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USING CHILDREN’S LITERATURE TO ENHANCE VIEWS OF NATURE OF SCIENCE AND SCIENTIFIC ATTITUDE IN FOURTH GRADERS

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The University of Southern Mississippi

USING CHILDREN’S LITERATURE TO ENHANCE VIEWS OF NATURE OF
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by

Kathryn Walker Hampton

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

Approved:

December 2007
The University of Southern Mississippi

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ABSTRACT

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This project was an effort to study the effect of integrating children’s trade books into the fourth grade science curriculum on the students’ views of the nature of science and their scientific attitude. The effect on the students’ reading and language achievement, and science content knowledge was also analyzed. This was done by comparing the nature of science views and scientific attitudes, reading and language achievement scores, and the science grades of the treatment group, prior to and immediately following the intervention period, with the control group which did not participate in the integration of children’s books. The science teacher’s views on the nature of science and her attitude towards teaching science were also evaluated prior to and after the intervention. The selected trade books were evaluated for their coverage of nature of science aspects.

Three intact classes of fourth grade students from a local elementary school were involved in the study along with their science and reading teacher. Two of the classes made up the experimental group and the remaining class served as the control group. All students were assessed prior to the intervention phase on their views of the nature of science and scientific attitudes. The experimental group was engaged in reading selected science trade books during their science class and study hall over a semester period.

The results of the study showed a significant difference in the groups’ initial reading and language achievement, which may have affected the lack of an effect from
the intervention. The instrument selected to assess the student’s views on the nature of science and scientific attitude (SAI II) was not reliable with this group. There was no significant difference on the students’ science content knowledge as measured by their semester grade averages. The results from the teacher’s response on the STAS II did indicate slight changes on her views on the nature of science. Sixty-nine of the eighty-three children’s trade books selected had one or more aspects of the nature of science included.
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CHAPTER I

INTRODUCTION

“Our populations have never been more ignorant of science and yet their lives are being influenced ever more by revolutions in molecular biology, genetics and surgery. Too many kids are having their curiosity stomped out by insensitive teaching in schools”, Nobel Physicist Leon Lederman (Merrow, 2005, pg. 42)

In May of 2006, a bill was introduced in the US House of Representatives to amend the No Child Left Behind (NCLB) Act to ensure that science would be included in the Adequate Yearly Progress (AYP) system of accountability beginning in 2008-2009. A survey of NSTA (National Science Teachers Association) members’ opinions concerning the AYP responded two to one that science should be included in AYP and that science achievement is no less important than math and language arts. The Mississippi State Department of Education has responded to the NCLB by developing Elementary/Middle Grades Science Assessments that will be administered in the fifth and eighth grades. The majority of science teachers in the United States are elementary teachers, but many lack adequate training in science. Most elementary teachers do not understand the nature of science and do not have the necessary science content background (Froschauer, 2006).

Current high-stakes testing has reduced time allowed in the elementary grades for science instruction, so there is renewed interest in integrating reading instruction with science. There have been increased calls for the use of trade books in science classrooms
as a welcome alternative to textbooks, pointing out: the benefits of up-to-date content in
the thousands of books published each year; their focus on select science topics; their
production quality; and their overall appeal to children. Through a mixture of quality
writing, excellent photography, engaging graphics and layouts, and topic selection, the
books directly address children's interests. The recent rise of accountability testing in
writing and reading across grade levels can be seen as an opportunity to emphasize
literacy practices within science. A sample of children's books have been evaluated and
found to have great potential for representing scientists to children in a realistic,
nonstereotypical manner in alignment with the National Science Education Standards.
These books can be tools within inquiry contexts and convey a sophisticated image of the
nature of science with contextualization by knowledgeable teachers and used in a manner
authentic to goals for scientific literacy (Ford, 2006).

"It is likely that the nature of science is a global conception that frames a learner's
total scientific knowledge, the set of tacit skills and beliefs which allow one to understand
and build scientific knowledge. If a learner's infrastructure contains misconceptions and
contradictions, subsequent knowledge and concepts built upon these faulty ideas are
likely to be erroneous and fragmented. These conceptions influence the kinds of
information they find relevant and therefore tend to seek and value" (Hammerich, 1998,
pg. 128).

"More than anything else, what has pushed nature of science considerations to the
forefront of contemporary science education, is the prominence that constructivism has
 gained in the science, mathematics, and literature education community. Constructivism
at its core; is, as it was with Piaget, an epistemological doctrine, and is coupled with commitments to certain views about the nature of science” (Matthews, 1998, pg.xv).

In 1962, Joseph Schwab (1962) said, that the nation faced three important needs, each of which required that science be taught not as a rhetoric of conclusions but as a fluid, ongoing activity. The first was the need for additional scientists who could probe frontiers of scientific knowledge. The second was for competent leaders who could operate effectively in a world dominated by science and technology and who could develop policy agendas based on the sometimes-conflicting claims of scientists. The third need was for a public that was aware of and sympathetic to an ongoing program of scientific research and discovery, a public that realized that scientific knowledge was not final and that was willing to support pure research even if the practical outcomes were not obvious. Today, these needs must still be in the forefront of curriculum design for school science. The media reports frequently of the “science wars” in which religious leaders and science educators debate issues on inclusion of Intelligent Design and creation science in biology classes (Cavanagh, 2006).

Hundreds of years ago thoughtful theologians and scientists carved out their spheres of influence and expertise and have coexisted since with little acrimony. Today, only those who fail to understand the distinction between science and religion confuse the rules, roles, and limitations of these two important worldviews. These ‘myths of science’ are commonly included in science textbooks, in classroom discourse and in the minds of adult Americans. Misconceptions about science are most likely due to the lack of philosophy of science content in teacher education programs and the failure of such programs to provide real science research experiences for preservice teachers. Another
source of the problem may be the generally shallow treatment of the nature of science in the textbooks to which teachers might turn for guidance. Science textbook writers are among the most egregious purveyors of myth and inaccuracy (McComas, 1998). Recent studies on the portrayal of the nature of science in children’s trade books are contradictory (Abd-El-Khalick, 2002; Bricker, 2005).

Statement of the Problem

Can the integration of children’s trade books enhance elementary science students’ knowledge of the nature of science? Can children’s trade books be used to promote scientific inquiry in elementary science classes? Can the integration of children’s trade books in science content units improve an elementary teacher’s attitude towards teaching science and their views of the nature of science? What was the difference in reading, language arts and science performance of the treatment group compared to the control group of who did not receive the intervention?

Purpose of the Study

This study examined the change in fourth grade students’ knowledge of the nature of science and attitude towards science after participating in scientific inquiries that may be prompted by reading selected children’s trade books. The process of integrating children’s trade books in their science classes was considered for close alignment with the NSES content standards and the Mississippi Science Frameworks competencies. The problem of selecting trade books that can demonstrate all of the aspects of NOS was addressed. Finally, the purpose of this study was to provide information to teachers and
researchers in understanding the benefits and difficulties of integrating children's trade books into their science classes in order to promote scientific inquiry. The study was conducted in the spring semester of the academic year of 2006-2007 with the fourth grade class of a local public school.

Hypotheses

The following hypotheses were tested in this study:

1. There is no significant difference between the pretest means of the control and treatment groups on the variable of scientific attitude as measured by the Scientific Attitude Inventory (SAI II).

2. There is a significant difference in the posttest means between the treatment and control groups on the variable of scientific attitude as measured by the SAI II.

3. There is no significant difference between mean scores on the criterion variables of reading and language achievement of the treatment and control groups as measured by the Mississippi Curriculum Test (MCT) scores from the spring of 2006.

4. There is a significant difference between the mean scores on the criterion variables of reading and language achievement of the treatment and control groups as measured by the MCT administered in the spring of 2007.

5. There is no significant difference in the mean semester science grades between the treatment and control groups on the variable of science content knowledge as measured by the fall semester averages.
6. There is a significant difference in the mean semester science grades on the variable of science content knowledge between the treatment and control groups as measured by the spring semester averages.

Research Questions

The following questions were examined using qualitative methods:

- Can children’s trade books be selected that will provide an opportunity to examine all aspects of the nature of science?
- Will the process of designing and implementing the integration of children’s trade books into science enhance the elementary teacher’s view of NOS?
- Will the process of implementing the integration of children’s literature into science enhance the teacher’s attitude toward teaching science?
- Will the teacher become more comfortable with planning and implementing inquiry-based science units as the semester progresses?

Definition of Terms

For the purpose of clarifying terms in the above problem statement, the following definitions are provided.

1. Children’s trade books: books published for distribution to the general public through booksellers.

2. Nature of science-sometimes referred to as the scientific world view, critical features of science that distinguish it from other ways of knowledge generation (Dass, 2004).
3. Inquiry-based instruction—“the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world” (Colburn, 2003).

4. Scientific attitude—“the willingness to give up an old established theory as soon as it is proved to be definitely inconsistent with a single scientific fact”, “being willing to accept only carefully and objectively verified facts and to hold a single fact above the authority of the oldest theories” (Podolsky, 1965).

5. Science content knowledge—scientific facts and concepts that are required to be taught by the Mississippi Science Frameworks.

**Delimitations**

The delimitations of this research were as follows:

1. The subjects for this study were limited to the fourth grade teacher and her students enrolled during the academic year 2006-2007.

2. The collection of data was limited to three intact classrooms of students enrolled in this school during the spring of 2007.

3. The study was limited to the variables of change in knowledge of the nature of science as measured by the Science Attitude Inventory II, and STAS-II (Science Teaching Attitude Scale); Science Achievement as measured by Students’ Semester Grades, Reading and language Achievement as measured by the Mississippi Curriculum Tests.

4. Any subjects, conditions, or variables not so specified are considered beyond the scope of this study.
Assumptions

The following principles guided this research.

1. The theoretical basis for the study was valid.
2. The social interactions involved in the research was equitable, fair, and conducted with mutual respect between participants and facilitator.
3. The researcher assumed that the students and teachers would answer honestly and free from any form of coercion.

Justification for the Study

One consistent theme in science education reform is the need for individuals to understand the nature of science (American Association for the Advancement of Science, 1989; National Research Council, 1996). The Mississippi Science Framework (MDE, 2001) includes the history and nature of science as one of five process strands that should be incorporated into every science course and at every level from elementary through high school. For each course and level, specific teaching objectives are recommended with suggested activities to address NOS. And yet, many science classrooms do not demonstrate that inquiries into NOS are frequent. Hipkins, Barker, and Bolstad (2005) explored the continuing mismatch between curriculum reform rhetoric in science education and actual classroom practice. Lack of philosophical consensus about the nature of science (NOS); lack of appropriate curriculum guidance, classroom materials and pedagogical content knowledge for NOS teaching; teachers' personal theories of learning; and the realities of classroom constraints are all implicated as interacting factors that contribute to the mismatch.
A National Science Teachers Association (NSTA) position paper on the nature of science states that all those involved with science teaching and learning should have a common, accurate view of the nature of science. The following premises are important to understanding the nature of science.

- Scientific knowledge is simultaneously reliable and tentative. Having confidence in scientific knowledge is reasonable while realizing that such knowledge may be abandoned or modified in light of new evidence or reconceptualization of prior evidence and knowledge.

- Although no single universal step-by-step scientific method captures the complexity of doing science, a number of shared values and perspectives characterize a scientific approach to understanding nature. Among these are a demand for naturalistic explanations supported by empirical evidence that are, at least in principle, testable against the natural world. Other shared elements include observations, rational argument, inference, skepticism, peer review and replicability of work.

- Creativity is a vital, yet personal, ingredient in the production of scientific knowledge.

- Science, by definition, is limited to naturalistic methods and explanations and, as such, is precluded from using supernatural elements in the production of scientific knowledge.

- A primary goal of science is the formation of theories and laws, which are terms with very specific meanings.
o **Laws** are generalizations or universal relationships related to the way that some aspect of the natural world behaves under certain conditions.

o **Theories** are inferred explanations of some aspect of the natural world. Theories do not become laws even with additional evidence; they explain laws. However, not all scientific laws have accompanying explanatory theories.

o Well-established laws and theories must:

  ▪ be internally consistent and compatible with the best available evidence;

  ▪ be successfully tested against a wide range of applicable phenomena and evidence;

  ▪ possess appropriately broad and demonstrable effectiveness in further research.

• Contributions to science can be made and have been made by people the world over.

• The scientific questions asked, the observations made, and the conclusions in science are to some extent influenced by the existing state of scientific knowledge, the social and cultural context of the researcher and the observer’s experiences and expectations.
• The history of science reveals both evolutionary and revolutionary changes. With new evidence and interpretation, old ideas are replaced or supplemented by newer ones.

• While science and technology do impact each other, basic scientific research is not directly concerned with practical outcomes, but rather with gaining an understanding of the natural world for its own sake (NSTA, 2000).

