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I am submitting herewith a dissertation written by Patricia Lynn Bricker entitled "Children's Books and The Nature of Science: A Multisite Naturalistic Case Study of Three Elementary Teachers in the Rural Southeast." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Teacher Education.

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# Children’s Books and The Nature of Science:
# A Multisite Naturalistic Case Study of
# Three Elementary Teachers in the Rural Southeast

A Dissertation
Presented for the
Doctor of Education Degree
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## Abstract

This naturalistic case study describes the efforts of three elementary teachers in a rural southeastern school to use children's books in support of inquiry-based science and specifically addresses issues related to the nature of science. Data were collected through 26 classroom and meeting observations, 16 semi-structured and informal interviews, 35 documents and 76 children's books used by the teachers. Three themes were identified related to the nature of science and the selection and use of children's books in the teachers' second, fourth, and fifth grade classrooms.

1. Science was portrayed as a human endeavor that connects to the lives of people and that involves fascination, passion, and interest; imagination and creativity; values; and diverse views. The collection of books was analyzed to look specifically at race, culture, and gender issues. While women, people of color, and different cultures were represented in the book collection, they were not represented well when considering the collection as a whole.
2. Books and the teachers' use of them supported firsthand investigation of the natural world and the idea that empirical evidence underlies scientific understanding. This theme involved observation and journaling, identification of questions to investigate and procedures to use, reasonable interpretations of results, and inferential thinking.
3. Books helped teach about the durable body of scientific knowledge we have discovered over time. They were used to broaden background knowledge and as references after firsthand investigations.

The complexity of science education is revealed in these cases. The teachers were able to artfully balance multiple aspects of the nature of science in their book selection and presentation. Particularly promising aspects include their work to use fiction and poetry to promote connections between imagination, creativity and science and their innovative use of books to help students interpret data and infer. Important aspects of the nature of science were not addressed in these themes—including the tentative nature of knowledge, the unknowns we have about the natural world, and an understanding of scientific theories and laws. Issues of race, culture, and gender in the books revealed the crucial need to help teachers embrace critical ways of thinking.

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# Chapter 1: Introduction

> Illa Podendorf, science educator and children's book author, was working with two students, trying to teach them to observe more closely. She had placed two turtles of similar size and with similar markings in a pan and asked the children how they could tell the turtles apart. "That's easy," announced one of the children. "Just name them."
>
> The obvious links between language and science that this child's answer implies—the idea that for him, naming was synonymous with knowing, that through a name one might capture the complexity and gestalt of "difference," and that a feeling of power in science is fueled by identification—are merely part of the complex relationship between these subjects. What worries me, however, is that we in the field of education are looking to connect literacy and science instruction by using methods that are almost as simple as those suggested by Ms. Podendorf's student. (Saul, 2004, p. 1)

For this research I have had the opportunity to spend considerable time with three teachers whose practice reflects the depth and complexity needed for meaningful connections between literacy and science education, the depth and complexity Saul is referring to in this opening quote. As colleagues in a rural elementary school in western North Carolina, Charlie Benson, Jeff Sanderson, and Jody West are committed to integrating the teaching of science and literacy. These teachers possess an unusual dedication to inquiry-based science education at a time when considerable pressure exists to focus on reading, writing, and mathematics due to high-stakes testing in these areas (Jorgenson & Vanosdall, 2002). With the school's outdoor education center as a central focus, they wrote and received a substantial grant to gather resources to help connect their science, reading, and writing curricula. A significant portion of their work has been the collection and use of science-related children's books. This dissertation focuses on the nature of science in the books the teachers selected and the ways they used them with their second, fourth, and fifth grade students.

**Statement of the Problem**

Inquiry-based science is the primary teaching method supported by current science reform efforts and integration is encouraged in elementary education (Jorgenson & Vanosdall, 2002; NCDPI 2003a; NRC, 1996). However, within the science education community, people are concerned about the use of science books (Cervetti, Pearson, Bravo & Barber, 2005; Saul, 2004b). Will teachers use books in place of hands-on instruction? Will the reading of science-related texts focus on literacy skills at the expense of science content and concepts? What aspects of the nature of science will be conveyed through books?

Research exists about the effectiveness of inquiry-based science and numerous recommendations exist about the use of children's books in science, showing the potential for meaningful integration of science and literacy education. At the same time, a general consensus exists about the importance of teaching about the nature of science (Lederman, Abd-El-Khalick, Bell & Schwartz, 2002; Osborne, Collins, Ratcliffe, Millar & Duschl, 2003; Smith, Lederman, Bell, McComas & Clough, 1997). However, the research base on the use of children's books as part of the inquiry-based science process and as resources for teaching about the nature of science is very limited. In Ford's analysis of children's book content and potential for science teaching, she advised that the books are tools not teachers and are best viewed as one tool that can help students understand science (2004). Abd-El-Khalick (2002) did investigate the nature of science in middle grades science trade books in an exploratory study of 4 books but outwardly acknowledges the limitations of studying such a small number of books and that his study was more about presenting a framework for book analysis. Neither of these studies investigated teachers and the ways they actually use children's books in practice, leaving definite research needs.

**Purpose and Significance of the Study**

This purpose of this study is to describe three teachers' efforts to use children's books in support of inquiry-based science and to specifically address issues related to the nature of science. This study is significant because it shares the experiences of teachers committed to implementing inquiry-based science and to integrating the use of children's books into inquiry-based science in meaningful ways. It specifically illuminates the possibilities in a western North Carolina rural environment. This setting is especially valuable because there is insufficient understanding and research on teaching and learning science in rural schools (Royster, 2001). In addition, the study is significant because it investigates the nature of science, the characteristics of scientists, and the embedded cultural and social values as portrayed in these books and the teachers' uses of them. It helps illuminate issues related to expanding the traditional views of science and science education to be more inclusive, culturally responsive, and empowering.

Although we cannot draw general conclusions from a careful study of a small number of teachers, there is intrinsic value in learning their stories. In addition, by looking at results from this study, elementary teachers have potential to find ideas to use with their own students. School administrators may discover ideas to try in order to support science teaching and integration. Teacher educators might choose to share the findings with preservice teachers, helping them see real possibilities for their own teaching.

## Research Question

My research is based upon on the question:

> In what ways do three teachers in a western North Carolina rural elementary school use children's books to support inquiry-based science?

Four related sub-questions are:

1. What are the characteristics of children's books teachers select and use to support inquiry-based science?
2. How do teachers guide and support students in using these children's books as part of inquiry-based science?
3. What is the nature of science as portrayed in the books selected and in the ways teachers present them?
4. What successes and challenges do teachers encounter when using children's books to support inquiry-based science?

This dissertation addresses sub-question 3 and focuses on the nature of science as portrayed in the books and the ways these teachers use them.

## Limitations

Some conditions that I did not control may have influenced the outcomes of this study. Despite the clear commitment of these teachers to science education, state testing influenced school and district-wide priorities and put pressure on the teachers to focus on reading, writing, and mathematics. Allocation of time became an even larger challenge with special programs and school closings and delays due to inclement weather, which included hurricanes, flooding, snow and ice during the period of study. The integration of language arts with science and the teachers' commitment to science education helped address this issue but did not alleviate it. The state science curriculum also influenced choices teachers made about book selection and teaching plans.

**Delimitations**

The conclusions drawn from this study are also influenced by conditions I did control especially the selection of participants and the methods of data collection. I chose to study three teachers from the same school who were working on a joint project funded by a $10,000 grant. While this school's population is economically and culturally diverse, 97% of the students are white. Situations do vary between schools and the teachers' collaboration and funding affect the findings. The choice of studying three teachers allows for comparison but also limits the depth of each case. I was not able to observe every day in each classroom so my data will be a sampling of what was actually happening in classrooms. I arrange observations in advance, which influenced findings. These teachers were highly engaged in many projects such as leading professional development workshops and their own graduate coursework, which limited their time available for this study. Finally, some people may believe my researcher role of participant-observer created a bias that limits the study.

**Assumptions**

From my own experiences as a teacher, I bring beliefs about quality teaching. Particularly relevant to this study is my support of constructivist pedagogy, inquiry-based science education, and the use of children's books in elementary education. While there is research to support these ideas, I also consciously sought to be open to different perspectives throughout this research study.

**Definitions of Terms**

*Active-Member-Researcher*: Researcher who takes part in the core activities of the participants. Assumes a functional role in the setting, not just research or social roles. A colleague or coparticipant in a joint endeavor (Adler & Adler, 1987).

*Audit Trail*: A record of research data collection that provides a chain of evidence. A way to cross-check research (Janesick, 2000). In this study the audit trail was used to keep track of interviews, observations, documents, and children's books.

*Case*: A bounded system that is the object of study (Merriam, 1998). In this study the three cases are the elementary teachers Charlie, Jeff, and Jody.

*Constructivism*: Paradigm based on local and specific constructed realities and a transactional view of knowledge; a position that aims to understand and reconstruct (Lincoln & Guba, 2000).

*Critical Theory*: Paradigm based on historical realism and a virtual reality shaped by social, political, cultural, economic, ethnic, and gender values; a position that aims to critique and transform as well as restitute and emancipate (Lincoln & Guba, 2000).

*Inquiry-Based Science*: Process that includes observation; questioning; planning investigations; reading books and reviewing information already known on the topic; gathering, analyzing, and interpreting data; proposing answers; and communicating results (NRC, 1996, p. 23).

*Member check*: Participant review of research data such as interview transcripts and observation notes and of research analysis such as thick descriptions. A way to cross-check research (Janesick, 2000).

*Multisite Case Study*: Involves collecting and analyzing data from several cases. Also known as collective case study, cross-case, and multicase (Merriam, 1998).

