</td>
</tr>
<tr>
<td>peach</td>
<td>9 g</td>
</tr>
<tr>
<td>sepia</td>
<td>10 g</td>
</tr>
<tr>
<td>black</td>
<td>10 g</td>
</tr>
<tr>
<td>apricot</td>
<td>10 g</td>
</tr>
<tr>
<td>tan</td>
<td>10 g</td>
</tr>
<tr>
<td>armstrong</td>
<td>10 g</td>
</tr>
</tbody>
</table>

87

10

does the sum of the mass of each crayon equal the mass of the box of crayon?

I've learned that you can weigh lots of mass. It is fun to weigh stuff. It is something great about science.
Can matter be a solid and a liquid at the same time? We have it almost have it. At we can see little dots. We are trying to take out the little dots, will it work? Next we are going to try whole milk. Will it work? We used 1/2 a cup of every thing.

Moo... Glue
9/22/09

I really enjoyed this experiment. We glued dice and a penny to a paper envelope. I glued really good, but then it came off. It was really fun and we mixed three thing. Milky, vinegar and baking soda.
<table>
<thead>
<tr>
<th>Grape Juice</th>
<th>Apple Juice, Baby Oil</th>
<th>Water</th>
<th>Vinegar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. Arthur</td>
<td>30 ml</td>
<td>15 ml</td>
<td>15 ml</td>
</tr>
</tbody>
</table>

It worked so good.

Nothing happened.

Try again.

It went low.

About 3 parts of the school.

Dishwash (me)

Went low.

5 ml

5 ml went down.

Why didn't oil work?

Because.

Mix Z.

Went low.
<table>
<thead>
<tr>
<th>Float</th>
<th>Didn't Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>boat were hollow</td>
<td>Too heavy, flat, no hole, light, short, Did not built tightly, have edges, Volume,</td>
</tr>
</tbody>
</table>

Notes: Shape

Water displacement Surface of boat
Measuring Force

1. How many newtons did it take to pull on the book without moving it?
   2.0 newtons

2. How many newtons does it take to move your sci. book?

3. How many newtons does it take to move two sci. books?

Our Airplane

1st. It got wobbly did a loopy-loop and went about 2 feet
2nd. Squiggly-slowly 1/3 miles
3rd. Got a little too slow and we threw it a little too hard.
Interview questions

Name __________________________ Date

1. How do you feel you did on your research?

2. What was the question?

3. Did you answer your question?
   You think this because....

4. Did you work well with your team?
   You think this because....

5. Do you think others understood the information you presented?
   You think this because....

6. What grade would you give yourself for this project.... A  B  C  D
   You think the should be your grade because....
APPENDIX G

SURVEY TEST
The Science Questionnaire is a modified copy of the Test of Science-Related Attitudes (TOSRA). The purpose of this survey is to find out your attitude towards science or more specifically science class in general. You will be asked what you think about these statements.

School A Elementary    N=20    Grade 3

For each statement, draw a circle around

SD=strongly disagree  D=disagree  N=not sure  A=agree  SA=strongly agree

1. Scientists are just as interested in art and music as other people are.

   SD  D  N  A  SA
   0%  0% 30% 25% 45%

   Mean= 1.95  St. Dv. = 0.89

2. It is better to ask the teacher the answer than to find it out by doing experiments.

   SD  D  N  A  SA
   35% 50% 10% 0%  5%

   Mean= 1.85  St. Dv. = 0.97

3. I am unwilling to change my ideas when evidence shows that the ideas are poor.

   SD  D  N  A  SA
   10%  5% 35% 15% 35%

   Mean= 3.6  St. Dv. = 1.31
<table>
<thead>
<tr>
<th>Question</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. The material covered in science lessons is uninteresting.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>55%</td>
<td>30%</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Mean= 4.05</td>
<td>St. Dv. = 1.41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Listening to talk about science on radio would be boring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>25%</td>
<td>10%</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Mean= 3.35</td>
<td>St. Dv.= 1.53</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. A job as a scientist would be interesting.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5%</td>
<td>10%</td>
<td>15%</td>
<td>25%</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td>Mean=2.05</td>
<td>St. Dv.= 1.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Science can help to make the world a better place in the future.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5%</td>
<td>0%</td>
<td>10%</td>
<td>25%</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>Mean=1.65</td>
<td>St. Dv. = 1.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Few Scientists are happily married.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>10%</td>
<td>5%</td>
<td>50%</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Mean=2.05</td>
<td>St. Dv. = 1.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I would prefer to do an experiment on a topic than to read about it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>5%</td>
<td>20%</td>
<td>20%</td>
<td>55%</td>
</tr>
<tr>
<td></td>
<td>Mean=2.05</td>
<td>St. Dv. = 0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. In science experiments, I reported unexpected results as</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>0%</td>
<td>30%</td>
<td>30%</td>
<td>40%</td>
</tr>
</tbody>
</table>
well as expected ones.  

<table>
<thead>
<tr>
<th>Question</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. I look forward to science lessons.</td>
<td></td>
<td>0%</td>
<td>10%</td>
<td>15%</td>
<td>75%</td>
</tr>
<tr>
<td>Mean = 1.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Dv = 0.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I would enjoy visiting a science museum at the weekend.</td>
<td>5%</td>
<td>0%</td>
<td>5%</td>
<td>5%</td>
<td>85%</td>
</tr>
<tr>
<td>Mean = 1.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Dv = 0.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I would dislike becoming a scientist because it needs to much education.</td>
<td>35%</td>
<td>30%</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>Mean = 3.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Dv = 1.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Money used on scientific projects is wasted.</td>
<td>45%</td>
<td>45%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Mean = 4.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Dv = 0.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. If you meet a scientist, he would probably look like anyone else you might meet.</td>
<td>10%</td>
<td>10%</td>
<td>30%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Mean = 2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Dv = 1.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. It is better to be told scientific facts than to find them out from experiments.</td>
<td>30%</td>
<td>25%</td>
<td>30%</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Mean = 3.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Dv = 1.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I dislike listening to other people’s opinions.</td>
<td>35%</td>
<td>50%</td>
<td>0%</td>
<td>5%</td>
<td>15%</td>
</tr>
<tr>
<td>Mean = 3.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Dv = 1.25</td>
<td></td>
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<tr>
<td></td>
<td>Question</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>18.</td>
<td>I would enjoy school more if there were no science lessons.</td>
<td>75%</td>
<td>25%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean = 4.75</td>
<td>St. Dv. 0.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>I dislike reading newspaper articles about science.</td>
<td>30%</td>
<td>30%</td>
<td>20%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean = 3.55</td>
<td>St. Dv. 1.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>I would like to be a scientist When I leave school.</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean = 1.4</td>
<td>St. Dv. 0.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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