Much research over the decades since the science curricula reforms of the 60’s was designed to evaluate teaching methods to improve science literacy which includes the concepts of the nature of science (NOS). Curricula assuming that NOS would be improved through inquiry and hands-on science projects have not been able to demonstrate effectiveness. Recent research efforts have examined an explicit approach to improving students’ concepts of NOS. Michael Matthews (1994) said, that it could be argued that this approach demands students have certain views of the scientific enterprise. However, Lederman and Abd-El-Khalick (1998) contend that certain views of NOS have been imposed on students that are well-documented and persistent NOS misconceptions. These were probably not gained by internalizing implicit messages about science in their high school and college science experiences, but were explicitly taught by teachers with naïve ideas about NOS.

Regardless of these persistent arguments advocating an accurate portrayal of the enterprise of science, numerous studies have shown that science students possess significant misconceptions concerning NOS. Because of these concerns, many teachers and textbook publishers have begun to devote a portion of their course to the NOS. Even
so, these one- to two-week efforts have failed to reject the myths from student conceptions of science (Clough, 1997).

The National Science Education Standards, Benchmarks for Science Literacy and the Mississippi Science Frameworks emphasize the importance of teaching the history and nature of science in all science classes at all levels. Even though the vast majority of science teachers are elementary teachers, many of their reasons for becoming science teachers are simply because nobody else would. Although most have risen to the challenge, many have very limited experience with formal science and many have negative memories of their own science schooling. With the push for more science assessments from the No Child Left Behind Act, “teaching for the test” may lessen any chance of enriching these classes with NOS (Keske, 2002).

“Many children get turned off to science very early in their school careers so that by high school they tend to avoid the more advanced science courses. Using literacy-based instruction increases motivation because science becomes more dynamic. Students can relate science concepts to events in stories they have read. The processes of literacy and science have many common elements, so parallel instruction can be designed” (Casteel & Isom, 1994, p.542). Morrow, Pressley, Smith & Smith (1997) found the integration of literature-based activities with science textbook instruction to be more powerful than traditional instruction alone.

Textbooks structure from 75 to 90 percent of classroom instruction, but the aggregate volume of material required by many states must be compressed to the point of being incomprehensible. Elementary science textbooks were found to fail in exposing children to the processes of scientific inquiry due to the emphasis on the products of
science (Tyson & Woodward, 1989). Science has been left behind since the NCLB, and elementary science teachers only have time to give text-reading assignments with its accompanying worksheet. The only sections of the texts that “are covered” are those that cover the state’s benchmarks. “It’s no fun anymore!” (Teacher’s personal communication)

This study examined the change in fourth grade students’ knowledge of the nature of science after participating in scientific inquiries that would be prompted by reading selected children’s trade books. The process of integrating children’s trade books in their science classes was considered for close alignment with the NSES content standards and the Mississippi Science Frameworks competencies. The problem of selecting trade books that can demonstrate all of the aspects of NOS was addressed. Finally, the purpose of this study was to provide information to teachers, administrators and researchers in understanding the benefits and difficulties of integrating children’s trade books into their science classes in order to promote scientific inquiry. The study was conducted in the spring semester of the academic year of 2006-2007 with the fourth grade class of a public school.
CHAPTER II

REVIEW OF THE LITERATURE

What is the nature of science?

“Science is built up with facts as a house is with stones, but a collection of facts is no more a science than a heap of stones is a house” (Poincare’, 1998, p. 211).

The phrase ‘nature of science’ (NOS) has come to refer to the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge (Lederman, 1992). There have been changing conceptions of NOS with new developments in the various science disciplines and shifts in emphasis in the fields of philosophy, sociology, and history of science. Generally, the twentieth century can be divided into two periods of focus in the philosophy and sociology of science with the publication of Kuhn’s *Structure of Scientific Revolutions* (1962), whose approach marked a shift from emphasizing the context of justification to delving into the context of discovery. His paradigmatic approach was criticized (Popper, 1970) for introducing all sorts of relativism and irrationalities into accounts of the development of scientific knowledge. Nevertheless, the hallmark of post-Kuhnian philosophy of science is a preoccupation with reconciling accounts of science with actual scientific practice and has been legitimimized by descriptive accounts of laboratory studies and sociological analysis of scientists’ discourses (Abd-El-Khalick, 2000).

A definition of nature of science (NOS) is basically the sum total of the “rules of the game” leading to knowledge production and the evaluation of truth claims in the natural world. William McComas, director of the Program for Advance Science
Education at the University of Southern California, has compiled a set of nine core NOS ideas from the literature on the history and philosophy of science. These key ideas can then be used as objectives to shape instruction.

1. Science demands and relies on empirical evidence. Not all empirical evidence is collected experimentally and a great deal of our understanding relies on basic observation. Faith alone plays no final role in science.

2. Knowledge production in science includes many common features and shared habits of mind. However, there is no single step-by-step scientific method by which all science is done.

3. Scientific knowledge is tentative, but durable. Science can not prove anything because the problem of induction makes 'proof' impossible, but scientific conclusions are still valuable and long lasting because of the way that knowledge eventually comes to be accepted in science.

4. Laws and theories are related but distinct kinds of scientific knowledge. Where as laws are generalizations or patterns in nature, theories are explanations for why the laws operate.

5. Science is a highly creative endeavor. Creativity is involved in the selection of problems, methods of investigation, and the inspiration that leads from fact to conclusions.

6. Science has a subjective component. Initial discovery and analysis are ultimately personal and uniquely subjective events. Scientists recognize this subjectivity and require that ideas and conclusions be reviewed by other experts to be tempered by checks and balances.
7. There are historical, cultural, and social influences on science. What research is performed or discouraged or prohibited is best understood by considering human forces such as history, religion, culture, and social priorities.

8. Science and technology influence each other but they are not the same. Technology, often called applied science, involves problems related to a particular need, whereas “pure” science aims at basic understanding of the fundamental nature of reality.

9. Science cannot answer all questions simply because some can not be investigated using scientific means. Such is often the case with questions of morality, ethics, and faith; which are for many, in the domain of religion (McComas, 2004).

Historical Perspective of Nature of Science in Science Education

“A renewed stress on scientific inquiry and nature of science are what distinguish current reform documents in science education from previous efforts. Unfortunately, classroom teachers, as well as, teacher educators, remain uncertain about the specific attributes of scientific inquiry and nature of science, let alone their integration into current science instruction and curricula” (Flick & Lederman, 2004,p. 2)

Science instruction has been part of the education of American youth in some form since the early days of the country. Most of the goals that science teaching expected then remain with us today. The language to express them may have changed,
but they included the intellectual goals of thinking and reasoning, personal goals of appreciation and understanding, practical goals that help us as intelligent citizens and the futuristic goals of innovation and creativity. The first use of the actual phrase, 'nature of science', in *The History of Ideas in Science Education* by DeBoer (1991) is quoted from the National Society for the Study of Education’s (NSSE) Thirty-First Yearbook published in 1932. The context in which it was used was in response to declining student populations taking science courses in secondary schools. Many educators believed that this decline was due to the overspecialization in the science classes that was not relevant to most students. The NSSE committee stated in its 1932 report that “the very nature of science and the objectives of science education ... prompt the statement that mere lesson-assigning and lesson-hearing is a technique of instruction that the committee highly disapproves.” (p.81) From 1845 to the present, the calls for improvement in science education criticized the memorization from imperfect textbooks and started with complaints from scientists and presidents of colleges (DeBoer, 1991).

Thomas Huxley wrote in 1900 that science education should not rely on textbooks, but on direct observation of objects and phenomena so that science retains its uniqueness and role in developing the kind of mental discipline that other school subjects could not provide. He said that if explanations were merely verbal abstractions, they would not be meaningful to the child and the point of instruction lost. This view provided the major justification for the science laboratory as an opportunity for students to develop a clear and definite conception of natural phenomena. Then reading science textbooks would move beyond mere repetition of words. Whether in the classroom or laboratory, the teacher would be required to know the subject in the same practical way.
that the subject should be taught. If not, the teacher will be afraid to wander beyond the
limits of the technical phraseology and a “dead dogmatism” would result (Huxley, 1900).

In 1945, Harvard president James B. Conant commissioned the Harvard
Committee on General Education which reported that very little attention was given to
the examination of basic concepts, the nature of scientific enterprise, nor its history, great
literature or interrelationships with other areas of interest and activity. Conant (1947)
recommended in his book, On Understanding Science, that nonscientists be taught the
principles of science through its historical development which would impart and
understanding of the scientific process rather than the structure of the discipline as a set
of ordered facts which future scientists would need to understand. The AAAS in 1947
also recommended this historical approach for college science programs in order to
“clarify the nature of scientific thought, the cooperative aspects of scientific
investigations, the ethical implications of the free exchange of ideas and the important
effects of scientific discoveries on society” (DeBoer, 1991, p. 133).

By the late 1950’s, the perceived threats to national security and the shortages of
technical personnel brought on by World War II led education and political leaders to
criticize the progressive education movement for turning its back on traditional
intellectual values. Scientists with the support of their professional organizations and the
financial backing of the National Science Foundation (NSF) began to investigate ways to
improve the intellectual vigor in school science programs. Curriculum reform projects in
each discipline were funded by grants from NSF and led by college science professors
with help from schoolteachers. A number of educational theorists lent considerable
support to the movement. Jerome Bruner, psychologist from Harvard, led the Woods
Hole Conference in 1959 of 35 scientists, mathematicians, historians, psychologists and educators called together by the National Academy of Sciences to discuss the new developments in science and mathematics education. The group played an important part in generating momentum for the changes in emphasis on teaching the structure of the disciplines. Bruner advocated “that the current practice of teaching the conclusions of the sciences without providing a sense of the scientists’ spirit of discovery produced knowledge unrelated to the essence of the subject itself” (DeBoer, 1991, p. 160).

Another scientist, Joseph Schwab, stressed the importance of the processes in scientific investigation and made the case for a fundamentally different approach to science teaching that would more faithfully mirror a changing conception of science itself. He said that since scientists themselves no longer viewed scientific knowledge as stable truths, but principles of enquiry that could be revised when necessary; then school science should also promote this revised notion of science. The rate of change in the fundamental principles of science is so rapid that the presentation of science as stable was no longer faithful to the current view of the nature of science. Schwab thought that science teaching had not kept pace with science because the control of textbook writing had transferred from scientists to professional educators during the early decades of the 1900’s (Schwab, 1962).

Paul Hurd (1970) summarized the strengths of the new curriculum projects that included a more accurate picture of the nature of science, but having weaknesses of ignoring the role of science in society and not considering the importance of readiness for learning by the student. He was one of the firsts to use the term scientific literacy to describe an understanding of science and its applications to our social experience. Anton
Lawson (1979) described the issue of developmental readiness based upon the work of Jean Piaget and the essential cognitive skills for dealing with new knowledge. Piaget’s work had an enormous impact on theory and practice in science education with the implementation of curricula that focused on content-free strategies for developing generalized mental skills (Lawson, 1982).

Even though it was agreed that students should learn the scientific way of thinking, it was difficult to agree on what that method was. Earlier definitions of scientific method were based on conceptions of the inductivist and empiricist philosophies of the seventeenth centuries. However, questions about the portrayal of scientists as coldly rational were based on the work of philosophers of science in the 70’s. Hawkins and Pea (1987) summarized a new conception of the nature of science in which scientists shape as well as document the objects of study, that science is best viewed as constructed knowledge within a community, and revisionist rather than cumulative.

Twenty-five years after the curricula reform efforts funded by NSF grants, Richard Duschl (1985) wrote of the same crisis in science education. Even though these projects were focused on getting students to operate and think as scientists, this was occurring at a time when our conceptions about how scientists produce knowledge was being drastically altered. Between 1956 and 1966, the prevailing ideas among historians and philosophers of science about the nature of science was being challenged and changed. The notion of inquiry, as presented by the NSF curricula, was being rejected and replaced by new notions of how science conducts inquiry. Science educators were perpetuating the myth that science was totally objective and non-speculative thus giving future scientists and students a limited view of the nature of science (DeBoer, 1991).
In 1989, the AAAS Project 2061 published *Science For All Americans* (1989), a consensus on what students should know to be scientifically literate. The teaching of science was recommended to be consistent with the nature of scientific inquiry and as such should give students problems to investigate requiring a personal analysis of evidence. Personal intellectual development as well as responsible citizenship was highlighted as goals of becoming scientifically literate.