*Naturalistic Inquiry*: Research conducted in real-life natural settings. In this study the real-life setting is an elementary school.

*Nature of Science*: Socially and culturally embedded values, beliefs and assumptions underlying scientific processes. Scientific knowledge is tentative, dynamic, empirical, theory-laden, and a product of human involvement, imagination, and creativity. No cookbook methods exist for doing science. (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002)

*Participant Observation*: An observation conducted in a setting in which the researcher plays a role. In this study, the researcher is a consultant who assists in their classrooms and regularly meets with the participants to discuss, plan, and reflect upon their collaborative work.

*Peer Debriefing*: Talking with a peer outside the study in order to explore aspects of the inquiry that might otherwise not be addressed (Lincoln & Guba, 1990). Adds to trustworthiness.

*Qualitative Case Study*: A study focused on holistic description and explanation. Considered particularistic, descriptive, and illuminating of understanding. (Merriam, 1998). Involves interpretation in context (Cronbach, 1975 as cited in Merriam, 1998).

*Rural*: Areas that contain fewer than 200 people per square mile (NC Rural Economic Development Center, 2002). The county in this study had approximately 100 people per square mile in 2000.

*Trade Book*: A book intended for general readership, as compared to a textbook that is prepared specifically for use in schools.

*Triangulation*: Using multiple perceptions to clarify meaning. Reduces the likelihood of misinterpretation (Stake, 2000). This study triangulates interviews, observations, and documents.

**Organization of the Dissertation**

The remainder of this dissertation is organized into four chapters. In Chapter II, a review of literature is presented with sections focused on rural education, the nature of science, the role of inquiry in science education, and the integration of literacy and science education. Chapter III describes the research methodology used in this study with particular attention to qualitative methods, case study design, participant selection, data collection and recording, analysis, and quality criteria. In Chapter IV, the data is presented and analyzed. Themes are stated and explained through descriptions, quotes, tables, and graphs. Chapter V focuses on reflections and new questions related to this study.

# Chapter 2: Review of the Literature

This study describes the efforts of three teachers in a rural elementary school to effectively integrate literacy and science education by using science-related children's books. It looks specifically at the nature of science as portrayed in the books the teachers select and in the ways they use them. It is important to situate their work in the context of what is already known and to show how their stories can add to existing understandings. In this review I set the stage by first discussing literature related to science education in rural areas. I move on to address the nature of science and suggestions for teaching nature of science characteristics to students. In the third section I review the role of inquiry in science education. I discuss in the final review section the integration of literacy and science education and look specifically at the use of science-related children's books.

## Science Education in Rural Areas

When considering rural areas, one should have a clear understanding of what rural means. However, that is easier said than done. According to Herzog and Pittman (1995), rural areas are often defined from an urban perspective. Their position was quickly confirmed with a brief internet search for the United States Census Bureau and the term rural. The following definitions were displayed:

> Urban - All territory, population and housing units in urban areas, which include urbanized areas and urban clusters. An urban area generally consists of a large central place and adjacent densely settled census blocks that together have a total population of at least 2,500 for urban clusters, or at least 50,000 for urbanized areas. Urban classification cuts across other hierarchies and can be in metropolitan or non-metropolitan areas.

> Rural - Territory, population and housing units not classified as urban. Rural classification cuts across other hierarchies and can be in metropolitan or non-metropolitan areas. (U.S. Census Bureau, 2005)

In order to obtain a clearer picture of rural life, Herzog and Pittman surveyed 108 students at Western Carolina University in Cullowhee, North Carolina—a university in the region where this dissertation study was conducted and where I am a faculty member. Most respondents to the survey thought of people, nature, and community. Students emphasized relationships and relatedness. They discussed farms, gardens, mountains, and waterfalls. They expressed positive and idealistic feelings about the word rural. Commonly used positive words in this survey included peaceful, safe, warmth, closeness, comfortable, friendly, home, quiet, and relaxing. Herzog and Pittman remind us that rural schools have problems including high poverty rates, low levels of educational attainment, low faculty salaries, less well-educated faculty, and issues with facilities, curriculum, and student achievement. They conclude by stating:

> For rural schools to be successful in combating their problems, they will have to capitalize on the community and family ties that our rural students rated as so important. It is curious that rural communities, which for so long have been marginalized by the dominant culture, have precisely the qualities for which the critics of American schools are now looking. As educators, we need to recognize these strengths, take advantage of them, and build the preparation of rural educators around them. We have neglected this task for too long. (p. 118)

When addressing science education in particular, Yager (2001) reinforces many of Herzog and Pittman's findings. According to Yager, rural areas tend to have fewer students in a grade level, less diversity in parent jobs and socio-economic levels, and strong community bonds. Often times people in rural areas have a closeness to nature and local folklore. People in rural areas regularly strongly support science education and set aside local resources to provide for it (Yager, 2001). However, it is common for there to be fewer specialized teachers of science.

Based upon characteristics of rural life in contemporary Appalachia, Eller (2001) suggests that an emphasis on science, mathematics, and technology is essential in protecting rural ways of life in the 21st century. In order to meet the needs of rural communities, Eller calls for integrating the family into education, addressing gender issues for both female and male students, more collaboration with local institutions outside the school, and for education to be more closely connected to local contexts and experiences. He relates this to extending the classroom to local communities and ecosystems, to active learning, and to a student-centered curriculum.

Insufficient understanding and research exists on teaching and learning science in rural schools (Royster, 2001). Reform efforts typically recommend generic strategies that have been tested in urban and suburban schools, not rural ones. Local leadership and attention to local context is needed in order to keep schools and communities in touch with each other and appropriate, relevant, real world context is essential for understanding science (Howley, 2001; Yager, 2001). Systemic initiatives such as Appalachian Rural Systemic Initiative can help address the particular needs of rural communities by connecting people and resources, developing instructional materials such as interactive science simulations, and providing teacher training and support materials (Gerber, Price, Barnes, Hinkle, Barnes, Gordon, & Stanley, 2003). This study adds to the limited information currently available about science education in rural schools.

**The Nature of Science**

Within the academic world, particularly the philosophy of science and history of science communities, public debate exists over the nature of science (Alters, 1997; Lederman et al., 2002; Osborne et al., 2003; Smith et al., 1997). While some embrace the ideas of objective reality and science as a way to find truth, others see science as a social construction influenced by culture, values, and gender.

Despite this scholarly debate, evidence exists that there is a general consensus regarding what should be taught about the nature of science in K-12 science education (Lederman et al., 2002; Osborne et al., 2003; Smith et al., 1997).

> Too much is being made of disagreements concerning the NOS that involve tenets that are esoteric, inaccessible, and probably inappropriate for most K–12 instruction... a careful review of many of the international standards documents has shown a remarkable level of agreement regarding the principle NOS elements currently being espoused for precollege science students. (Smith et al., 1997, p. 1102)

In a study of national standards, McComas & Olson (1998) identified 11 themes related to the nature of science. Each theme was present in at least 6 national standards documents. Osborne et al. (2003) provided empirical evidence for this consensus regarding a simplified nature of science appropriate for school students. They gathered data from 25 expert historians and sociologists of science, scientists, science educators, science communicators, and philosophers. Through three rounds of questionnaires they were able to identify nine themes regarding the nature of science to include in science curriculum. In reviewing national standards documents and the literature as described in Table 2.1, common features of the nature of science relevant to K-12 education include the understandings that:

Table 2.1. *The Nature of Science as Relevant to K-12 Education*

| Science For All Americans (AAAS, 1989) | National Science Education Standards (NRC, 1996) | McComas & Olson (1998) | Lederman et al. (2002) | Osborne et al. (2003) |
|---|---|---|---|---|
| ▪ The world is understandable<br>▪ Scientific ideas are subject to change<br>▪ Scientific knowledge is durable<br>▪ Science cannot provide complete answers to all questions<br>▪ Science demands evidence<br>▪ Science is a blend of logic and imagination<br>▪ Science explains and predicts<br>▪ Scientists try to identify and avoid bias<br>▪ Science is not authoritarian<br>▪ Science is a complex social activity<br>▪ Science is organized into content disciplines and is conducted in various institutions<br>▪ There are generally accepted ethical principles in the conduct of science<br>▪ Scientists participate in public affairs both as specialists and citizens | Science as a human endeavor<br>▪ Individuals and teams contribute<br>▪ Ethical traditions<br>▪ Part of society. Influenced by culture, personal beliefs, and ways of viewing the world.<br>Nature of scientific knowledge<br>▪ Empirical standards, logic, and skepticism<br>▪ Explanations must be logical, respect rules of evidence, open to criticism<br>▪ Subject to change based on new evidence<br>Historical perspectives<br>▪ Diverse cultures have contributed to science<br>▪ Usually change in science happens in small modifications of extant knowledge<br>▪ Sometimes advances in science have important long-lasting effects on science and society<br>▪ Science evolves over time, | ▪ Scientific knowledge is tentative.<br>▪ Science relies on empirical evidence.<br>▪ Scientists require replicability and truthful reporting.<br>▪ Science is an attempt to explain phenomena.<br>▪ Scientists are creative.<br>▪ Science is a part of social tradition.<br>▪ Science has played an important role in technology.<br>▪ Scientific ideas have been affected by their social and historical milieu.<br>▪ Changes in science occur gradually.<br>▪ Science has global interpretations.<br>▪ New knowledge must be reported clearly and openly. | ▪ Scientific knowledge is:<br>o Tentative<br>o Empirical<br>o Theory-laden<br>o Partly the product of human inference, imagination, and creativity<br>o Socially and culturally embedded<br>▪ Observation versus inference<br>▪ Lack of universal recipe-like methods<br>▪ Theories and laws | ▪ Science and certainty<br>▪ Analysis and interpretation of data<br>▪ Scientific method and critical testing<br>▪ Hypothesis and prediction<br>▪ Creativity<br>▪ Science and questioning<br>▪ Cooperation and collaboration in the development of scientific knowledge<br>▪ Science and technology<br>▪ Historical development of scientific knowledge<br>▪ Diversity of scientific thinking |

- Science is a human endeavor to understand and explain the natural world.
- Empirical evidence underlies scientific knowledge. Observations must be analyzed and interpreted.
- Science leads to theories and laws. Scientific theories are inferred explanations based on large amounts of indirect evidence. Theories lead to predictions that are tested against empirical data. Scientific laws typically describe relationships between observable objects.
- Knowledge is durable yet tentative and subject to change based on new empirical evidence and new interpretations.
- There is no one universal scientific method; instead numerous scientific methods are used. A diversity of scientific thinking exists.
- Creativity and imagination are important parts of science.
- Ethical principles guide scientific work.
- Science is embedded in society, culture, and history.