The National Research Council (1996) soon followed with the publication of the *National Science Education Standards* with major funding provided by the National Science Foundation, the US Department of Education, the National Aeronautics and Space Administration, The National Institutes of Health, and the National Academy of Sciences. The standards were designed to enable our nation to achieve the goal of all students becoming scientifically literate in the 21st century because science has become a central aspect of our society. They are presented in six chapters with one dedicated to the science content that outlines what students should know, understand and be able to do in the natural sciences over the course of K-12 education. The history and nature of science is one of the eight categories and recommends the use of history in science programs to clarify different aspects of scientific inquiry, the human aspects of science, and the role that science has played in the development of various cultures. The writers emphasize that none of the eight categories should be eliminated (National Research Council, 1996).

McComas and Olson (1998) analyzed eight science education standards from the US and four other countries for their agreement on NOS issues. Over half of the documents include the nature of science discussion at the onset, which leads to the belief that student understanding of the nature of science is a vital foundation for all future
science learning. New support for inquiry teaching was provided by these standards by pointing out the correspondence between scientific inquiry and effective student-centered teaching. The developing focus on constructivist pedagogy was consistent with important aspects of scientific inquiry (DeBoer, 2004).

Michael Matthews (2003) reevaluated Thomas Kuhn’s impact on science education. His original ideas about scientific knowledge development influenced especially the constructivist theorizing and conceptual change research. Matthews stated that there has been minimal appreciation of how Kuhn qualified his initial irrationalist views of scientific development and that researchers have frequently had limited understanding of Kuhn’s original ideas. One lesson that should be learned by science educators is to more seriously engage with the ongoing debates and analysis within the community of the history and philosophy of science.

What is Constructivism?

Constructivism is a theory about knowledge and learning that describes both what knowing is and how one comes to know. This theory describes knowledge as emergent, developmental, viable constructed explanations by humans engaged in making meaning in communities of discourse. Learning is viewed as a self-regulatory process of struggling with conflict between existing personal models and discrepant new insights to construct new representations of reality. Even though constructivism is not a theory of teaching, it recommends taking a different approach to instruction from that used in most schools. The traditional hierarchy of teacher as the autocratic knower and learner as the
unknowing subject, who must practice what the teacher knows, is replaced with the 
teacher as facilitator and learners taking more ownership of ideas (Fosnot, 2005).

What sets constructivism apart from other theories of cognition is the idea that 
Piaget launched 60 years ago of knowledge having an adaptive function, not the purpose 
of representing an independent reality. Piaget’s view of what we see, hear, and feel is the 
result of our own ways of perceiving. Thus knowledge, according to Piaget, comes from 
actions and reflections on them (Glasersfeld, 2005).

Very early in his career, Piaget proposed that equilibration was the mechanism 
that explained development, but it was his last 15 years that he directed his attention back 
to his work as a biologist on snails. From observations of the variability of the snail’s 
adaptations and of plant growth, Piaget proposed a middle ground position between the 
thories of evolution at the time - Lamarck’s and Darwin’s. Piaget’s proposition was that 
the activity of the organism drives evolution of new structures because a new behavior 
causes an imbalance in the genome, a series of possibilities in the genome and then those 
most suitable to the environment survive. He believed that humans are developing 
organisms, physically and cognitively. Through his research, he demonstrated that the 
mechanism causing change in cognition is the same as that in evolution, equilibration. 
Just as the genome generates new possibilities when disturbed, cognitive structures 
generate possibilities of new actions or explanations of surprising results. Some have 
argued that Piaget’s notion of structures relate more to math and science thinking, but 
structural shifts have been described in reading, spelling, writing and all literacy 
strategies (Fosnot & Perry, 2005).
Lev Vygotsky created the idea of the zone of proximal development to differentiate between the child's developmental level and their level of potential development under adult guidance or in collaboration with more capable peers. This zone becomes the construction zone or scaffolding where individuals construct new knowledge by interacting with others (Roth, 1993). Vygotsky thought that the most effective learning occurs when the adult tempts the child to a jointly constructed potential level of performance. Bruner and his associates continued this idea with the notion of scaffolding from studying the interactions of mother-infant communication rituals with the mother at times imitating the child, but then changing her response to challenge the baby (Fosnot & Perry, 2005).

In 1996, Osborne (1996) offered a critique of constructivism in which he said that it was flawed with instrumental epistemology that misrepresents the views and practice of science and scientists. He also stated that constructivism in science education confused the manner in which new knowledge is made with the manner in which old knowledge is learned. Because of these failings, it provides no guidance on adjudication between theories, the organization and sequencing of content and rejects any value for didacticism.

General principles of learning proposed by constructivism and listed by Fosnot and Perry (2005) to inform educational practices are:

- Since learning is development that requires invention and self-organization, teachers must allow learners to raise their own questions and hypotheses to test for viability, defend and discuss in communities of discourse.
• Since disequilibrium facilitates learning, errors need to be perceived, not minimized or avoided. Open-ended investigations need to be allowed for learners to explore and contradictions in particular need to be discussed.

• Reflection through journaling and discussing connections must be encouraged to facilitate reflective abstraction.

• Dialogue within the classroom should be seen as part of a community of discourse in which ideas are accepted as truth if they make sense to the community after defending and justifying. (p.33)

Assessing Understanding of NOS

“The nature of science should be a central instructional purpose rather than an optional prelude” (McComas, 2004, p.27).

Lederman, Wade & Bell, (1998) critiqued 24 instruments developed between 1954 and 1995 to assess the nature of science. Beginning in the early 60’s, the formal instruments emphasized a quantitative approach that allowed for easy grading and quantified measures of individuals’ understandings. Regardless of the instruments used, four consistent findings were reported over the last three decades:

1. Science teachers appear to have inadequate conceptions of the nature of science.

2. Efforts to improve teachers’ conceptions of the nature of science have achieved some success when either historical aspects of scientific knowledge or direct attention to the nature of science have been included.
3. Academic background variables have not been significantly related to teachers’ conceptions of the nature of science.

4. The relationship between teachers’ conceptions of NOS and classroom practice is not clear, and the relationship is mediated by a large array of instructional and situational concerns.

The authors concluded from their review that there remain clear implications for future research into the critical question concerning teachers' explicit attention to the nature of science during instruction. “It is time to move on to questions of classroom practice” (P.347).

**Elementary Teachers’ Understandings of NOS**

“There are good reasons to believe that teachers’ views of the nature of science form part of a hidden curriculum in their science teaching: thus an understanding of them is necessary to an understanding of learners’ experiences of science teaching” (Lunn, 2002, p. 1).

Elementary teachers’ understanding of the nature of science has been extensively studied since the 60’s. Many of the studies focused on the effect of science teaching methods courses (Barufaldi, Bethel, & Lamb, 1977; Olstad, 1969; Riley, 1979; Wood, 1972) and found that inquiry-based methods courses improved teachers’ views of the tentative nature of science with high science undergraduate grade point averages having a significant positive relationship. Scharmann (1988a) found that the social-personal variable of locus-of-control orientation was a significant discriminator in preservice
elementary teachers to develop an understanding of the nature of science. He suggested that these students need to be identified and given manipulative laboratory experiences to foster an understanding of NOS.

Scharmann (1988b) went further to find that the preservice curricular sequence should promote a complementary view of science as content and process, but must not exceed the students’ ability to synthesize the ‘mutual fit’. Many studies have attempted to find the most effective strategies for improving elementary teachers’ conceptions of the nature of science (Abell & Smith, 1994; Bianchini & Colburn, 2000; Gustafson & Rowell, 1995; Murcia & Schibeci, 1999). Most were found effective with the use of hands-on or inquiry activities.

Bencze and Hodson (1999) described a collaborative study between a university-based researcher and two middle-school science teachers to design and implement a more authentic science curriculum through action research. The underlying principle for this approach was the recognition that teacher development cannot be achieved by compulsion, nor persuasion, and that action research creates a sense of ownership essential to effective change in curriculum. The group work consisted of repeated cycles of: reflecting on and challenging each other’s beliefs and practices; seeking alternative views to develop new approaches; and field testing and evaluating them in class. At the beginning of the project, both teachers felt overwhelmed by science, regarding it as a body of complex knowledge properly understood only by experts. Their anxieties about science teaching fell into three categories; feeling inadequate in content, uncertainty about scientific methods, and a sense of need to over-rely on didactic methods. The project significantly improved the teachers’ confidence in all three areas. Their students
were given a more creative role in inquiry and showed increased emphasis on the nature of scientific inquiry. One valuable lesson from this research was that the university research must challenge everyday practices vigorously and explicitly if change is to occur, but if too vigorous, the challenge can result in feelings of anxiety, vulnerability and insecurity.

Lederman and Abd-El-Khalick (1998) developed a reflective, explicit, activity-based approach that was specifically designed to address many aspects of NOS within a science methods course for elementary science. The students showed substantial improvement in their views of some of the aspects of the NOS. This reflective, explicit approach has been implemented effectively within science content courses for other prospective elementary teachers (Abd-El-Khalick, 2001; Akerson, Abd-El-Khalick, & Lederman, 2000; Cochrane, 2003; Craven, Hand, & Prain, 2002) and found to improve their conceptions of various aspects of the NOS.

In an interpretive case study of seven elementary science teachers, interviews were employed to collect their perspectives on the nature of science and their views on science teaching. These subjects demonstrated an awareness of the cultural and social aspects of science, the multiplicity of methods available to scientists, and the tentative nature of science, but a naïve view about the relationship between theories and laws and the theory-ladenness of observation (Keske, 2002).

Abd-El-Khalick and Akerson (2004) found that preservice elementary teachers made substantially more progress in obtaining a sophisticated view of the nature of science from an explicit reflective instructional approach when they were motivated by the importance and utility of teaching NOS. The teachers that made the most progress
also exhibited a deep processing to learning and viewing science and religion as two distinct enterprises rather than opposing ones. However, Akerson, Morrison, and McDuffie (2006) found that five months after instruction, some students had reverted back to their earlier naïve views of NOS. Implications sighted were concerned with whether we can expect K-6 learners to attain and retain levels of understanding promoted by the science education reforms.

Elementary Pupils’ Understanding of NOS

“Unfortunately, current prevailing assumptions about children’s scientific reasoning capabilities significantly underestimate the power of their thinking...Virtually all cognitive development [research] has come to reject a strong universal stage model such as proposed by Piaget, this advancement has not appeared to have permeated the belief system of elementary school teachers. Changing teachers’ understanding of children’s capabilities is crucial to achieving their willingness to engage their children in more intellectually substantive inquiry.” (Metz, 2004, p. 105).

A study of sixth-grade students’ knowledge of the epistemology of science found that those students taught from a constructivist perspective developed a more sophisticated view than those in a traditional class. The students held a stance toward science that focused on the central role of ideas on the kinds of mental, social, and experimental work involved in understanding, developing, testing and revising ideas. This study concluded that elementary students are more capable of formulating
sophisticated epistemological views than many have thought. The students taught in the constructivist environment saw the goal of science as developing and testing ideas as opposed to those in a traditional class saw the goal of science as doing things with little mention of finding explanations. The types of questions that the students sought to investigate were both more metacognitive and theoretical than in the traditional class (Smith, Maclin, Houghton & Hennessey, 2000). Cochrane (2000) also found that sixth grade students instructed in a constructivist class developed a more sophisticated view of the nature of science and were able to evaluate theoretic claims against evidence.

Khishfe and Abd-El-Khalick (2002) studied the difference in effect on sixth grade students’ views of NOS from the influence of explicit versus implicit inquiry-based instruction. The implicit group showed no difference after the intervention, whereas the explicit group articulated a more informed view on the target aspects of NOS.

Akerson and Abd-El-Khalick (2003) studied and supported the efforts of an experienced elementary teacher to help her fourth grade students gain informed views of the inferential, tentative, and creative nature of science. The lead researcher visited weekly and modeled explicit instruction in the target NOS aspects.

Akerson and Volrich (2006) studied a preservice teacher’s efforts to explicitly teach NOS in her first-grade internship classroom. Using three teacher-designed methods, this teacher was able to influence the students’ views of the inferential, tentative, and creative aspects of NOS. This teacher emphasized NOS by using an “Introduction to the NOS aspect lesson, and concluded the lessons with “how was what we did like what scientists do?”
Bartholomew, Osbourne, and Ratcliffe (2004) worked with 11 UK teachers for a year to teach aspects of the nature of science in a mix of elementary, junior high and high schools. They argued that there are five critical dimensions of teachers’ pedagogy that determine their ability to teach effectively about science:

1. Teacher’s understanding of the nature of science
2. Teacher’s conception of their role as a facilitator of learning
3. Teacher’s use of open and dialogic discourse
4. Teacher’s learning goals include development of reasoning skills
5. Classroom activities are authentic and owned by students.

Akerson and Abd-El-Khalick (2005) explored the views of 23 fourth grade students in a self-contained class whose teacher had an informed view of NOS. Using an open-ended questionnaire coupled with interviews, the researchers focused on the students’ understandings of the distinction between observation and inference, the creative nature of science, and the tentative yet reliable nature of science. Most students held contradictory views of the relationship between observations and inferences, and the question was raised that students’ knowledge may be specific to contexts in which they have actually made those observations and inferences. Only two students were able to describe creativity as something to do with thought processes and not only artistic work. A typical response about the tentative nature of scientific knowledge was “Science never changes. It is put in books so we can learn it”. A few students indicated more sophisticated views about the tentative NOS with statements such as, “you find new evidence all the time, so science changes”. The results of the study provide evidence that
inquiry science instruction alone does not teach NOS conceptions that are consistent with those recommended by the reforms.

Integration of Children’s Literature into Science

“It is more important to pave the way for a child to want to know than to put him on a diet of facts he is not ready to assimilate” (Carson, 1956, p.32).

In 1992, an integrative curriculum was developed to emphasize science process skills and hands-on activities and replace the basal reading program in fourth grade classrooms. The study found that in those classes that incorporated the reading and language arts objectives into the science reading activities, students scored significantly higher on reading and science achievement assessments. These students also showed a more positive attitude toward science and reading and greater self-confidence in learning science (Romance & Vitale, 1992).

Short and Armstrong (1993) found that second-grade students’ interactions with literature improved their inquiry processes by creating interest in a particular topic and encouraged a broad exploration of content. Literature supported inquiry by making better connections with the children’s’ life experiences and improved their finding of focused questions to research, as well as engaging the children in in-depth discussions and sharing their ideas with others.

Maria and Junge (1993) investigated the difference in fifth graders’ recall of scientific information from reading a science textbook or an informational storybook. The results indicated that the recalls from the informational story were longer than from
the expository text, but that children in either condition recalled very few informational
ideas from either text. The researchers recommended that teachers need to set clear
purposes of reading either type of text.

Royce (1996) reported the need for caution in using children’s literature in
science since there was very little quantitative support, and that it could foster
misconceptions. However, Madrazo (1997) made a strong argument for using children’s
trade books as resources for further scientific inquiry. She described the Outstanding
Science Trade Books for Children that are published each March in Science and Children
and are available online by the NSTA (http://www.nsta.org/publications/ostb/).

Morrow et al. (1997) reported finding significant improvements on all literacy
measures with an experimental group of sixth-graders that had been in a literature-based
program of science. Even though there were no hands-on science opportunities tied to
the literature in this study, the researchers found a significant improvement in the
students’ scores on tests of science facts and vocabulary.

In 1998, Monhardt found little effect on elementary students’ perceptions and
attitudes toward science when their science instruction was changed to integrate literature
into their science curriculum. The study was the final survey of students’ perceived
changes in their science instruction in a four-year program called Science: Parents,
Activities, and Literature. However, the program only used children’s literature for
homework assignments that were to be completed with their parents (Monhardt, 1998).

Utilizing student-generated questions to guide interrogation of texts has been
shown to improve instruction and to enhance reading comprehension. The quality of
research questions can be improved with explicit instruction for middle school students
(Cuccio-Scherrigue & Steiner, 2000). Even though constructivist teachers want students to initiate and guide their own inquiries and knowledge construction, students are not as likely to generate wonderment questions that initiate discussion about hypotheses, predictions, experiments, and explanations (Chin, Brown, & Bruce, 2002).

Rop and Rop (2001) sighted the review journal, *Science Books and Films*, published by the American Association for the Advancement of Science as another guide for selecting recommended books every year. They also point out that the effectiveness of the trade books depends on the effectiveness of the context in which they are used. Some of the difficulties in using trade books were availability in local and school libraries and budget constraints in purchasing. To facilitate the process of selection; two aspects of the books should be attended to:

1. Selection of books for their role in supporting student learning.
2. Think in terms of trade books that will balance content, science attitude, and student performance goals

Trade books can be used as motivation at the beginning of units, or as resources for students to investigate questions that arise during the unit. Storybooks that relate to the topic or biographies of scientists who work in that science field can be used to extend student interests.

Abd-El-Khalick (2002) randomly selected four award-winning trade books for the years 2000 and 2001 to analyze for their images of the nature of science that are expected to be achieved by the end of the eighth grade. All four books were found to be devoid of any explicit references to ideas about NOS. Neither were there any discussions of the processes involved in the development of the scientific ideas and claims presented in the
books. These four books presented science as a body of facts with no reference to the individuals who were doing the science. Abd-El-Khalick recommended that reform-minded science teachers need to be aware of the images of NOS that are portrayed in books and presented a modality for critically examining such books for the purpose of insuring that the images conveyed do not reinforce inaccurate conceptions of NOS.

Diana Rice (2003) delineated the facts and fallacies of using trade books in elementary science. Trade books:

- are generally more up to date than many text books, and more focused with an in-depth look at single concepts;
- Can accommodate many different reading levels and learning styles.
- are generally more interesting with story lines and colorful graphics
- Can be used to support inquiry, introduce scientific methods, excitement of discovery, and enhance creativity and thinking skills.
- Present a more human side of science and more diversity of achievement.

She states that the growing acceptance of trade books as a resource in science has prompted several textbook publishers to include them to accompany new editions and many science methods texts to identify trade books that can be integrated into science lessons.

However, there had only been one study by Mayer (1995) at the time evaluating the influence of a trade book on children’s conceptual understanding. This study concluded that the book interfered with development of concepts and that children remembered only the story, not the embedded science. Teachers must be able to recognize weaknesses in trade books. Rice (2003) found that many trade books contain
misinformation and recommended caution in selecting books as supplements. Many elementary teachers may not be discriminating in selecting trade books, nor have the time to check the accuracy of content in all the books in the school’s library. Another source Rice cited additional sources for reviews of children’s books are: *Appraisal: Science Books for young People, Science Books: A Quarterly Review, and Bulletin of the Center for Children’s Books.* “The ability of teachers to identify both the short comings and strengths of trade books is critical to the effective use of this valuable resource.” (p. 563)

“Does a children’s book with glossy photos and obscure text that is written to meet readability requirements actually contribute to, rather than dispel, scientific misconceptions? Does it promote critical and creative thinking? When a truly effective literacy-science connection is created in the classroom, both literacy and the science work undertaken by students makes sense in terms of both disciplines. Neither is subsumed under the other” (Saul, 2004, p.5).

Patricia Bricker (2005) studied the efforts of three elementary teachers to use children’s literature to support inquiry-based science in their second, fourth and fifth grade classrooms. Of particular interest was selecting and addressing the nature of science through these books. She identified three themes that were related to NOS in the 76 children’s books selected by the teachers.

1. Science as a human endeavor that involves fascination, passion, interests, imagination, creativity, and diverse views. Gender, race and culture were not represented well in the collection as a whole.

2. Support of inquiry and the idea that empirical evidence underlies scientific understanding. Observation, journaling, identification of
questions to investigate, procedures to use, interpretation of results, and inferential thinking were all involved.

3. Books helped teach about the durable nature of scientific knowledge, discovered over time, and used as references after investigations.

Two important aspects of NOS that were not addressed were the tentative nature of scientific knowledge, and an understanding of scientific theories and laws.

The integration of literature into science lessons is believed to be a perfect antidote to leaving science behind in the elementary classroom. Lessons can be designed in which children read first from a picture book; then explore objects, organisms, and events related to what they have read; discern patterns and relationships in the world around them; and then read more to gather more information for explanations and find more questions to investigate. A study of third-graders found those who used trade books instead of a science textbook scored higher on district science performance assessments. Their teachers developed inquiry lessons using the BSCS 5E’s Instructional Model that provided an authentic purpose for reading informational text in order to find the answers to their own questions (Ansberry & Morgan, 2005).

Ford (2006) examined 44 randomly selected juvenile science trade books in a suburban public library for their explicit and implicit representations of science. She concluded that the books are not likely to convey a sophisticated image of NOS without contextualization by teachers, but that the books could have potential as tools within inquiry.
CHAPTER III

METHODOLOGY

This chapter describes the methods that were used in collecting and analyzing the
data for this study. It presents information on the selection of subjects, research design,
treatment and control protocols, data collection, instrumentation and analysis of the data.

This study was a multitiered teaching experiment (Lesh & Kelly, 2000) in which
the researcher assisted an elementary science teacher in designing, implementing and
evaluating the effect of using children’s trade books to improve the students’ and
teacher’s views of the nature of science, attitudes towards science and science inquiry.
The study employed a quasi-experimental control group pretest/posttest design.
Standardized Mississippi Curriculum Test scores, the Science Attitude Inventory and
semester science grades were compared between the experimental group and the control
group to assess the effect of the treatment on the students’ views on the nature of science
and attitudes towards science as well as reading, writing and science achievement. The
study was qualitative in order to investigate the process of selecting, obtaining and using
children’s trade books in science to enhance the students’ opportunity for scientific
inquiry activities and the teacher’s attitude towards teaching science. The qualitative data
consist of questionnaires, field notes, classroom observations and debriefing sessions.
The intervention was implemented during the spring semester of 2007.
Research Design

The independent variable was the treatment of using children’s trade books in science lessons given to the experimental groups. The dependent variables were the scores on the following:

1. Science Attitude Inventory II, pretest and posttest, was administered at the beginning and end of the intervention period to determine whether the integrated instruction had an effect on students’ view of the nature of science and their attitude towards science.

2. The Mississippi Curriculum Test Reading and Language Subtest Scores were obtained from 2006 and 2007 to determine if there was an effect on reading and language scores from the intervention.

3. Students’ Science Grades as reported at the end of the fall and spring semesters to determine if there was an effect from the intervention on the students’ science content knowledge.

4. The Science Teaching Attitude Scale (STAS II) was given as a pretest and posttest to the teacher to determine whether the intervention program had an effect on her knowledge of the nature of science and her attitude towards teaching science.

5. The ESTEEM Science Classroom Observation Rubric (Category I) was used to guide observations of the science classes to determine if there was an effect from the intervention on enhancing the opportunity for student-initiated inquiry.
Participants

The subjects in this study consisted of three intact classes of fourth grade students enrolled (N = 72) at a Mississippi public school during the academic year of 2006-2007. The demographics of the school are 81% Caucasian, 16% African American, and 3% other ethnic groups; a ratio of female to male of nearly 50:50, and a socioeconomic status of low to middle class with 46% of the students qualifying for free or reduced lunch. The experimental group was two of the fourth grade classes who received the addition of children’s trade books to their science lessons. The control group did consist of the remaining fourth grade class that was selected for convenience by the teacher due to scheduling constraints that would prohibit any additional instructional time.

The fourth grade of this public school was purposively chosen to participate in this study because this grade is departmentalized with the reading teacher also teaching science. Criteria for selection of this school included familiarity and rapport of the researcher since she taught the upper science courses at the high school in this attendance center for several years in the past.

Qualitative Research Design

The qualitative research studied the process of integrating children’s literature into elementary school science and its effect on the fourth-grade teacher’s views on the nature of science, science inquiry and attitude towards teaching science. Can we find children’s trade books that will improve the students’ views of all the key ideas about the nature of science? How can the trade books be incorporated into the 5 E’s learning cycle? Will the trade books prompt the students to ask their own questions for inquiry? Will the
use of trade books improve the teacher’s knowledge of the nature of science and attitude towards student inquiry? The researcher worked closely with the teacher during the spring semester to answer these questions. During this time, the researcher provided the teacher with information on guided inquiry (Abell & McDonald, 2004; Magnusson, Palinscar, & Templin, 2004; Minstrell & Zee, 2000), integration of literacy and science (Douglas, Klentschey & Worth, 2006; Saul, 2004), and key ideas about the nature of science (McComas, 2004).

In this descriptive qualitative research, I interacted directly with the teacher to collect formative data using questionnaires, interviews, debriefing sessions, field notes and analysis of videotaped classes. An informal and personal voice was used to report the findings of this part of the study.

Instrumentation

Instrumentation for this study consists of: the Scientific Attitude Inventory II (SAI II) (Appendix C), Mississippi Curriculum Test (MCT) reading and language arts subscores, the Science Teaching Attitude Scales (STAS II), (Appendix D) and the ESTEEM Science Classroom Observation Rubric Category I (Appendix E).

The Mississippi Curriculum Test is a criterion-referenced program developed by the Mississippi Department of Education to assess grades 2-8 students on the Mississippi curriculum frameworks in language arts and mathematics. Teacher committees formed from exemplary teachers in each grade and content area developed the assessment specifications. The test item types are multiple-choice and open-ended questions that were selected finally based on tryouts with students in the fall of 2000. All live test forms
were administered in the spring of 2001, and the reading test at the fourth grade level was found to have a reliability of .88 to .89 and the language arts of .89. The possible score range for the Fourth Grade Reading is 255 to 690 and for the language arts, 220 to 690.