For the most part these common features rely heavily on a traditionally Western understanding of science. However, despite a mainstream portrayal and acceptance of Western science, there is no one basis for science (Kawagley, Norris-Tull & Norris-Tull, 1998; Stanley & Brickhouse, 2001). Culture, ethnicity, socioeconomics and gender influence ways in which we understand the natural world (Calabrese Barton, 2003; Fusco & Barton, 2001; Rodriquez, 1997). The dangers of portraying an accepted understanding of the nature of science applicable to public school education is oversimplifying this complexity, relying too heavily on a Western understanding of science, and under-representing the influence of context. Students should be aware of these issues regarding what science is and how it is done (Stanley & Brickhouse, 2001).

Along these lines Kawagley et al. (1998) contend that the nature of science portrayed in schools needs to be culturally relevant to the students taught. They describe how the Yupiaq culture in southwestern Alaska grows to understand the natural world in ways similar to but also different from Western science. For Yupiaq people, science is part of their daily lives, is informal, and involves observation and experimentation in the natural world— not labs. Science is connected to art, storytelling, hunting, and craftsmanship. The scientific work is done by people of the village, all people have access to the knowledge, and the work is not elitist. Elders hold the knowledge and pass it on to the young. Considerable focus is on connections and relationships. An ecological view of the world is connected to a spiritual view and knowledge comes from observation and from spirit, leading to a sense of responsibility to protect the environment. The authors argue that it is important to blend knowledge from the Yupiaq culture with ideas learned from Western culture and in a more general sense that by drawing upon indigenous knowledge, views, and culture, valuable learning opportunities are created for students far and wide.

An inclusive portrayal of the nature of science also addresses gender (Calabrese Barton, 2003; Rodriquez, 1997). Concern exists that the Western perspective creates a masculine bias emphasizing rationalism, objectivity, reason, and mind (Brickhouse, 2001; Harding, 1996). In science we have traditionally viewed the world through dualisms including masculinity versus femininity, mind versus body, objectivity versus subjectivity, and reason versus emotion. Yet to create a science for all people we need to understand knowledge as situated in cultural values, including gendered values, instead of thinking there are universal truths. We need to realize that in addition to reason, critical thinking includes creativity, emotions, imagination, intuition, and passion (Stanton, 1996; Thayer-Bacon, 2003; Walter, 1990 as cited in Stanton, 1996). We need to recognize the social nature of science. For example, Sandra Ruddick (1996) has said:

> There are many kinds of knowing how and knowing that, many uses of received, procedural, and connected capacities, required for building a bridge. I want to

> know where the bridge will lead, who can make use of it, what goods are brought over and how they are distributed, who if anyone is permitted to bomb the bridge, and who can stop the bombing. (p. 267)

The political nature of education plays a role here, calling us to understand the relationships between power and knowledge (Calabrese Barton, 2003; Fusco & Barton, 2001). As educators we should ask ourselves—*Whose science are we teaching in schools? Whose should we be?* The influence of society, culture and history are broadly addressed in the national standards and literature reflecting a consensus on the nature of science but context, values, and power issues need more direct attention than they have been receiving (Calabrese Barton, 2003; Fusco & Barton, 2001; Rodriguez, 1997).

The traditional perspectives on science have been challenged by various theoretical traditions including critical, feminist, multicultural, and poststructural theories which seek to create a more inclusive science education (Fusco & Barton, 2001). Fusco & Barton "have attempted to pull together the common threads." (p. 339) In doing so, they look at the nature of science and knowing science, the role of science in society, and science as a school subject. A summary of their ideas is provided in Table 2.2 which is taken directly from their work.

Once decisions are made about *what* nature of science we should teach, we must consider *how* to best do this teaching. A considerable amount of research provides support for the idea that students' views of the nature of science do not match current understandings of science (Akerson, Abd-El-Khalik, Lederman, 2000). This can be

Table 2.2. *Critical Science Education (Fusco & Barton, 2001)*

| | |
|---|---|
| The nature of knowing in science | ▪ Scientific knowledge is a human made explanation of how the world works, and is thus subjective yet rigorous and reflexive.<br><br>▪ Concepts, although rigorously tried, are culturally based and need-based explanations of natural phenomena to be applied in everyday activities.<br><br>▪ Science is a social activity and involves understanding how human values and characteristics shape scientific knowledge. |
| The intersection between science and society | ▪ Science has ethical responsibility for the knowledge it produces about the world.<br><br>▪ Scientific concepts emerge from dealing with societal problems/real life and the needs of the local community, which are seen as fundamental to the creation and production of science. |
| Science as a school subject | ▪ The teaching and learning of science ought to contain elements of action and change, i.e., learning is not just an academic task, it is about interacting with/in the world.<br><br>▪ Science teaching and learning should include the content, process, histories, norms for participation, and discursive practices.<br><br>▪ Students should be viewed as users and producers of science. |

explained, at least in part, by the naïve views of the nature of science held by many elementary and secondary teachers as repeatedly discovered in studies. Many teachers do not have an understanding of the tentative nature of scientific knowledge and instead believe that scientific knowledge is proven and constant. They do not have accurate understandings of what scientific theories and laws are. Many have an inaccurate belief in “the scientific method,” a single set of steps that all scientific endeavors follow, and consequently stifle the roles of creativity and imagination in science.

Two approaches to teaching the nature of science have been advocated (Akerson, Abd-El-Khalik, Lederman, 2000). In the first approach, the nature of science is taught implicitly through process skills, science content, and the doing of science. The second approach involves explicit direct teaching about the nature of science and builds upon the history and philosophy of science. While there is limited direct research about how we can effectively improve learning about the nature of science, evidence is growing for explicit reflective teaching that includes opportunities for ideas to be stated, tested, and revised, and that includes applied real world contexts (Scharmann, Smith, James & Jensen, 2005).

In conducting this study I have consciously decided to be open to different ways of understanding the natural world and different methods for teaching about the nature of science. My mission has been to describe what is happening in these cases, not to impose a predetermined structure regarding the nature of science or predetermined beliefs about the best ways to teach it.

**The Role of Inquiry in Science Education**

Exemplary science teachers have been described in research as teachers who actively engage students in inquiry-based and hands-on activities (Foster, 1998; Penick & Yager, 1993; Penick, Yager, & Bonnstetter, 1986; Pittman, 2000). The central teaching strategy recommended in current reform efforts such as the *National Science Education Standards* is inquiry-based science that focuses on authentic questions connected to students' lives (NRC, 1996). Llewellyn (2002) describes inquiry as:

> …the science, art, and spirit of imagination. It can be defined as the scientific process of active exploration by which we use critical, logical, and creative thinking skills to raise and engage in questions of personal interests. (p. 16)

According to the *National Science Education Standards*, inquiry involves observation; questioning; planning investigations; reading books and reviewing information already known on the topic; gathering, analyzing, and interpreting data; proposing answers; and communicating results (NRC, 1996). Inquiry-based teaching provides opportunities for students to set their own goals, to work towards achieving them, and to monitor their own progress.

While inquiry plays a big role in recommendations in the national standards document, the standards themselves are primarily theoretical and the published version does not include significant citations to empirical evidence.

> Despite strong theoretical grounding, support for a Standards-based science program is still largely anecdotal. It seems reasonable to us that assessment of the effectiveness of instructional practices promoted by the authors of the Standards, however well informed conceptually, should be evaluated using the same rigorous evidentiary criteria that they recommend students apply to scientific inquiry in the classroom. (Von Secker & Lissitz, 1999)

What does current research tell us about the teaching practices recommended in the standards and specifically about inquiry-based teaching and learning?