The Scientific Attitude Inventory II and the Science Teaching Attitude Scales were both developed by Richard Moore in 1970 and revised in 1997 to eliminate gender bias and for easier reading levels. When the revised form was field tested on 588 students from 6th, 9th and 12th grades, the responses of the top and bottom 27% of the respondents on the total instrument were compared on the six subscales to provide evidence for the validity. A significant $t$ in each case was found at the .05 level which Moore and Foy (1997) reported as demonstration “that the instruments distinguish between those who score high and those who score low on the total score and are useful in establishing the validity of the SAI II.” The face validity for the SAI II was also claimed based on the original judgements regarding the attitude position statements that were not altered in this revision. A split-half reliability coefficient of .805 and a Cronbach’s alpha reliability coefficient of .781 were reported. A fourth-grade reading teacher verified that the SAI II has a reading level appropriate for the fourth grade. The SAI II consists of 40 Likert-type items; with twelve position and attitude statements with equal positive and negative. A five-point Likert scale is used with a score of 5 assigned to strongly agreeing with the positive statements. The range of scores for the entire SAI II is 40 –200.

The Science Teaching Attitude Scales (STAS II) incorporates the same revisions and was designed to use in studies involving the attitudes of both students and their teachers. (Moore, 1973) It is a 60 Likert-type item that incorporates statements
concerning the teacher’s attitude towards teaching elementary science. There are eight scales with six positive and six negative statements; and three of these scales concerned with teaching science and the rest are statements about the nature of science. The range of scores for the STAS II is 60-300.

The Science Classroom Observation Rubric (Appendix E) is one of a battery of instruments called the Expert Science Teaching Educational Evaluation Model (ESTEEM) developed at the Center for Research on Educational Accountability and Teacher Evaluation (Burry-Stock & Oxford, 1994). The rubric consists of a Likert scale rating 1 to 5 observed teacher behaviors that are considered to be constructivist. The reliability of the rubric is reported to be .91 and construct validity was found significant at the .01 level.

Procedures

Data Collection

After permission was obtained from the Human Subjects Protection Review Committee (Appendix A) and the receipt of permission from the parent/guardian of the students (Appendix B), the following data was collected:

1. The Science Attitude Inventory II was administered at the beginning and end of the intervention period to provide the pretest and posttest measures of knowledge of nature of science and attitude towards science.

2. The Mississippi Curricula Reading and Language Subtest scores from 2006 and 2007 were obtained from the students’ cumulative records.
3. Fall and Spring Semester science grade averages of the participants were obtained from the teacher.

4. Field notes that were kept on the process of developing and implementing the lessons using the trade books.

5. Field notes on debriefing sessions after the lessons.

6. Videotapes of the classes during each unit and their analysis using the ESTEEM Science Classroom Observation Rubric.

7. Formative assessments throughout the spring semester designed to monitor students’ views about the NOS.

Control Protocol

The fourth grade class was composed of three sections. The section that served as the control group met during the middle of the day (See class schedule in Appendix F) and thus was selected by the teacher since the time allotted to it and lunch would not allow for any intervention. This section continued to be instructed as usual with the first hour dedicated to the reading skills and stories from the Reading: Seeing is Believing and Reading Practice Book (Afflerbach, P., Beers, J., Blachowicz, C., Boyd, C. D., Cheyney, W., Diffily, D., et al., 2004). Typically, this class had less than 30 minutes for their science lesson that consisted of assigned reading and worksheets from the Harcourt Science, Mississippi Edition (Frank, Jones, Krockover, Lang, Mcleod, Valenta & Van Deman, 2002). This class frequently had homework because they could not finish all of their assignments in class and they never had time for any of the hands-on activities that
are in their workbooks. A typical week in the control group class can be seen from the teacher's lesson plan book included in Appendix G.

Experimental Protocol

The first experimental group met for two hours in the morning during a prescribed school-wide reading period (Appendix F). The other experimental group met for approximately one and one half-hours in the afternoon, but was with this teacher for their study hall of one hour after lunch. Within each of these class periods, reading lessons were presented first, and then the science lesson usually having about thirty minutes left. The reading and science lessons continued as before in the control group and the treatment group took home the same homework that they would have finished given the additional time that was allotted to the intervention activity.

During the spring semester, the fourth grade classes must cover approximately eight of the ten science content competencies from the Mississippi Science Frameworks. This entailed three units of study using nine of the chapters in the Harcourt Science textbook. For each science unit, the researcher obtained a children's trade book on the topic and at the fourth grade reading level. These trade books were chosen with the goal of addressing many of the aspects of the nature of science that are specific to the process strands required in the state frameworks for the fourth grade. According to the Mississippi Science Frameworks, the process strands of Science as a Human Endeavor and Science as Inquiry should be incorporated into each content strand.

This procedure was expedited by using the NSTA Outstanding Trade Book Selections, the AAAS Science Books and Films review journal, and the public and

So that the entire class could see the illustrations and class discussions facilitated, a PowerPoint presentation of the book was made by the researcher. At the beginning of each unit, the trade book was read to the class using the PowerPoint presentation. The students were given “Science Trade Book Review” sheets (Appendix H) that were adapted from Lovedahl and Bricker (2006) to take notes as the book was read. These worksheets were adapted over the semester to promote the students’ views of different ideas about the nature of science that could be observed from reading biographies such as *Starry Messenger* (Sis, 1996) during the solar system unit. The teacher was encouraged to solicit student questions for inquiry using methods to improve scientific discourse as reported by Magnusson, Palinscar, and Templin (2004).

The teacher was encouraged to use the ‘Wonder Notebooks’ strategy from Jones and Leahy (2006) to spark the children’s curiosity and questioning skills. This strategy required that the teacher first model and share her own questions that she ‘wonders about and longs to explore’. Then the students were to be encouraged to write down things related to the topic in the storybook that they wonder about in their Wonder Notebooks. The teacher was to assist the class in grouping their questions into overarching questions that they could then investigate in small groups. If this strategy worked as planned, the
students would become engaged in hands-on and minds-on inquiry that they could
conduct within the class period.

As the semester progressed, the researcher would have liked to see the science
classes become more constructivist. This would have entailed the teacher learning how
to promote student inquiry through their engagement with children’s trade books. The
students would initiate their own inquiry through choosing their own questions to
investigate either through reading additional science trade books; or designing
experiments and analyzing their own data. The classes were videotaped and these were
evaluated using the ESTEEM rubric.

The students’ and teacher’s knowledge of the nature of science and attitude
towards science was determined again as a posttest in May with the SAI II and STAS II.
The MCT reading and language test was administered in early May and these scores were
obtained in June to use as a posttest to determine an effect on the students’ skills in
reading and language arts.

Limitations

The limitation of this study was the small number of students, and single teacher
at this single school. The researcher could only work with one teacher at a time in
developing an intervention that would be appropriate for her classes.

Another limitation may have been the difficulty in preventing cross-
contamination from the experimental group to the control group. The videotaping of both
groups was used to validate that the intervention was used only in the experimental
group.
Analysis of Data

The statistical technique of paired t-tests was used to test the differences between the pretest and posttest. Independent t-test was used to test the difference between the control group and treatment group means. An alpha level of significance of .05 will be used. Calculations were performed with the SPSS statistical software package.
CHAPTER IV

ANALYSIS OF DATA

The purpose of this study was to determine the effect of an intervention on the scientific attitude of a group of experimental subjects as compared to a group of control subjects not receiving the treatment. In addition, hypotheses pertaining to the variables of reading, language and science achievement were tested. Descriptive measures on the variables of the study are presented. The subjects of this study were three classes of fourth graders numbering 69 total with 46 in the treatment group and 23 in the control group. Mississippi Curriculum Test scores on reading and language for the previous year were collected on all but 4 subjects. These test scores were again collected at the end of the treatment period. The SAI II questionnaire that was administered to subjects at the beginning and at the end of the treatment period to measure the variable of scientific attitude did not behave in this study. The students’ science grades for first and second semesters were analyzed for differences between the treatment and control groups’ science achievement.

Descriptive Data

Effect on Reading Achievement

The variable of reading achievement was tested with the Mississippi Curriculum Tests administered in the spring every year. The scores of the reading test from the prior year (2006) for the treatment group of 46 had a mean of 508 with a standard deviation of 38.2. The control group reading scores from 2006 had a mean of 520 with a standard deviation of 54.7. The reading scores for 2007 for the treatment group had a mean of 507
with a standard deviation of 40.1 and the control group had a mean of 538 with a standard deviation of 75.4. Data pertaining to this analysis is reported in Table 1.

Table 1.

Reading Scores for Treatment and Control Groups from 2006 and 2007

<table>
<thead>
<tr>
<th>Year</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Treatment</td>
<td>46</td>
<td>508</td>
<td>38.2</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>21</td>
<td>520</td>
<td>54.7</td>
</tr>
<tr>
<td>2007</td>
<td>Treatment</td>
<td>46</td>
<td>507</td>
<td>40.1</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>23</td>
<td>538</td>
<td>75.4</td>
</tr>
</tbody>
</table>

Effect on Language Achievement

The variable of language achievement was tested with the Mississippi Curriculum test that is administered every spring. The test scores for the treatment group from the year prior to the study had a means of 511 with a standard deviation of 48.6. The control groups’ scores from the prior year had a mean of 523 with a standard deviation of 54.8. The treatment groups’ scores from the spring immediately following the intervention had a mean of 514 with a standard deviation of 46.6. The control groups’ scores from the following spring had a mean of 519 with a standard deviation of 59.6. This data is shown in Table 2.
Table 2.

*Language Scores for Treatment and Control Groups for 2006 and 2007*

<table>
<thead>
<tr>
<th>Test date</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Treatment</td>
<td>46</td>
<td>511</td>
<td>48.6</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>21</td>
<td>523</td>
<td>54.9</td>
</tr>
<tr>
<td>2007</td>
<td>Treatment</td>
<td>46</td>
<td>514</td>
<td>46.6</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>23</td>
<td>519</td>
<td>59.6</td>
</tr>
</tbody>
</table>

*Effect on Science Content Knowledge*

The variable of science content knowledge was measured by the students’ first and second semester science averages in their science class. These were obtained from the cooperating teacher’s grade book. The science grade means at the end of the first semester for the treatment groups was 84.96 with a standard deviation of 9.9. The control groups mean science grade at the end of the first semester was 84.95 with a standard deviation of 10.1. At the end of the second semester, the treatment group’s science mean was 86.43 with a standard deviation of 7.0. The control group’s mean science average was 86.96 with a standard deviation of 7.2. This data is reported in table 3.

Table 3.

*First and Second Semester Mean Science Grades for Treatment and Control*

<table>
<thead>
<tr>
<th>Semester</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Treatment</td>
<td>47</td>
<td>84.96</td>
<td>9.9</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>22</td>
<td>84.95</td>
<td>10.1</td>
</tr>
</tbody>
</table>

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Tests of Hypotheses

The following hypotheses were tested in this study using univariate analysis of variance for the comparison of the means between the control and treatment groups. This method was used because the pretests means for the control group were higher in all cases except the science content knowledge measure. Therefore an estimated marginal means was used to adjust for the higher means in the control groups’ pretests. For the science content knowledge, an independent samples test was used.

The instrument used to measure the variable of scientific attitude did not behave in this study. When an item analysis was run on the Science Attitude Inventory II responses, the Cronbach alpha was not adequate for most of the scales. Therefore the hypotheses 1 and 2 will not be tested. Hypothesis 1 states that there will be no significant difference between the pretest means of the control and treatment groups on the variable of scientific attitude as measured by the Scientific Attitude Inventory (SAI II). Hypothesis 2 states that there will be a significant difference in the posttest means between the treatment and control groups on the variable of scientific attitude as measured by the SAI II.

Hypothesis 3 states that there will be no significant difference between mean scores on the criterion variables of reading and language achievement of the treatment and control groups as measured by the Mississippi Curriculum Test (MCT) scores from the

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Second</td>
<td>Treatment</td>
<td>47</td>
<td>86.43</td>
</tr>
<tr>
<td>Control</td>
<td>22</td>
<td>86.96</td>
<td>7.2</td>
</tr>
</tbody>
</table>

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spring of 2006. The results of the independent samples \( t \)-test indicated no significant
difference between the control and treatment groups on either the reading \( \left( t(65)=1.08, \\
p=.284 \right) \) or language tests \( \left( t(65)=.879, p=.383 \right) \). From these results, hypothesis 3 is
accepted. The control group’s mean reading and language scores were not significantly
higher than the treatment groups in 2006.

Hypothesis 4 states that there will be a significant difference between the mean scores
on the criterion variables of reading and language achievement of the treatment and
control groups as measured by the MCT administered in the spring of 2007 while
controlling for spring of 2006 scores. The results of the univariate analysis of variance
with estimated marginal means (Table 4) indicated a significant difference between the
treatment and control groups on the Reading Subtest in 2007 \( \left( F= 6.58, df=1/63, p=.013 \right) \).
From these results, hypothesis 4 is accepted. The control group’s adjusted mean score on
the 2007 MCT reading achievement test was significantly higher than the treatment
group’s. The analysis of the language scores for 2007 (Table 4) indicated no significant
difference in the adjusted means of the two groups \( \left( F= 0.68, df=1/63, p= .796 \right) \). From
these results, the hypothesis concerning the effect on language achievement would be
rejected. There is no significant difference in the mean language scores on the 2007
MCT between the treatment and control groups.

Table 4.

Analysis of Variance for 2007 MCT Reading and Language Scores

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>adj Xs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>Control</td>
<td>537.487</td>
</tr>
</tbody>
</table>
Hypothesis 5 states that there will be no significant difference in the mean semester science grades between the treatment and control groups on the variable of science content knowledge as measured by the fall semester averages. The results of the independent samples test (Table 5) indicate that there was no significant difference between the two groups on their mean science grades for the first semester ($t(67)=.001$, $p=.95$). From these results, hypothesis 5 is accepted. The control and treatment groups had no significant difference in the first semester science averages.

Hypothesis 6 states that there will be a significant difference in the mean semester science grades on the variable of science content knowledge between the treatment and control groups as measured by the spring semester averages. The results of the independent samples test (Table 5) indicate that there is no significant difference on the two groups’ spring semester science averages ($t(68)=.295$, $p=.68$). From these results, hypothesis 6 is rejected. The control group’s science grades were not significantly different from the treatment groups after the intervention.

Table 5.

*Independent Samples Test on Fall and Spring Science Grades*

<table>
<thead>
<tr>
<th>Semester</th>
<th>$t$</th>
<th>df</th>
<th>sig.</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>-.001</td>
<td>67</td>
<td>.95</td>
<td>.00</td>
</tr>
<tr>
<td>Spring</td>
<td>.295</td>
<td>68</td>
<td>.68</td>
<td>.53</td>
</tr>
</tbody>
</table>
Research Questions

The following questions were examined using qualitative methods, which included field notes, videotapes, debriefing sessions and the Science Teaching Attitude Scale (STAS II) questionnaire.

*Children’s Science Trade Books and NOS*

Can children’s trade books be selected that will provide an opportunity to examine all aspects of the nature of science? In this study, a total of 89 children’s trade books were selected for use in the science units, and 67 of them were found to include at least one aspect of NOS which is 75 percent of the selected books. Most were obtained from the local public library consortium, some were available at the school library and a few were purchased. The books were reviewed for their nature of science content and those that had any are reported in Appendix I. Ten aspects of the nature of science were found in the books and are listed in Table 6 with the percentage of books that contained them.

Table 6

*NOS Aspects in Percentage of Children’s Trade Books*

<table>
<thead>
<tr>
<th>NOS Aspect</th>
<th>% of Books</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Discusses theory or law</td>
<td>28</td>
</tr>
<tr>
<td>2 Showed tentativeness of scientific knowledge</td>
<td>27</td>
</tr>
<tr>
<td>3 Showed creativity of scientist</td>
<td>40</td>
</tr>
<tr>
<td>4 Demonstrated evidence-base</td>
<td>38</td>
</tr>
<tr>
<td>5 Included scientist of female gender</td>
<td>35</td>
</tr>
<tr>
<td>6 Included scientist of minority race</td>
<td>33</td>
</tr>
</tbody>
</table>
Only the latter six of the aspects above are considered appropriate for kindergarten through fourth grades in the *National Science Education Standards* (NRC, 1996), but the first four aspects were included since there has been interest in elementary students beginning to understand the other aspects of NOS. The *Mississippi State Science Frameworks* (Mississippi Department of Education, 2001) point out that under the process strands of the history and nature of science, fundamental concepts should include science as a human endeavor. This is further delineated as:

- Science and technology have been practiced by people for a long time.
- Men and women have made a variety of contributions throughout history.
- Science will never be finished for much more remains to be understood.
- Many people choose science as a career and devote their entire lives to it (NRC, 1996, p.141).

Twenty-four of the books were found through the NSTA at their Outstanding Science Trade Books website (http://www.nsta.org/publications/ostb/) and the Teaching through Trade Books in *Science and Children* journal for elementary teachers also available online (www.nsta.org/elementaryschool). Thirty-two of the books were biographies of scientists or astronauts. Most of the books were obtained through the public library consortium. The school elementary library had many science books available but most of
them were older than ten years and never freely selected by the children to read unless they were on the Accelerated Reading lists.

Three of the books were read to the treatment classes along with a PowerPoint presentation of their illustrations. *Owen and Mzee: The True Story of a Remarkable Friendship* (Hatkoff, Hatkoff, & Kahumbu, 2006) was read within a unit of study on habitats. This book engaged the children very well and led to some Internet searches during their computer lab to follow up with the students’ questions about the animals. *Snowflake Bentley* by Martin and Azarian (1998) was used early in a unit on weather. This book won the Caldecott award and is a beautifully illustrated biography of Wilson Bentley who discovered that there are no two snowflakes alike and published a book of his photographs of snowflakes in 1931. The reading of this book solicited some good questions from the children and prompted some ideas for further inquiry. Since most of the children wanted to use a microscope, planning was initiated to take to class to the high school science lab to use some of the microscopes, but this idea never transpired due to problems with time and safety.

The last book that was read to the class was a wonderfully illustrated biography of Galileo, *Starry Messenger*, by Peter Sis (1996) during the unit on the solar system. The PowerPoint presentation made for this book included call outs added by the researcher to help focus the teacher and students’ attention on some of the many references to NOS issues. From the videotape and debriefing of this reading session, it became apparent that the concepts in this book were difficult for the children to understand by the questions that they asked. The teacher said, “It was over their heads. Heck, some of it was over mine!”
There are so many great children’s books on the solar system and space exploration that we decided to have a set of them in the science classroom for the treatment classes to read during their free time and to write a book review on one of their choosing. A book review form (Appendix H) was designed to focus the student’s attention on NOS aspects of the books, but the results were mostly dismal with just a few highlights. The fourth graders at this school have never done book reports and seemed tortured by having to write anything. There were few indications of the children developing any questions that they wondered about investigating further. However, the teacher reported that the students asked her if they could please read the books during their study hall, because they didn’t have enough time in her class. The other treatment group’s homeroom teacher reported that the students checked out more books on the planets from the library.

Because of the lack of enthusiasm for writing the book reviews, I decided that for the final unit, I would provide as many books as possible for each of the two treatment class homerooms to read during their study hall. With access to the nine public libraries in our area consortium and the school’s elementary library, I was able to obtain sixty books that met my criteria. These criteria were that they had to; either be on the same content of the physical science unit, or be about scientists that we hadn’t already read in the previous unit. For this unit, I left the books with the instructions that I would like to interview them on camera about the books as shown on Reading Rainbow. Each book was given a temporary library card for us to know who was reading them. I wanted to compare their interest in the books that were on the NSTA Outstanding Books lists with those that were not, but on the same subjects. There were several books that were excellent sources of NOS aspects that the children enjoyed reading, but were not on the
NSTA lists. A few books from the NSTA lists were not chosen by the students to read, such as the biography of Copernicus. Even the best reader in the treatment classes tried it, but gave up. This book is written at the 9-12 year old level, but other books on Copernicus can be found that are shorter and at a slightly lower reading level. There are many great children’s books that do not make the NSTA Outstanding Trade Book Lists every year.

*Teacher’s View of NOS*

Will the process of designing and implementing the integration of children’s trade books enhance the elementary teacher’s view of NOS? The Science Teaching Attitude Scale (STAS II) was administered to the teacher just prior to and after the intervention to answer this question. The STAS II has eight subscales, five of which address nature of science issues. The teacher’s response to the questionnaire was hand analyzed by the researcher and slight changes were found in most aspects of NOS. On the scales involving the issue of scientific laws and theories being subject to change, her responses indicate a stronger conviction of agreement. On the NOS aspect of addressing the limits of science, her responses indicate a movement from undecided towards mildly agreeing that some questions can not be answered by science. The most consistent response changes were toward a more informed view of the scientific enterprise and the necessity of intellectual honesty with the willingness of altering one’s position based on evidence. There was no commitment to the importance of creativity in science, and the teacher was committed to the idea of science being technology. The teacher’s response indicated a decrease in agreement that most people should and can learn science.
Teacher’s Attitude toward Teaching Science

Will the process of implementing the integration of children’s literature into science enhance the teacher’s attitude toward teaching science? Three of the STAS II subscales were used to answer this question. On the idea of teaching science, the teacher’s responses were generally neutral and unchanged, except for a decline in agreement on her feeling that she understands the nature of science well. One statement about how much science she teaches changed dramatically from agreeing strongly that she does not teach much science to disagreeing strongly. This could have been due to misreading a negative statement. On the importance of teaching process skills, the teacher changed from being neutral to strongly agreeing with them being the most important in science for children. However, she was neutral on the importance of children learning to design experiments and to control variables. Her responses indicated that she consistently agreed that children should learn certain basis scientific facts in elementary school. On the aspect of a science teacher being a guide and resource person; the teacher’s responses were not consistent and she wrote in a free response concerning the last statement saying, “I wish!” but had selected the neutral response. This statement was, “The teacher should arrange things so that children spend more time experimenting than listening…” This is consistent with our many conversations about having no time or place for science activities.

Teacher’s Planning and Implementing Inquiry-based Lessons

Will the teacher become more comfortable with planning and implementing inquiry-based science units as the semester progresses? The teacher had been teaching
fourth-grade science for several years and stated often that it was no longer fun to teach. Since NCLB was enacted, there was never enough time to do any activities anymore. Her lesson plans from the previous year (Appendix G) indicated that she had usually planned a group activity for Fridays. However, so far this year, she had not been able to plan anything for her classes and hoped to at least have the students make a model of the solar system as a home project. Our intervention began early in the second semester and she was running late, so the students had just submitted models of the body systems from their home. The teacher also bemoaned the fact that this class of children was very undisciplined; and as such, she was concerned about trying any classroom activities. This was reiterated by the other fourth grade teachers when I suggested that we plan a field trip to the local planetarium. They refused to even consider it with this ‘awful’ class. So, many of the activities that were implemented were first done with me modeling it for the first period group with the intention of her leading the other treatment group. Most of the activities that were planned as adjuncts to the children’s books were not implemented due to time constraints or lack of an appropriate space. For instance, a trip planned to go to the high school lab to use the microscopes after reading *Snowflake Bentley* had to be canceled for safety concerns and scheduling reasons.

Over the course of reading and presenting PowerPoint slides of the three books to her classes, the videotapes of these sessions showed an improvement in comfort with the equipment, but frequently her modeling of ‘wondering’ questions were absent and the children’s comments and questions were not noted. The teacher did demonstrate an improvement in addressing some of the children’s lack of background knowledge while reading *Starry Messenger* to her second group. There were several lost opportunities to
note the children’s questions about this book that could have lead to some inquiry activities. Questions from the students such as: Can we use a telescope?, or How do sunspots happen? We did schedule a day for the students to view the half moon with a telescope; but on the only day available, the sky was cloudy.
CHAPTER V
DISCUSSION

Summary

The purpose of this study was to determine the effect of using children’s trade books on their knowledge of the nature of science and attitude towards science. The effect on their reading and language achievement, as well as science content knowledge was also studied. The process of obtaining appropriate children’s books and integrating them into the school schedule was documented. The effect on the teacher’s knowledge of the nature of science, attitude towards teaching science, and comfort with planning and implementing inquiry-based activities was considered also.

The subjects for this study were three intact classes of fourth grade students and their reading/science teacher in an elementary school. A total of sixty-nine students completed the pretests, intervention, and posttests with 23 in the control group and the remaining 46 in the treatment group. The same science teacher who implemented the intervention taught all three of the classes.

The pretest phase was the administration of the SAI II questionnaire and its teacher component STAS II at the beginning of the second semester for the assessment of NOS and attitude towards science. The reading and language pretest were the Mississippi Curriculum Test scores obtained from the students’ cumulative records for the previous year. The science content knowledge pretest was the students’ science semester grade averages from the fall semester.