The empirical evidence about the effectiveness of inquiry-based instruction and hands-on teaching and learning is somewhat inconclusive. Inquiry and hands-on science are sometimes associated with higher overall science achievement and with more equitable achievement among diverse students (Davison, 2000; Ruby, 2001; Shymansky, Hedges, & Woodworth, 1990; Stohr-Hunt, 1996; Von Secker & Lissitz, 1999). A meta-analysis of 105 research studies on new inquiry-oriented science curricula of the 1960's and 1970's showed positive impact on achievement, process skills, problem solving, and attitude (Shymansky, Hedges & Woodworth, 1990). These curricula emphasized the nature of science, science process, lab activities as part of the core of instruction, an appreciation of science, and higher cognitive skills. A longitudinal study of a nationally representative sample of eighth-grade students showed that students who regularly participated in hands-on activities, meaning at least once a week, scored significantly better on standardized science achievement tests than students who participated in hands-on science once a month or less (Stohr-Hunt, 1996). In studying 1,400 eighth grade students and their teachers in Southern California, Ruby (2001) found that the level of hands-on science was positively associated with student test scores on standardized multiple choice and performance tests, regardless of student ability. Davison (2000) found that implementation of hands-on curriculum units led to significant learning over a two-year period, with schools that had students from lower socio-economic status showing a more significant increase. However, this is not always the case. According to

Hodson (1993 as cited in Watson, 2000), published research provides little evidence that hands-on work helps students learn scientific knowledge, and there is some evidence that other methods are more successful. Watson describes a study in which two groups of 150 students were compared. One group had significant hands-on experience while they other did not, but there were few differences in their understandings. A challenge of evaluating research on inquiry-based and hands-on science is the wide range of activities often considered in this category, from recipe-like activities to teacher demonstrations to open-ended investigations (Watson, 2000). One way to consider these variations is to identify the amount of learner self-direction and the amount of direction from a teacher or material (NRC, 2000).

A current research project being conducted by the Center for Science Education at Education Development Center, Inc. should help. Funded by the National Science Foundation, this study is focused on the impact of inquiry science on student outcomes (CSE, 2004). Research conducted from 1984 through 2002 in K-12 environments is being systematically synthesized. Their work is divided into three phases: Phase I involved report collection and is complete; Phase II involves report screening and coding and is currently being conducted; Phase III will involve analysis and dissemination of results. As of March 2005, 316 studies were identified as having at least some level of inquiry (CSE, 2005). This will be an extremely valuable synthesis because of its comprehensive look at the research, the inclusion of studies that have used a range of research methods and that have looked at diverse student outcomes, and its consideration of sociocultural factors such as race, gender, and socio-economic status. While we can and should continue to look at individual studies, it is important for the science education community to put the pieces together in an informed comprehensive way.

It does become clear that in an inquiry-based classroom the teacher plays a crucial role in facilitating progression from observations to conceptual understanding (Watson, 2000). Talk, the students' ability to ask questions, thinking time, writing, and reading are important parts of this process (McRobbie et al., 1997; Roth et al., 1997; Scott & Leach, 1998; Watson, 1994; White, 1988 all as cited in Watson, 2000; Klentschy & Molina-De La Torre, 2004; Yore, Bisanz, & Hand, 2003). Cooperative learning plays an important role as well and evidence exists that cooperative learning can improve student performance (Wood, 1992 as cited in Swango & Steward, 2003). These ideas are reflected in the learning cycle, a common structure used for inquiry-based teaching. The first stage of the learning cycle involves a thinking phase. It is followed by the collection of evidence and ends with another thinking phase. But even when implementing a relatively simple three phase lesson structure like this, teachers often cut off the crucial final thinking phase because other parts took more time than expected (Watson & Wood-Robinson, 1998 as cited in Watson, 2000). This can have significant consequences for conceptual understanding.

Yet elementary teachers have numerous responsibilities. Considerable pressure exists to focus on reading, writing, and mathematics teaching and learning due to high-stakes testing in these areas (Jorgenson & Vanosdall, 2002). Under these conditions teachers, administrators, and systems are often negative or apathetic towards science and have had to decrease or even eliminate time devoted to science education, greatly jeopardizing the state of science education (Jorgenson & Vanosdall, 2002; Mulholland & Wallace, 2001). In addition, many elementary teachers are uncomfortable teaching science due to a lack of content and pedagogical knowledge (Mulholland & Wallace, 2001). A partial answer is integration, as described below.

## Integration of Literacy and Science Education

Integration is a key strategy for elementary educators seeking to teach all curricular areas (Jorgenson & Vanosdall, 2002; NCDPI, 2003b). This is illustrated in the North Carolina Department of Public Instruction *Balanced Curriculum* (2003) document.

> It is important to teach all areas of the curriculum, not just those which are assessed. For example, one of the most effective strategies for teaching the entire curriculum is to teach English language arts and mathematics in conjunction with science, social studies, healthful living, foreign languages and the arts. Integration as a curriculum implementation strategy links the content and skills from various disciplines. It is our belief that students who receive a balanced curriculum and possess the knowledge, skills, and abilities to transfer and connect ideas and concepts across disciplines will be successful as measured by standardized tests as well as other indicators of student success. (NCDPI, 2003a, p. 1)

### *Literacy in the Work of Scientists*

When considering integration of science and literacy, there is value in studying how scientists authentically use literacy in their work (Yore, Bisanz, & Hand, 2003). Scientists are pragmatic readers—their purposes, prior knowledge, and evaluation criteria influence their reading strategies. They are familiar with the structure of peer-reviewed journals and often read them with pencil in hand. In their own field, they tend to read results and discussions first but outside their field they often read the introduction first.

Scientists' language use is a function of their purpose and setting. They use language to construct, describe, and share science claims and arguments, to obtain funding, to *do* the science work, and to influence public policy. Scientists attempt to communicate their ideas without distorting them or over-stating their certainty. Language is a tool or technology scientists use to direct their intellectual power to problems. Instead of just describing their work, language actually helps to determine it.

In studying scientists' writing, Yore, Hand, and Prain (2002) found that some viewed writing as a reporting of discoveries while others viewed writing as a process of knowledge construction. This may be a function of their beliefs about science, with the "writing as knowledge telling" view connected to traditional epistemology and "writing as knowledge transforming" view connected to contemporary or postmodern epistemology. This may also be connected to the scientists' perceptions of writing as a physical act of putting words on paper or as a process that includes thinking and interpersonal interactions (Yore, Hand, & Florence, 2004).

Yore et al. (2004) identified different kinds of writing used by scientists. The most frequent included preparing for seminar and talks, recording in laboratory or field notebooks, emailing colleagues, and writing lecture notes. Other types of writing included:

- journal research articles
- review articles
- commentaries
- grant proposals
- administrative writing
- grant progress reports
- internal research reports

- grant and manuscript reviews
- monographs
- conference proceedings
- laboratory manuals
- textbooks, handbooks and other books for the public
- personal reminders
- Internet research listservs

When asked how they learned to write like scientists or engineers, most participants said that it was a cumulative process learned by doing it over time, reading good examples, and modeling their work after these examples. Participants stated that good scientific and technological writing is clear, concise, well organized, easy to follow, and well referenced. It includes a clearly stated research question and hypothesis, relevant review of current knowledge, a well-designed and clearly reported experimental approach, clearly explained and illustrated results, and conclusions supported by the results. The quality of content and the quality of writing were not separated.

In *Science Notebooks: Writing about Inquiry*, Campbell and Fulton (2003) give attention to how two scientists use their notebooks. In interviews these scientists explained how they list, describe, note changes and problems, calculate, describe equipment, and sketch in their notebooks. At times they need to record weather, demographic information or case numbers, depending upon the kinds of work they are doing. Sometimes notebooks belong to the community with many people recording in them, requiring special attention to legibility and consistency. Sometimes recording systems are already in place and need to be followed. These scientists use their notebooks over time to notice trends, gather a set of supporting data for an argument, and as a basis of their research.

*Meaningful Integration*

The ways in which scientists authentically use language should guide us as we consider the best ways to integrate literacy and science education in schools (Saul, 2004a). While integration can be a powerful tool, we need to be sure to achieve the desired outcomes of the disciplines involved (Akerson, 2001; Pratt & Pratt, 2004; Saul, 2004a). In classrooms meaningful integration connects subjects in natural and authentic ways and fosters understandings useful in interpreting the world (Saul, 2004a).

Saul (2004a) describes the importance of distinguishing between integration focused on teaching specific skills and knowledge and integration that aims to get at the essence of meaningful science and literacy work. For example, she describes current efforts focused on reading science-related nonfiction in order to improve reading test scores and de-emphasizing hands-on science, a form of integration that loses sight of what is really important in both literacy and science education. She identifies two core values as the gifts of science: embracing inquiry and acknowledging that science is built on evidence that must be continually evaluated. Her core value of literacy is communication in context, also described as meaning-making or interpretation. I would elaborate on this, as Thier (2002) does, by saying that literacy embraces: reading to understand, retain, and apply meaning; writing and speaking clearly to clarify one's own thoughts and communicate them to others; listening to understand what others truly mean; and the ability to critically analyze information through all forms of media. When integrating literacy and science education, our key work is to consider how literacy strategies promote and connect to science inquiry and evidence.

As Thier (2002) points out, we often think of quantitative skills in science and see few connections between the work of science and literacy. Yet with a deeper look we can identify numerous parallel processes that complement and strengthen each other. Science adds to literacy by giving meaning and purpose. Literacy adds to science by providing a lens for focus and clarification.

In *New Standards: Performance Standards and Assessments for Schools,* reciprocal skills for literacy and inquiry-based science have been identified ((Learning Research and Development Center at the University of Pittsburgh & National Center on Education and the Economy, 2000 as cited in Klentschy & Molina-De La Torre, 2004 and in Thier, 2002). These include the following skills:

- Note details
- Compare and contrast
- Predict
- Work with sequences of events
- Link cause and effect
- Distinguish fact from fiction
- Link words with precise meaning
- Make inferences
- Draw conclusions

Meaningful ways do exist to connect these fields. To help guide this work, Saul (2004) identified four questions to consider about science and literacy integration.

1. Is the connection natural and authentic? Does the connection distort either discipline? Is it intellectually honest?
2. Does the connection foster understandings useful in interpreting the world; that is, does it provide a strong and useful light for interpreting experience and information, or is it the intellectual equivalent of momentary spark?
3. Does the connection, even if it allows a teacher to check off boxes on a curricular rubric, take away from time that may better be spent in other ways?
4. Who/what benefits from promoting (or not promoting) this particular notion of connections? (p. 450)

Saul calls specific attention to several strategies to question their role and remind us of what is most important. Why do we provide instruction on using headings, indexes, and tables of contents and lessons on recognizing main ideas and details? Why do we substitute science vocabulary lessons for inquiry and exploration? My sense is that Saul does not want to eliminate these practices; they can be valuable. Instead she wants us to keep larger goals in mind and be clear about how these larger goals help us decide on instructional strategies.

Integration can be powerful because of increased student understanding of disciplinary connections and because of efficient use of time, but we must be sure to achieve the desired outcomes of both disciplines (Pratt & Pratt, 2004). Interdisciplinary instruction alone is not enough (Akerson, 2001). We need discipline specific instruction, cannot just read and write science, and cannot focus all our reading and writing on science content. We need to provide opportunities to explore and investigate science and need to read and write on a range of topics.

We may be oversimplifying to say that integration is the key for elementary educators; it is much more complicated than it may seem. Roth (1994 as cited in Holliday, 2003) has said that it can be difficult to teach within an integrated curriculum without in some way distorting or diminishing one or another of the disciplines. Saul, Pratt, Thier, and the *New Standards* provide a lens to help us work through these challenges.

*Science-Language Integration Strategies*

A wide range of science-language integration strategies has been suggested and found effective for classrooms. Notebook or journal writing, writing-to-learn, and publication of scientific findings can improve scientific understanding and promote literacy skills (Karmazin, 1996; Klentschy & Molina-De La Torre, 2004; Marzano, 1991). Oral language can help uncover student thinking, promote conceptual growth, and positively influence science achievement (Gayford, 1993; Kempa & Ayob, 1991; Robinson & Niaz, 1991 all as cited in Yore et al., 2003). Explicit instruction of reading strategies can improve science reading comprehension, science achievement, and metacognition (Holden & Yore, 1996; Spence et al., 1999 both as cited in Yore, 2004).

Definite interest exists in the use of science trade books. Each year a joint National Science Teachers Association (NSTA)/Children's Book Council review panel identifies outstanding science trade books. Since 2003 the NSTA elementary journal *Science and Children* has had a Teaching through Trade Books column in each issue that describes one to three trade books as well as investigations they can inspire.

Teachers are encouraged to use children's books in science for a range of purposes (Dieckman & Saul, 2005a). They can introduce concepts, engage students, and begin inquiry and also expand on ideas during and after hands-on exploration and inquiry (Fredericks, 2003; Rice, Dudley, & Williams, 2001). Nonfiction children's books can help students learn about science from the perspectives of practicing scientists, show how scientists use reading and writing in their work, portray the excitement and complexity of science inquiry, and reflect the dedication of practitioners (Melber, 2003; Buxton &

Austin, 2003). Using nonfiction literature teachers and students can discuss the nature of science including accuracies and inaccuracies, the tentative nature of information, and the need to verify information (Akerson, 2001; Rice, Dudley, & Williams, 2001). Children's books with science themes can be used for independent reading, guided reading, genre study, read aloud, and student-selected reading (Akerson, 2001; Fredericks, 2003; Harms & Lettow, 2000; Holliday, 2003; Saul, Reardon, Pearce, Dieckman, & Neutze, 2002). Nonfiction texts can be chosen specifically to teach reading strategies (Akerson & Young, 2004). Dieckman and Saul (2005b) advocate interactive science read aloud-think alouds for numerous purposes related to science concepts and content, inquiry, scientific thinking, problem-solving, and literacy development. Harms & Lettow (2000) encourage the reading of poetry during environmental studies. They state that poems can enhance children's sensitivity to the world; help children think of things in new ways; encourage them to revisit, enjoy, and reflect; help them connect to prior experience and enhance understanding; introduce cultural perspectives; help build conceptual understandings; and provide models for student writing. Children's books can also develop the content knowledge of teachers (Akerson, 2001).

A structure for thinking about roles that texts can play in inquiry-based science has been proposed by Cervetti and her colleagues (2005). While their understandings originated in the context of developing science readers as part of an NSF-funded curriculum development and research project called *Seeds of Science/Roots of Reading,* their ideas have potential to apply in at least some ways to the use of children's trade books. The authors contend that texts can provide context; deliver content; model inquiry, literacy, and the nature of science; and support both firsthand and secondhand inquiry. They clearly state a vision in which texts support but do not replace inquiry-based science learning. Instead they explicitly state that students can not learn all the science they need to through texts but they also can not learn exclusively through firsthand investigation. The authors emphasize the potential that exists in embracing the synergies between science and literacy.

Despite numerous suggestions about the use of books to support inquiry-based science, the research base is limited. Very few studies have looked closely at the details of how children's books can support inquiry-based science.

> We have mixed feelings about making yet another contribution to the very enlightening, interesting, and even provocative—but largely "data free"—conversation about the science-literacy connection. On the one hand, we believe that we have a genuine contribution to make to this conversation. On the other hand, we believe that all of us who care about this interface, ourselves included, need to move beyond theoretical ruminations about the benefits of integration to tough-minded empirical examinations. (Cervetti et al., 2005)

A notable exception is Ford's study (2004) of highly-recommended trade books and their potential use in inquiry-based science. Ford investigated the content, images of science, writing style/genre choices, and suitability and practicality of using recommended books for inquiry-based science instruction. She found that potential does exist to use trade books to support inquiry-based science but that there is a need to plan how we use the books in order to maximize authentic science learning. Her study showed that the books' content was dominated by life science, with more than one-third of the books focused on animals and a clear under-representation of earth and physical science. The majority of the recommended books were information texts focused on one science topic and represented science as factual information with no discussion of methods or people associated with the facts. A smaller significant percentage did portray science as an active process including observations, experiments, and a personalized view of science. Narrative and artistic texts were found to avoid deeper scientific issues. The books tended to focus on careful and appreciative observation in outdoor settings and were well suited to invite students to observe, think creatively, and engage in science. Minimal attention was given to data analysis, theory development, and the role of the scientific community and the books were seen as less useful in modeling or supporting inquiry. Ford advised that the books are tools not teachers and are best viewed as one tool that can help students understand science. It is the ways in which teachers use the books that can make them worthwhile as part of the inquiry process.

> There are exciting possibilities for the use of trade books in elementary classrooms, if appropriate matches between books and classroom contexts can be made. (p. 289)

Ford's study focused on the potential uses of highly-recommended trade books and did address some components of the nature of science.

I found one study specifically addressing the nature of science in trade books for middle grade students (Abd-El-Khalick, 2002). In his analysis of four award-winning science trade books, Abd-El-Khalick concluded that he could not generalize from the small sample but that the books studied did a poor job of addressing the nature of science. None of the books directly discussed the nature of science. The books all presented science as a collection of facts about the natural world. There was no mention of science processes, of scientific ways of thinking, or of evidence underlying scientific claims.

People were rarely connected to the information presented, leading to an objectification of knowledge. Abd-El-Khalick's acknowledged mission was to suggest a way to critically examine books for nature of science themes and ideas.

Of course we need more than these two studies to get a holistic understanding of the role of trade books in inquiry-based science and in teaching about the nature of science. In addition these studies did not investigate teachers and the ways they actually use children's books in practice and they did not look at multicultural issues related to these books. The research presented in the following chapters will help to address these definite research needs.

# Chapter 3: Methodology

Decisions regarding methodology significantly influence a study. This chapter begins with a description of the theoretical framework brought to this research. As the chapter continues, reasons are presented for the use of a multisite naturalistic case study. The process of case selection is described, the context is presented, and each participant is introduced. My role of active-member-researcher is discussed. Forms of data collection are presented and methods of data analysis are explained. To conclude the chapter, issues of trustworthiness and quality are addressed.

## Theoretical Framework

I approached this research from a social constructivist paradigm. I believe that “reality” is contextually-bound, local, and specific (Lincoln & Guba, 2000). In other words, we create our understandings, which are subjective understandings, through interactions with others and the world in a process of co-construction (Hatch, 2002/2003; Lincoln & Guba, 2000). I envisioned my role as a constructivist inquirer in a way similar to the description provided by Lincoln and Guba (2000)—a “passionate participant” who facilitates “multivoice reconstruction”. I believe in shared control between inquirers and participants as a way of honoring people’s voices and teachers’ professionalism. Along these lines, in this particular study my mission has been to promote deep understanding of these specific teachers and to co-create rich descriptions.

Lincoln and Guba also discuss “some commensurability” between constructivist, and criticalist approaches (2000). I join critical theorists in the belief that race, class, gender, culture, and politics affect our views on reality. From a constructivist perspective, it seems to me that a contextually-bound reality connects to an acknowledgement of the role of race, class, gender, culture, and politics. Gender is an area of particular interest for this topic, especially in regards to the high percentage of female elementary teachers combined with the focus on science, a field historically dominated and defined by white males of European descent. Science traditionally has been defined in this Euro-western perspective as neutral, objective, independent of the observer, and universal and scientists as people who seek to dominate nature, yet feminists (myself included) call for different ways. Feminist theory calls for a dynamic and alive worldview that emphasize connections, unity, complementary descriptions, wholeness, socially constructed and contextualized realities, flexible and adjustable knowledge, and an understanding of the world through inquiry that is full of compassion, humility, and cooperation (Thayer-Bacon, 2003). These critical issues are key components of my social constructivist perspective.

**Selection of Methodology**

My research purpose and questions led to the choice of methodology. The purpose of this study has been to describe teachers' efforts to use children's books in support of inquiry-based science. The study originated with the question:

> In what ways do three teachers in a western North Carolina rural elementary school use children's books to support inquiry-based science?