The intervention was the integration of 89 children’s science trade books within the treatment groups’ science and study hall classes during the spring semester. The control group was given the same science instruction as the treatment group but did not
have additional time for reading the children's books. Three of the children's books were made into PowerPoint presentations and read to the treatment group during their regular science class. These sessions were videotaped along with the concurrent control classes to monitor for consistency in planned implementation, cross-contamination, and to capture any movement towards student-initiated inquiry. The rest of the books were placed in the classrooms for the treatment subjects to read during their free time within their last two units of science. For the unit on the solar system, 25 books were selected for their content on biographies of people involved with space exploration and astronomy, or the state science objectives. The students were asked to complete a book review (Appendix H) and the teacher was debriefed on her observations. For the physical science unit, 60 books were obtained that were representatives of the science trade books available at all of the area libraries and were either biographies of scientists, on the unit content, or on the NSTA Outstanding Trade Books Lists. These were placed in the homerooms of the treatment groups for them to self-select and read during their study period. At the end of the unit, the treatment groups were interviewed on videotape for their candid assessment of the books. The books were reviewed for their content of NOS aspects. The interest level of the students was ascertained by keeping sign-out cards on each book.

The SAI II and STAS II posttests for the study were administered at the end of the spring semester. The reading and language posttests were obtained from the MCT scores that had been administered at the end of the spring semester. The spring semester science grades were obtained from the teacher. This data along with the pretest data were obtained to determine an effect on the subjects' knowledge of the nature of science,
attitude towards science, reading and language achievement, and science content knowledge.

Conclusions

The first conclusion that can be derived from this study is that the SAI II instrument used to measure the students' views of the nature of science did not work with these subjects. When the reliability analysis was run on the pretest and posttest, only one of the 6 subscales was reliable. The scale that measures the student's interest in studying or working in science did have an adequate reliability. Even though this instrument was written for 6th graders, the reading instructor for the fourth grade at this school thought that the reading level was appropriate for these subjects. If the reading level is appropriate for this group, then the only other explanation for the lack of reliability for the instrument is the cognitive level necessary to understand the concepts assessed, such as theory and law. Other researchers have questioned the ability of elementary students to comprehend the idea of theory and other aspects of the nature of science (Smith et al., 2000). Only with sustained constructivist pedagogy throughout the elementary years have sophisticated views of the nature of science been developed by the sixth-grade students.

An interesting observation was made from a reading test (Afflerbach et al., 2004) that the fourth graders were taking on the same day that I was present. ‘Theory’ was a vocabulary term that was tested and this selection test was on the story “Out of the Blue” (Fritz & Tomes, 2004) which is about Benjamin Franklin. If it is being used in their language arts curriculum, then certainly the students could be developing a practical use of theory in their science curriculum. This reading text lists ‘theory’, ‘evidence’, and ‘experiment’ in the glossary; whereas, the science text does not. Surprisingly, the reading
text was more advanced in the nature of science than the science textbook for this fourth grade class!

The second conclusion that can be derived from this study is that the control group had a higher mean achievement level than the treatment group from the beginning of the study. The assumption that the three fourth-grade classes were similar in reading and language abilities was wrong and the results of this study may have been affected. The treatment group had a slight decrease in their mean reading score, whereas the control group had a significant increase. For language scores, the treatment group showed a slight improvement in mean scores, but the control group had a slight decrease. These results may reflect the current trend in test scores referred to as the “4th grade slump”. Researchers have noted that this national occurrence may be due to the shift from basic decoding to development of fluency and comprehension (Samuels, 2007). The slight positive effect in language that the treatment group demonstrated could have been due to the intervention with the children’s science trade books.

A third conclusion that can be made from this study is that the intervention did not affect the treatment group’s science content knowledge. This variable was measured by the fall and spring semester science averages as calculated by the teacher. Both treatment and control groups improved slightly in their mean science grades from fall to spring. This result is reassuring in that the intervention with the trade books did not negatively affect the science classes of the treatment group. This science teacher may be encouraged to use science trade books in the future, but was concerned about using library books with this age group who are so rough with the books. The teacher felt that if
we had been using the books longer, and had better integrated them into the units of study that we might have seen better results.

Another conclusion that can be made from this study is that children’s science trade books can be found that address all aspects of NOS. This is in contrast to research that found children’s science trade books lacking in NOS content (Abd-El-Khalick, 2002; Bricker, 2005; Ford, 2006). Even though some of the NOS aspects may be only implicitly covered, a well-informed teacher could point them out with appropriate scaffolding of her questions and comments during group reading. There are many more children’s books on scientists that are written at slightly different reading levels and have excellent content on NOS that were not selected for this study. They were not available through the public library consortium, or the elementary school library.

Generally there was a great benefit to having access to the public library system from which there were nine libraries to borrow books. This system is available to all members online and is very open to extensive searches and an almost unlimited number of books available for teachers to checkout and keep for very reasonable periods. The librarians were concerned that most teachers do not use the system for their classrooms and rarely request any books for their students. Here again, this may be more due to discipline issues than teachers’ lack of awareness. Even though the school libraries have much larger funding, most of the NSTA Outstanding Science Books were found at the public libraries, not the school library. The school librarian was not aware of the list that NSTA publishes yearly.

From this study, the conclusion that can be made is the integration of children’s books into science did improve the teacher’s view of the nature of science. However,
more explicit instruction is needed which has been well documented by other research on elementary teachers (Akerson, Abd-El-Khalick, & Lederman, 2000; Cochrane, 2003; Lederman, 1992; Lunn, 2002). The questionnaire, STAS II, was given before and after the intervention to the teacher. By comparing her responses on this likert-scale, she appears to have become more certain of her convictions on four of the NOS aspects. However, she still disagreed with the role of creativity in science and showed an uninformed view of the relationship between technology and science. The only explicit instruction that the teacher was given early in the study about the nature of science was the article, “Keys to Teaching NOS” by McComas (2004). When we were planning the physical science unit, I realized that this teacher had not seen all of the science process strands for the fourth grade in the Mississippi Science Frameworks (Mississippi Department of Education, 2001) even though she took a course in Science for Teachers during her preservice training. As many new science teachers, she had only been given the 2-3 pages of the frameworks that delineate the science competencies, but not the underlying ground work for them. These process strands include the nature of science, which were directly taken from the National Science Education Standards (NRC, 1996). The teacher was given the NSES so that she could read the section for Kindergarten through 4th grade.

The process of using the children’s books in her science classes seems to have had very little effect on enhancing the teacher’s attitude towards teaching science. This was assessed with the STAS II questionnaire that has 3 subscales attending to attitude towards teaching science. She did respond as if she was less sure of her knowledge of the nature of science, which may indicate a metacognitive shift from being previously unaware of...
some of the aspects of NOS. The teacher also became more strongly convicted of the importance of teaching process skills, and was frequently frustrated when trying to plan any inquiry time for her students. Many comments were made about the lack of time now due to NCLB putting most importance on reading. The school day is too full already and her classroom is not designed for anything more than deskwork. The teacher had enjoyed teaching science for two years previously; and when given the choice to change this year, she chose to continue teaching science.

Did the teacher become more comfortable with planning and implementing inquiry-based science units as the semester progressed? Due to space limitations in the classroom, the video camera was only used when the children’s books were being read to the classes and at the last session of interviewing the students about the books. The students in the treatment group were asked to write down things that they wondered about while the books were read to them. The teacher and I planned to use these to help the students in finding answers to their questions. They resisted writing anything, but frequently wanted to know more about something in the book. There were many more authentic questions asked by the students about the books than in the control class where the teacher was guiding the completion of worksheets.

From the videotapes and the students’ book reviews, there were many opportunities to lead the students in further inquiry. Most often these opportunities were lost due to time and resource constraints. The first book, *Owen and Mzee: The Story of a Remarkable Friendship* (Hatkoff et al., 2006) was read during the unit on habitats and solicited wonderful questions and lots of excitement. The teacher was well prepared to help the children learn more about this book because there is a website
(www.lafargeecosystems.com) where the caretakers of the hippopotamus and tortoise keep a picture diary. The school has a computer lab that the classes are scheduled to use for thirty minutes a week. Some of the children continued to follow the story at home.

The book that was read during the unit on weather was *Snowflake Bentley* by Martin and Azarain (1998). The teacher didn’t appear to notice many of their comments and questions, but it was difficult to hear every comment while reading and operating the PowerPoint presentation. However, her interaction with the treatment group was much more involved with her answering the students’ questions than the opposite occurring in the control group. The last book that was read to the classes was *Starry Messenger* by Peter Sis (1996) during their unit on the solar system. By this time, the teacher appeared better prepared to point out ideas in the book and clarify for the students any concepts that she knew they wouldn’t be aware of, such as the Pope of the Catholic Church. Even though this book is written for ages 4 –8, some of its content about the changing ideas from the Ptolemaic to the Copernican system was “over the students’ heads” and the teacher’s! By the end of the semester, there had been very little movement towards giving the students any opportunity for student-centered inquiry. There was one incident in which a boy handed me the worksheet from his science workbook (Frank et al., 2002) on an investigation that he wished that we could do. The teacher overheard this conversation and told me that when she had tried it, it did not work. This little boy could have been assisted in running the investigation or at least encouraged to run it at home.

**Limitations**

The results of this study should not be generalized to other fourth grade populations, but should be used to encourage educators to implement well planned,
integrated units of study. Having more time for the intervention could probably improve the results. With only one semester and the limitations of resources and especially space, it was difficult to implement many of the activities that we wished. The primary variable of the student’s view of the nature of science and attitude towards science was not measured because the instrument chosen did not work for this population.

Recommendations

Based on the conclusions of this study, the following recommendations for practice and research are made:

1. The National Science Education Standards should be completely adopted at the local level to include all of the process strands with the history and nature of science infused within all science content. The only way that this will be done is if the nature of science can be assessed reliably and is required by the current national policy of No Child left Behind. Present emphasis on reading and math achievement is appropriate, but can be addressed in the context of our modern societal needs of scientifically literate citizens.

2. Reliable assessment instruments for nature of science issues must be developed for the reading and cognitive level of elementary students. Test items must be designed that can be administered to large populations and evaluated objectively. The current trend locally is to eliminate the writing assessment for the fourth grade because of poor performance, but this is contrary to educational standards and communication imperatives.

3. An integrated curriculum for elementary education should be adopted to provide better use of time and energy. The reciprocal learning processes of reading and
science education elucidated by Casteel and Isom (1994) can easily be combined within one set of curriculum materials. This policy would facilitate elementary teachers’ mission by reducing the waste of time that is spent transferring between disciplines and would elevate the importance of science. This trend is implicit in the Reading First Program of ‘learning to read’ for the first three years of school, and then ‘reading to learn’ for the latter years of elementary education. The reading curriculum presently used in this school has wonderful interdisciplinary connections to science, social studies and mathematics (Afflerbach et al., 2004). The Harcourt Science curriculum adopted by this school for the fourth grade has reading skill development, mathematics and social studies connections, too (Frank et al., 2002). At the end of most chapters in the science text, there are history and nature of science essays that are rarely read and discussed. The hands-on investigations that are in the science workbook were not done in this class because of the lack of time and resources. Frequently, these recipe-type activities don’t work well; such as the one that was considered for the physical science unit.

4. All preservice elementary teachers should be introduced to the National Science Education Standards and their local science frameworks or benchmarks. The cooperating teacher for this study had never seen the national standards. Their college science courses should be designed to model the teaching methods by emphasizing the process strands within the science content. We can not expect teachers to implement inquiry-based learning if they have never experienced it themselves. All elementary education degree programs should require a robust science methods course along with the language arts and mathematics.
5. Professional development for elementary teachers should be made affordable, accessible and relevant. The cooperating teacher for this study had never been able to attend any summer workshops due to the long-distance travel and expenses involved. Teacher workshops can be offered at local community colleges with the university and state department sponsorship for accreditation and continuing education credits.

6. School librarians must make more recently published children’s science trade books available for our students. These fourth graders universally wished to have more time to read the books that had been borrowed from the public library system. The majority of the science trade books in the elementary library were older than ten years with many over forty years. The students do not choose these books. More of the biographies in the elementary library are about the lives of performing artists and athletes than scientists. If we want our children to read to learn on their own, we must afford the best books that children love to read. Many of the NSTA Outstanding Science Trade Books, that were not available at the libraries; were bought for as little as $.08 plus postage.

7. For group reading, make more of these excellent books into PowerPoint presentations so that the entire class can enjoy them together. The videotapes of the readings in this study showed twenty-plus children engrossed in the stories and wanting to know more. This method of presentation is very inexpensive after the initial equipment costs of a scanner and a projector. Many schools have this equipment available. For inexperienced teachers, ‘callouts’ can be added that focus attention on content that has NOS interest.
8. More biographies of current and native scientists need to be published with this young audience in mind. Some of the fourth graders responded on the book reviews that the biographies of the astronomers and astronauts made them ‘wonder’. Science is done everywhere and the scientists doing it, frequently; are never heard of in the public domain. Jane Goodall read *The Life of Dr. Doolittle* (Woronoff, 2002) when she was seven and says that started her life-long love of animals and wanting to go to Africa.