It focused more specifically on the sub-question:

> What is the nature of science as portrayed in the books selected and in the ways teachers present them?

Naturalistic inquiry was an appropriate choice for this research focused on the practices of teachers. Originating in the real world, naturalistic inquiry aims to deeply and richly describe the structure and meaning of lived experiences (van Manen, 1997).

The qualitative paradigm was clearly more appropriate than quantitative for my chosen focus. Quantitative research is based on a positivist or post-positivist paradigm that includes belief in universal truth, a separation of subject and object, and a search to explain and predict (Smith, 1983). On the other hand, this study lent itself to my developing close relationships with teachers, becoming a part of what I was studying, and creating descriptions that help us understand. These are characteristics of qualitative research (Smith, 1983).

Within naturalistic qualitative research there are many traditions to consider. One qualitative tradition that I considered is narrative research. In narrative research, people make sense of their lives through story (Hatch, 2002/2003). If I chose this tradition, I would have asked teachers for their stories through oral interviews as well as writing. As Hatch describes, I might use oral history, annals and chronicles, family stories, photographs, memory boxes and other artifacts, interviews, journals, writings, and notes from the field. Notes from the field might include observations during classroom visits. As researcher, I would seek to help participants elaborate, provide details, and reflect. This work could lead to rich descriptions of interpretations and would fit into a constructivist paradigm. However, I did not chose narrative research because it focuses primarily on asking participants to tell their stories, and my questions and purpose lend themselves to a stronger blend of observation, interview, and document analysis.

I also considered the ethnographic tradition for this work. Tedlock (2000) describes ethnography as, "an ongoing attempt to place specific encounters, events, and understandings into a fuller, more meaningful context" (p. 455). Ethnography typically involves close, long-term interactions with people in their daily lives along with detailed writing of fieldnotes in an attempt to describe and understand (Stratta, 2002/2003; Tedlock, 2000). I saw potential to investigate my topic through ethnography by immersing myself in a school, observing and interviewing and collecting documents and artifacts, and becoming a participant-observer. However, I did not choose to call my study an ethnography in the traditional sense because ethnography is often thought of as a broader picture of the culture than I aimed to undertake.

I chose to use a multisite qualitative case study approach for this research because of the rich, holistic account it can provide of a complex, contextualized phenomenon (Merriam, 1998). In case study research, the unit of study is a bounded system called a case and multisite case study involves collecting and analyzing data from several cases (Merriam, 1998). Each of the three cases in this study focused on an individual teacher committed to using children's books as part of inquiry-based science. Case studies are considered to focus on discovery, insight, and understanding that can result in thick, rich description (Welch, 2002/2003). They are particularistic, descriptive, heuristic, and inductive (Merriam, 1988). There are major conceptual responsibilities for people conducting qualitative case study research (Stake, 2000). As previously discussed, case studies need to be bounded, and the boundaries for my cases are the study of individual teachers. Case studies also require research questions to emphasize, and as stated earlier I identified my questions. Triangulation is important, and I have triangulated data through interviews, observations, and document analysis. I also identified patterns in the data and developed generalizations about the cases, focusing on representing the case not representing the world.

The case study tradition fits well with my stance as a researcher. It allows me to study specific teachers in context, to co-construct understanding with them, and to be a participant-observer. Through this work I have been able to consider the roles of race, class, culture, gender, and politics. Case study provided a way for me to describe and share the work and voices of teachers and allowed a range of possibilities for creative presentation of findings, a range that includes story and rich description and that honors my desire to think beyond traditional academic writing.

**Selection of the Cases**

The three participants are all teachers at a rural elementary school in Sullivan County, North Carolina. (In order to protect confidentiality, pseudonyms are used for the names of the school, county, and teachers.) Their collective commitment to inquiry-based science and the integration of children's books is demonstrated through a science education grant they wrote, received, and implemented throughout the study. The grant was focused on integrating literacy, science, and nature education through the use of the school's outdoor education center. From prior observations in their classrooms and conversations with the teachers as well as their colleagues and administrators, I knew that all three teachers had demonstrated characteristics of effective elementary science teachers. They establish classrooms in which students are actively engaged in hands-on activities. Cooperative learning, talking, reading, and writing are regularly integrated into their science instruction. The teachers seek out relevant contexts for curriculum and consistently use the schoolyard for real world application of ideas. They aim to create child-centered constructivist classrooms. All three give considerable attention to developing positive caring relationships with and between students. They are considered risk-takers, are viewed as consistently willing to help out as needed, and exhibit a significant commitment to ongoing learning.

This dissertation research was a natural extension of work I had done with these teachers over several years and built upon established relationships. As a faculty member at local university, I had supervised interns placed with two of the teachers, taught one of the teachers in a graduate science education course, and worked with one of the teachers who is a clinical faculty member for the university's intern seminar. In 2002 I led a staff development day about inquiry-based science in primary grades that two of the teachers attended. In January 2004 the teachers asked me to collaborate with them on their grant and I agreed to assist with a workshop for teachers at their school and to serve as a team member and resource person for their overall work with science and elementary education. Upon their request, I submitted a proposal and later presented with them at the April 2005 National Science Teachers Association annual conference.

**Context of the Cases**

Sullivan County, in the western part of North Carolina, is a popular tourist destination and is well known for creativity in crafts and the arts. The largest industries in the area include education, health, and social services; manufacturing; retail trade; construction; and art, entertainment, recreation, accommodation and food services (U.S. Census Bureau, 2000). According to a document produced by the county, there is a population density of approximately 100 people/square mile. The vast majority of the population is white (96.8%) with Hispanic/Latino people and African Americans as the largest minority groups. The county's median household income is below the state and national levels and the percentage of children between the ages of 5 and 17 living in poverty in the county is higher than the state and national levels, yet the local unemployment rate is less than the state and national rates.

The county school system includes 9 elementary, 3 middle, and 3 high schools and has approximately 8,000 enrolled students (NCDPI, 2003b). The average per pupil expenditure in the 2001-2002 school year was $6920. According to the school system's website and the state standardized test results for 2003-2004, over 90% percent of students in grades 3-8 were at or above grade level in reading and mathematics. High school test scores reflected improvement in six of the nine core areas tested. Sullivan County's average SAT score was 1043 – the highest in the history of the school system. This exceeded the State by 42 points and the National score by 17 points. At the start of the study school system priorities included creating and maintaining safe learning environments, providing adequate facilities for all students, and recruiting and retaining quality teachers and administrators. They advertised their recent achievements as including: elimination of combination classes; lower class sizes; additional counselors and social workers; lead teachers in each school; increased course offerings; facility improvement and increased student academic performance.

Since 1986, the elementary school in which the three participants teach has grown from a student population of 337 to a student population of approximately 450. Although once serving a rural farm population, the school now serves a more diverse population. Mirroring the county as a whole, the vast majority of the student population is white (about 97%) with African American and Hispanic/Latino students representing most of the minority population. The school receives Title I funding, with about 30% of the students receiving free or reduced lunch (personal communication with a school administrator, August 26, 2004). Economics diversify the student population. While families with school age children do live in some of the large newer homes in the area, many of these residences are second homes for people who live elsewhere or for retirees. According to a school system administrator, many of the students live in trailers—some with inconsistent electricity. The community includes a blend of long time native people with newer people creating a cultural diversity as well. There is a considerable transient population as well as large family turn over in the school.

The community strongly supports the school system (personal communication with a school administrator, August 26, 2004). The school and community worked together to build the existing track, soccer field, softball/baseball field and basketball area. In the fall of 2002, a PTO fall festival raised $30,000 that was used to replace the school's computer lab. In 2003-2004, 95% of the students in grades 3-5 were at or above grade level in reading and mathematics (North Carolina Department of Public Instruction, 2004). For three years in a row it has been a North Carolina School of Excellence, meaning that at least 90% of the students were at grade level on end-of-grade tests. No Child Left Behind standards were met in 2003-2004.

## The Participants

### *An Introduction to Charlie Benson, Fifth Grade Teacher*

Charlie Benson is well known for her passion about science and teaching. She is involved in numerous initiatives locally, regionally, and nationally related to science education. Charlie's interest in science education was sparked when placed as a student teacher at an outdoor education camp. This interest combined with strong science content knowledge developed through required undergraduate coursework.

Charlie's first teaching position was in an inner-city school with a significant English as a Second Language population. Their needs encouraged her to teach through hands-on activities. Originally from a small town not far from San Francisco, Charlie describes herself growing up as a "white middle class kid with an ethnic background but not raised with it." Her maternal grandfather was from the Philippines. She appreciated the diverse cultures in her early teaching experiences and at times misses this diversity in her current environment.

In her ninth year as a fifth grade teacher at Mountain Creek Elementary, Charlie has been the central figure in establishing the school's outdoor education center and has written and received several grants to support this work. Charlie believes in inquiry-based teaching and learning and also sees the need to guide students in this work. She is highly committed to integration of curriculum. She facilitates an after school environmental club for fifth graders and is also a workshop facilitator for a mathematics and science curriculum called AIMS: Activities Integrating Math and Science. Charlie is certified by the National Board for Professional Teaching Standards as a middle child generalist and has prior experience teaching eighth grade reading and sixth grade science—with a total of sixteen years of classroom teaching experience.

When you walk into Charlie's classroom, you immediately can tell that there is a great deal happening. Tables are covered with works-in-progress. Walls and whiteboards are decorated with teacher and student writing. Cabinets burst with science and math manipulatives. Shelves and boxes are filled with books. After time to take these first observations in, you may notice that there are no student desks. Instead students sit at tables which Charlie describes as facilitating group work more easily.

Students in Charlie's class are encouraged to be responsible and independent. She puts high priority on helping students develop work habits that will lead them to be successful when they move onto middle school the following year.

*An Introduction to Jeff Sanderson, Fourth Grade Teacher*

> It is an unseasonably warm January day and Jeff Sanderson has taken his fourth graders outside to test fly paper airplanes. Students participate in two different activities—one to test the distance the planes will fly and another to test the planes' accuracy.
>
> For the distance test, the class has set up three stations. Each one has a long straight rope marking the desired flight path. Students have labeled the ropes

> with distances from 0 at the starting point on to 20 feet. Because they are learning about fractions, Jeff had the students mark every 6 inches with masking tape and label the tape with the number of feet.
>
> Students have created two large bulls-eye targets for the accuracy test. The target rings are assigned different numbers of points. Students fly the planes at one of the two targets and keep track of where the planes hit.
>
> Students eagerly fly their planes and take turns. They run after the planes to see how far they go and how accurate they are. When Jeff tells them, they switch from one activity to the other.
>
> When the class headed outside, they planned to collect data. However, wind makes this difficult so they decide to do test flights instead. Jeff shares with me that he thinks these tests flights are actually working out well. It allows the students to get out some of their excitement and energy so the next time, when they actually do collect data, they can focus more.
>
> Jeff has prepared data collection sheets and folders for the students. There are separate tables to record distance and accuracy data. When they do collect data, students will do 10 tests for each and manipulate the data on a spreadsheet to determine statistics such as mean, mode, range, and total.
>
> After approximately 30 minutes of test flights, Jeff guides the students to gather their equipment. They head back to their classroom with arms full of paper airplanes, targets, ropes, and data collection sheets. Back in their room, students settle in quickly and begin work on a math assignment. (fieldnotes, January 12, 2005)

This activity was one of many in a long-term unit on flight. Jeff read aloud children's books about the Wright brothers to help them learn about North Carolina history. In the computer lab, the class visited numerous websites related to the Wright brothers and flight. Students designed and constructed their own paper airplanes. With an illustration as a guide, Jeff created a way for students to make detailed models of the Wright brothers' plane. They worked patiently over several months to measure parts to scale, cut out pieces, and glue them together. Students eagerly explained their work to visitors in the room.

Scenes like this are common in Jeff Sanderson's fourth grade class. With a productive buzz filling the room, students often work cooperatively and spread out at the various tables and meeting areas—with some sitting on the floor, others in chairs, and some standing. They often are decision makers considering choices such as what poem to read, which scene in a story to turn into a play, or what town to design. When problems arise, as they do in all classrooms, Jeff guides the students to work out solutions together.

A teacher with national board certification, Jeff has taught for seven years, all of them at Mountain Creek Elementary School. With most of his experience teaching primary grades, Jeff was in his first year of teaching fourth grade during this study. He felt challenged by the need to learn a new curriculum and to prepare students for standardized tests, yet embraced his new work and the opportunities it presented. He appreciated the deeper levels of thinking his student were able to achieve. He seemed inspired to integrate subjects in creative ways and to plan unique applications of required curriculum.

Before becoming a teacher, Jeff worked as a photographer and journalist. He has two undergraduate degrees, one in biology and one in elementary education. He is described by his colleagues and administrators as a caring and positive team player who is highly reflective and a leader in his school.

*An Introduction to Jody West, Second Grade Teacher*

Jody has been a second grade teacher at Mountain Creek Elementary for five years. She previously taught first grade in a nearby county for two years. Having grown up in the area, she is seen as personable and highly approachable by children, teachers, staff, and the larger community. She creates a loving environment for her students and is one of the most accepting teachers I have ever met.

For several years Jody has given considerable attention to her science teaching. She has shown special interest in building on student curiosities and using reading and writing to support science learning. Her students participate daily in both reading and writing workshops. A few years earlier, Jody received a grant to purchase materials to support science inquiry. Prior to this study, I had seen her create and use desktop aquaria and a bird feeding station with her students. She was working on her Master’s degree in Elementary Education while participating in this research.

In the year of this study, Jody described her class of 5 boys and 15 girls as a challenging one. Many students had special needs and classroom behavior was an ongoing issue. Jody and her intern worked hard to help the students learn to be kind to each other, to work cooperatively, and to progress academically. One indicator of their success was the interactions with their fifth grade buddies in Charlie Benson’s class. When the two classes met at the beginning of the year, it was loud, somewhat chaotic, and stressful for the teachers and the fifth graders. As time passed, while there were still challenges, the interactions became quieter, more enjoyable, and more productive. Because Jody had a fulltime intern for half of the school year, she was frequently able to work with small groups of students from her class and from Charlie’s class.

**My Membership Role**

> And so when we raise questions, gather data, describe a phenomenon, and construct textual interpretations, we do so as researchers who stand in the world in a pedagogic way. (van Manen, 1997, p. 1)

My research is designed to first and foremost respect, support and care for teachers and students. My role was an active-member-researcher as described by Adler and Adler (1987). I contributed to the participants and setting by meeting with them regularly, sharing my knowledge of elementary science education, and assisting in their classrooms as requested. I saw my role as a co-participant and colleague whose involvement was a combination of activity-oriented, businesslike, and personal. For example, participants asked for advice on book selection and for teaching ideas related to required curriculum and inquiry-based student-centered instruction. While I was involved in the setting, it was a limited involvement in which I integrated my research roles and participation. My insider role was balanced by keeping a reflective journal, having peer debriefings, my realization of temporary involvement, and my long-term commitments elsewhere.

**Forms of Data Collection**

Data were obtained through interviews, classroom and meeting observations, and document collection. The overall research design is illustrated in Figure 3.1. Anfara, Brown, and Mangione (2002) discuss the need to design data collection with careful attention to the research questions as well as to the triangulation of data sources. With their ideas as a guide, Table 3.1 was created as part of the study's original design. It presents the major research question and 4 sub-questions with their correlations to the

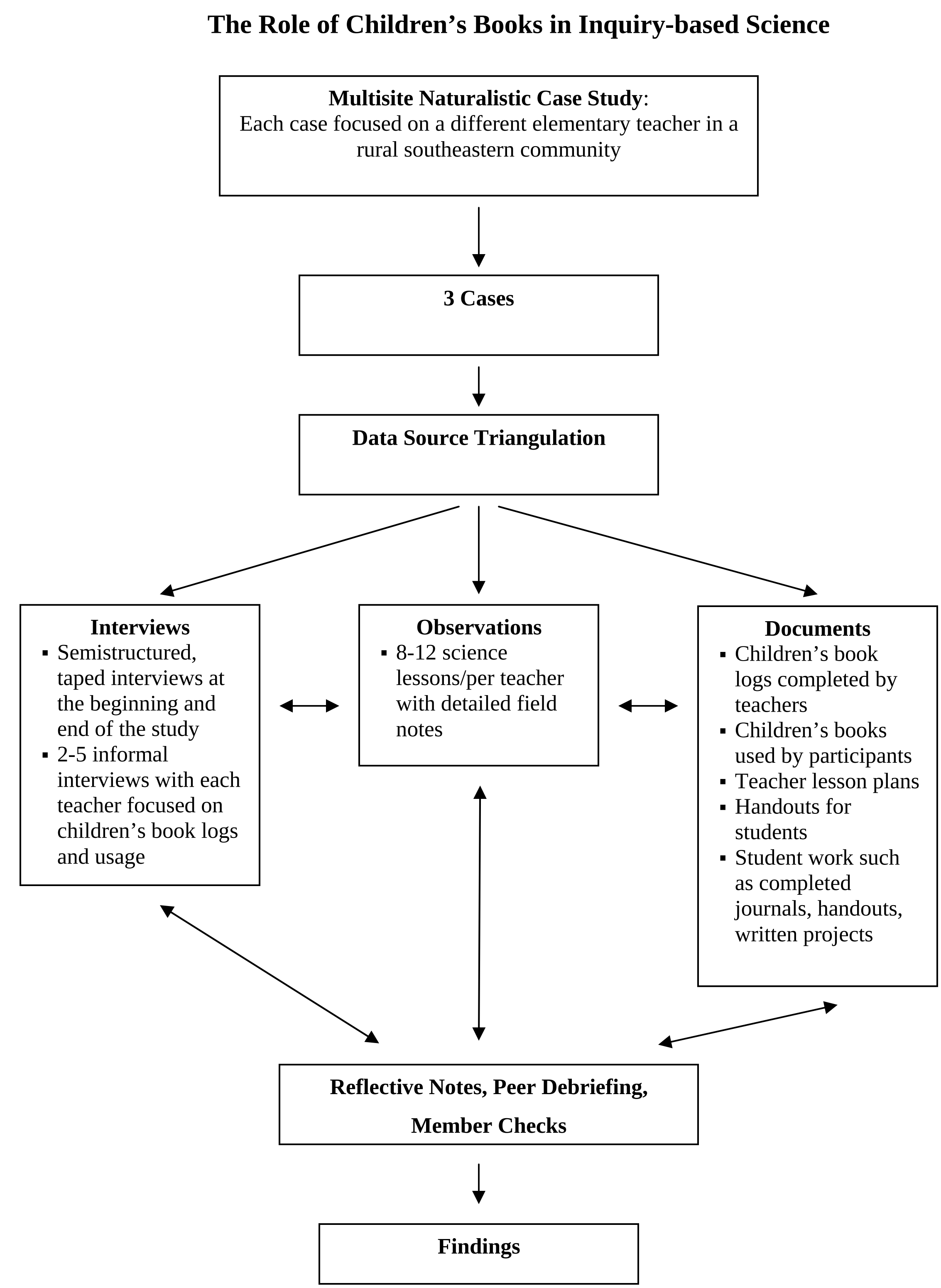



*Figure 3.1.* Research design demonstrating attention to trustworthiness.