9. Replication of this study with the same population but using a more reliable instrument to measure the subjects’ views of the nature of science and having a full year for treatment.

10. Development of a longitudinal study to determine the effect of the integration of children’s science trade books has on the subjects’ achievement in reading, language and science.
The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26.111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

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

**PROTOCOL NUMBER:** 27010406
**PROJECT TITLE:** Using Children's Literature to Enhance Views of the Nature of Science and Scientific Attitude in Fourth Graders
**PROPOSED PROJECT DATES:** 01/03/07 to 05/03/07
**PROJECT TYPE:** Dissertation or Thesis
**PRINCIPAL INVESTIGATORS:** Kathryn W. Hampton
**COLLEGE/DIVISION:** College of Science & Technology
**DEPARTMENT:** Science and Mathematics Education
**FUNDING AGENCY:** N/A

**HSPRC COMMITTEE ACTION:** Exempt Approval
**PERIOD OF APPROVAL:** 01/11/07 to 01/10/08

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

PERMISSION LETTER TO PARENTS

Center for Science and Mathematics Education
University of Southern Mississippi
118 College Drive #5087
Hattiesburg, MS 39406
(601) 266-4739

TO: Parents or Guardians

FR: Kate Hampton, Doctoral Student

RE: Permission to Participate

During the spring semester, I will be working with Mrs. Box’s fourth grade class on a research project designed to use children’s literature to enhance the students’ understandings about the nature of science and scientific inquiry. I will select children’s books that are age-appropriate, written about scientists and their work and that may engage the students’ interests in doing some of their own scientific inquiry. The benefit of these activities will be to enhance your child’s deeper understanding of how science works. The classes will be videotaped in order to validate that the activities are presented as planned. None of the activities have any risks, inconveniences, or discomforts. All personal information will be kept confidential and no names will be disclosed.

Participation in this research project is completely voluntary. If you do not wish for your child’s information to be included, there will be no penalty, nor prejudice to them.

If you have any questions at any time during or after the project, you may call me, Kate Hampton, at 601-643-2380. The Human Subjects Protection Review Committee at the University of Southern Mississippi has approved this project.

Thank you for allowing your child to participate in this project.

Sincerely,

Kate Hampton

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APPENDIX C

SCIENTIFIC ATTITUDE INVENTORY II

WHAT IS YOUR ATTITUDE TOWARD SCIENCE?

There are some statements about science on the next two pages. Some statements are about the nature of science. Some are about how scientists work. Some of these statements describe how you might feel about science. You may agree with some of the statements and you may disagree with others. That is exactly what you are asked to do. By doing this, you will show your attitudes toward science.

After you have carefully read a statement, decide whether or not you agree with it. If you agree, decide whether you agree mildly or strongly. If you disagree, decide whether you disagree mildly or strongly. You may decide that you are uncertain or cannot decide. Then, find the number of that statement on the answer sheet, and blacken the space that you agree with.

Please respond to each statement and blacken only ONE space for each statement.

1. I would enjoy studying science.
2. Anything we need to know can be found out through science.
3. It is useless to listen to a new idea unless everybody agrees with it.
4. Scientists are always interested in better explanations of things.
5. If one scientist says an idea is true, all other scientists will believe it.
6. Only highly trained scientists can understand science.
7. We can always get answers to our questions by asking a scientist.
8. Most people are not able to understand science.
9. Electronics are examples of the really valuable products of science.
10. Scientists cannot always find the answers to their questions.
11. When scientists have a good explanation, they do not try to make it better.
12. Most people can understand science.
13. The search for scientific knowledge would be boring.
14. Scientific work would be too hard for me.
15. Scientists discover laws that tell us exactly what is going on in nature.
16. Scientific ideas can be changed.
17. Scientific questions are answered by observing things.
18. Good scientists are willing to change their ideas.
19. Some questions cannot be answered by science.
20. A scientist must have a good imagination to create new ideas.
21. Ideas are the most important result of science.
22. I do not want to be a scientist.
23. People must understand science because it affects their lives.
24. A major purpose of science is to produce new drugs and save lives.
25. Scientists must report exactly what they observe.
26. If a scientist cannot answer a question, another scientist can.
27. I would like to work with other scientists to solve scientific problems.
28. Science tries to explain how things happen.
29. Every citizen should understand science.
30. I may not make great discoveries, but working in science would be fun.
31. A major purpose of science is to help people live better.
32. Scientists should not criticize each other's work.
33. The senses are one of the most important tools a scientist has.
34. Scientists believe that nothing is known to be true for sure.
35. Scientific laws have been proven beyond all possible doubt.
36. I would like to be a scientist.
37. Scientists do not have enough time for their families or for fun.
38. Scientific work is useful only to scientists.

39. Scientists have to study too much.

40. Working in a science laboratory would be fun.
APPENDIX D

SCIENCE TEACHING ATTITUDE SCALE II

WHAT IS YOUR ATTITUDE TOWARD SCIENCE AND SCIENCE TEACHING?

There are some statements about science and science teaching on the next few pages. Some statements are about a person's feeling about science. Some of these statements describe views about how science should be taught. You may agree with some of the statements and you may disagree with others. That is exactly what you are asked to do. By doing this, you will show your attitudes toward science and science teaching.

After you have carefully read a statement, decide whether you agree or disagree with it. If you agree, decide whether you agree mildly or strongly. If you disagree, decide whether you disagree mildly or strongly. If you do not agree or disagree with a statement, then you must be neutral.
Find the number of the statement on the answer sheet, and blacken the

A if you agree strongly
B if you agree mildly
C if you are neutral
D if you disagree mildly
E if you disagree strongly

Please respond to each statement and blacken only one space for each statement.

Please do not make any marks on this test booklet.
WHAT IS YOUR ATTITUDE TOWARD SCIENCE

AND SCIENCE TEACHING?

1. Scientists believe that nothing is known to be true for sure.

2. Scientific questions are answered by observing things.

3. It is a teacher's responsibility to tell children which things are important for them to know.

4. Only highly trained scientists can understand science.

5. I like science, and I probably will be (am) a better science teacher than most other teachers.

6. If a scientist cannot answer a question, another scientist can.

7. Scientific laws have been proven beyond all possible doubt.

8. A major function of the teacher in teaching science is to help children identify problems.

9. Most people are not able to understand science.

10. Scientific ideas can be changed.

11. Teachers have a responsibility to teach the processes of science.

12. Scientific work is useful only to scientists.

13. I do not understand science, and I do not want to teach it.

14. Children should able to design experiments -- at least by the sixth grade.

15. If one scientist says an idea is true, all other scientists will believe it.

16. Demonstrations should be used frequently so the children will understand what their teachers tell them.

17. A scientist must have a good imagination to create new ideas.

18. Ideas are the most important result of science.

19. Scientists are always interested in better explanations of things.
20. Anything we need to know can be found out through science.

21. A major purpose of science is to produce new drugs and save lives.

22. I am afraid to teach science because I can't do the experiments myself.

23. The senses are one of the most important tools a scientist has.

24. Electronics are examples of the really valuable products of science.

25. I understand science and I want to teach it.

26. As children experiment, a teacher may give helpful hints, but not the answer to a problem.

27. Science tries to explain how things happen.

28. I just never will understand science.

29. If an experiment does not come out right, the teacher should tell the children the answer so they will not be lost.

30. Science is pretty easy to understand.

31. Children should know that the blood carries oxygen to the cells -- at least by the sixth grade.

32. Good scientists are willing to change their ideas.

33. I am well-prepared to teach science.

34. Process skills are the most important things to be developed by children in science.

35. When scientists have a good explanation, they do not try to make it better.

36. Children must learn certain basic facts in elementary science so they can do well in science in junior high.

37. People must understand science because it affects their lives.

38. The idea of teaching science scares me.

39. Scientists should not criticize each other's work.

40. Some questions cannot be answered by science.
41. Children should know why iron rusts -- at least by the sixth grade.
42. It is important for children to develop process skills in science.
43. Scientists discover laws which tell us exactly what is going on in nature.
44. The teacher is the one who tells the children what they have to learn and know in science.
45. Every citizen should understand science.
46. Teachers have a responsibility to teach the basic facts science.
47. Scientists must report exactly what they observe.
48. Children should learn how to control variables in an experiment -- at least by the sixth grade.
49. In teaching science, a teacher might spend more time listening to the children than talking to them.
50. A major purpose of science is to help people live better.
51. Children must be told what they are to learn if they are to make progress in science.
52. Most people can understand science.
53. I think I understand the nature of science and science teaching pretty well.
54. It is useless to listen to a new idea unless everybody agrees with it.
55. A teacher should be a resource person rather than an information-giver in science.
56. Scientists cannot always find the answers to their questions.
57. I do (will) not teach very much science.
58. We can always get answers to our questions by asking a scientist.
59. Children should learn that air is approximately 20% oxygen -- at least by the sixth grade.
60. The teacher should arrange things so that children spend more time experimenting than listening to the teacher in science.
APPENDIX E

ESTEEM

SCIENCE CLASSROOM OBSERVATION RUBRIC
(Teaching Practices)

Category I: Facilitating the Learning Process from a Constructivist Perspective

A. Teacher as a Facilitator

5 Students are responsible for their own learning experience. Teacher facilitates the learning process. Teacher-student learning experience is a partnership.

3 Students are not always responsible for their own learning experience. Teacher directs the students more than facilitates the learning process. (Teacher-student learning experience is more teacher-centered than student-centered.)

1 Students are not responsible for their own learning experience. Teacher directs the learning process. (Teacher-student learning experience is completely teacher-centered, i.e. teacher lectures or demonstrates and never interacts with students.)

B. Student Engagement in Activities

5 Students are actively engaged in initiating examples, asking questions, and suggesting and implementing activities throughout the lesson.

3 Students are partially engaged in initiating examples and asking questions at times during the lesson.

1 Students are seldom engaged in initiating examples and asking questions during the lesson.

C. Student Engagement in Experience

5 Students are actively engaged in experiences (physically and/or mentally.)

3 Students are moderately engaged in experiences.

1 Students are seldom engaged in experiences.
D. Novelty

5 Novelty, newness, discrepancy, or curiosity are used consistently to motivate learning.
3 Novelty, newness, discrepancy, or curiosity are used sometimes to motivate learning.
1 Novelty, newness, discrepancy, or curiosity are used occasionally or not at all to motivate learning.

E. Textbook Dependency

5 Teacher does not depend on the text to present the lesson. Teacher and students adapt or develop own content materials for their needs.
3 Teacher does depend somewhat on the text to present the lesson. Teacher and students make some modifications.
Teacher does depend solely on the text to present the lesson. Teacher makes no modifications with students.
APPENDIX F

FOURTH GRADE CLASS SCHEDULE

7:35-7:55  Breakfast and Homeroom
8:00-10:00  First Class
10:00-10:15  Recess
10:15-11:45  Second Class
11:45-12:10  Lunch with Homeroom
12:15-1:15  Study Hall with Homeroom
1:15-1:30  Recess/Snack
1:35-3:00  Third Class (with Homeroom)
APPENDIX G

TYPICAL WEEKLY LESSON PLANS

Monday
Reading-TTW introduce and listen to story, introduce skill
Science-TLW define 14 vocabulary words, p. D2

Tuesday
Reading-TLW read story, go over elements & details, Workbook pages 171-173
Science-TLW Read, discuss pages D2-9, answer questions

Wednesday- Tutoring for MCT

Thursday
Reading-TLW study guide & workbook 177-180
Science-TLW complete reading comprehension & concept review

Friday
Reading-test & text structure sheet
Science-Group work-weather worksheets
APPENDIX H

SCIENCE TRADE BOOK REVIEW FORM

My Science Trade Book Review

Title of Book _________________________ Author ____________________

1. Did this book show how scientific knowledge changes over time? How?

2. Did this book show anyone being creative, making anything new?

3. Was the main character male or female? What was their race or ethnicity?

4. Did the book discuss any scientific laws or theories?

5. Did the book discuss how evidence was collected and used?


7. Did this book help you to better understand some scientific ideas? ___

8. Did this book make you wonder about anything else? What? ________________
## APPENDIX I

Children’s Trade Books and NOS Aspects

<table>
<thead>
<tr>
<th>Title</th>
<th># X's read</th>
<th>NSTA</th>
<th>Theory/Laws</th>
<th>tentative</th>
<th>creative</th>
<th>gender</th>
<th>ethnicity</th>
<th>Evidence based</th>
<th>Unanswered questions</th>
<th>Historical context</th>
<th>Life-long pursuit</th>
<th>Process</th>
</tr>
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<tbody>
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<td>A Picture Book of George Wilson Carver</td>
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<td>X</td>
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<tr>
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<td>X X X X</td>
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<td>X X X X</td>
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**Children’s Books**