Table 3.1. *Matrix of Research Questions and Data Sources*

| Research Question | Initial Interview Questions | Informal Interviews About Children's book Logs | Observations of Teaching and Meetings | Document Analysis |
|---|---|---|---|---|
| 1. In what ways do three teachers in a western North Carolina rural elementary school use children's books to support inquiry-based science? | All | X | X | ▪ Children's book logs completed by teachers<br>▪ Children's books used by participants<br>▪ Teacher lesson plans<br>▪ Handouts for students<br>▪ Student work such as journals, completed, handouts, written projects |
| a. What are the characteristics of children's books teachers select and use to support inquiry-based science? | 13, 15, 16 | X | X | ▪ Children's book logs<br>▪ Children's books |
| b. How do teachers guide and support students in using these children's books as part of inquiry-based science? | 12, 14, 17, 20 | X | X | ▪ Children's book logs<br>▪ Teacher lesson plans<br>▪ Handouts for students<br>▪ Student work |
| c. What is the nature of science as portrayed in the books selected and in the ways teachers present them? | 6, 7, 8, 9, 13, 14, 15, 16, 19, 20 | X | X | ▪ Children's book logs<br>▪ Children's books<br>▪ Teacher lesson plans<br>▪ Handouts for students |
| d. What successes and challenges do teachers encounter when using children's books to support inquiry-based science? | 18, 19 | X | X | ▪ Children's book logs<br>▪ Children's books<br>▪ Student work |

data sources, including the initial interview questions, the informal meetings about children's book logs, the observations, and document analysis. By the end of the study, I had conducted 16 interviews, observed 26 times, collected 76 children's books, and gathered 35 additional documents. A more detailed summary of the sources of data is provided in Table 3.2. I conducted this research study from August 2004 through November 2005 as described in Table 3.3.

Preliminary interviews were semi-structured and one-on-one. The interviews took place in January 2005, lasted approximately one hour each and were held at mutually convenient times and places. The interview protocol can be seen in Appendix A. An open-ended final interview was conducted with each participant in May 2005. These interviews were tape recorded and transcribed.

From January through May 2005, the teachers kept logs about the science children's books they used in support of inquiry. The logs included book titles and authors and places to record why this text was selected, how the text will be used, and reflections after its use. An example is seen in Figure 3.2. About once a month, I read the logs and subsequently met with each teacher to have informal interviews about the logs. These informal meetings helped me understand how teachers were selecting and rejecting books, how they were using them, and the successes and challenges teachers faced. I took field notes during these meeting.

Classroom observations included multiple pre-arranged observations of each participant's teaching throughout the school year, with at least 8 observations for each participant and a total of 24 observations. These observations were from 30 minutes to 5

Table 3.2. *Sources of Data*

| Data Sources | Quantities | | | |
|---|---|---|---|---|
| | CB | JS | JW | Total* |
| Interviews | 7 | 5 | 4 | 16 |
| Meeting Observations | 2 | 2 | 2 | 2 |
| Classroom Observations | 10 | 8 | 12 | 24 |
| Documents | 19 | 10 | 13 | 35 |
| Children's books | 48 | 18 | 38 | 76 |
| Total | 86 | 43 | 69 | 153 |

* Totals take into account observations and books that were connected to more than one teacher. Duplicates have been removed.

Table 3.3. *Research Timeline*

| Task | 2004 | | | | | 2005 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | August | September | October | November | December | January | February | March | April | May | June | July | August | September | October | November |
| Gain site access, identify participants and receive consent. | | | | | | | | | | | | | | | | |
| Initial semi-structured interviews | | | | | | | | | | | | | | | | |
| Classroom observations and document collection | | | | | | | | | | | | | | | | |
| Open-ended interviews | | | | | | | | | | | | | | | | |
| Data analysis | | | | | | | | | | | | | | | | |
| Writing/Revision | | | | | | | | | | | | | | | | |
| Presentation/Defense | | | | | | | | | | | | | | | | |

**Science Trade Book Log**

Teacher's Name: J.W        Date Log Started: 1/12/05        Date Log Completed:

| Book title | Author | Why the text was selected | How the text will be used | Reflections after its use |
|---|---|---|---|---|
| What Is Matter? | Lisa Trumbauer | I was looking for a book to go along with a liquid/solid activity. There aren't very many options for this topic. | Review the three states of matter. Explain matter w/ pictures. | This is a short text and I like that. By reading it at the beginning of the lesson and referring back to it throughout the lesson I was able to give better explanations |
| The Salamander Room | Anne Mazer | A small group wants to do a inquiry on salamanders. The book was read by one student to 3 others. | Discussion to begin ?'s. Idea for students. | After the group read the story they wondered if they could create their own salamander room. The book inspired readers, they wanted to take the book home to read again. |
| Snakes, Salamanders and Lizards (Take-Along Guide) | Diane Burns | Info (factual) about salamanders | Resource guide | My second grader read the facts and paraphrased in his journal. He wanted to ~~school~~ take his journal to the pond. I like this book b/c it has good info. |

D-6
JW
2/16/05
p. 1/2

*Figure 3.2.* Sample book log.

hours long with most lasting approximately 60 minutes. As part of their grant implementation, Charlie and Jody's classes were reading buddies and collaborated on science inquiry projects throughout the school year. As a result, six of my observations took place when their classes were together. I wrote field notes during each of these observations. I do believe that I observed until the point of saturation, meaning the point at which no new information was being discovered. When possible, I informally spoke with the participants before or after these observations.

In order to enrich the data collected, I asked participants for copies of science lesson plans and science-related handouts for children. Posters or charts created or used for science were collected or photographed for analysis. Throughout the study the teachers used, discussed, or wrote about work with 76 different children's books. These books were added to the document collection.

My role as an active-member-researcher created a few additional opportunities for data collection. On two occasions we meet as a group to discuss the teachers' grant work. I took field notes and tape recorded these meetings.

**Data Analysis**

The analysis of data went through several stages.

1. My first step involved identifying and extracting the data related to the specific sub-question for this study, in other words the information about the nature of science and children's books. I read through the interview transcripts,

observation fieldnotes, and documents numerous times, marked sections to extract, and created a new notebook that contained only these sections.

2. I read and reread the extracted data searching for patterns. I took preliminary notes in the margins of the pages and on separate paper.
3. I analyzed each of the children's books. At first I used the *Analyzing Science Trade Books* form designed at the beginning of the study. It allowed me to mark off characteristics of inquiry and the nature of science that were included in each book. It also provided a limited amount of space to write about the characteristics of scientists and the cultural and social values portrayed. An example is seen in Table 3.4. I soon realized that this structure was not allowing me to capture all the desired information, so I designed an additional more open-ended form. This provided space for ideas not originally considered and allowed the whole story to be told. An example is in Figure 3.3. Based upon advice received during a peer debriefing, I taped together the Analyzing Science Trade Books tables to create one oversized table that listed the books in columns and characteristics of inquiry and of the nature of science in the rows and helped me see patterns. A portion of the table is photographed in Figure 3.4. Through this process, it became clear that many of the books connect to multiple aspects of the nature of science. An example is shown Figure 3.5. I also needed to make decisions about which texts to include in and exclude from the study. I decided to include magazine articles because they are published for the world beyond classrooms, as are the trade

Table 3.4. *Example of an Original Science Children's Book Analysis Chart*

| | | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| **Title** | | What is Matter? (A reader, not a trade book) | The Salamander Room | Snakes, Salamanders, and Lizards | Salamander Rain: A Lake and Pond Journal |
| **Inquiry-Based Science (Check if included.)** | Observation | X | | X | X |
| | Questioning | | X | | XX |
| | Planning investigations | | X | X | X |
| | Reading books and reviewing information already known on the topic | | | | X |
| | Gathering data | | | | X |
| | Analyzing and interpreting data | | | | |
| | Proposing answers | | | | |
| | Communicating results | | | | X |
| **Nature of Science (Check if included.)** | The world is understandable and scientific knowledge is durable. | X | | X | X |
| | Scientific ideas are subject to change and science cannot completely answer all questions. | | | | |
| | Science relies on experimental and observational evidence. | | | | X |
| | Science is a blend of logic, creativity, and imagination. | | X | | |
| | Science does not follow universal recipe-like methods. | | | | X |
| | Procedures are reported and open to criticism. | | | | X |
| | Science is a socially embedded human endeavor and is affected by cultural and personal beliefs. | | X | | X |
| | Science is guided by ethical practices such as peer review and truthful reporting of information. | | X | | |
| **Inclusive Science** | Describe the characteristics of scientists (race, class, gender), as applicable. | Pictures of diverse children | | | Children can be scientists… |
| | Describe the cultural and social values portrayed. | | Caring for animal | Interest in wildlife & be kind to animals | Stewardship |

T-4 Used by CB, JW

Pratt-Serafini, K. J. (2000). *Salamander rain: A lake & pond journal*. Nevada City, CA: Dawn Publications.

Informational Text (blend of nonfiction and realistic fiction)

Inquiry notes:

- Observe. Explore. Collect data.
- Use science equipment. (Binoculars, camera, bucket…)
- Ask questions. Be curious. "What was he (bullfrog) doing all winter?"
- Get information already known on the topic from interviewing experts and reading books and going online
- Dig into areas of interest, your passions! Find out as much as you can from your own observations, from articles, from interviewing others…

NOS notes:

- Use of observational evidence.
- Science as a body of knowledge (blend)
- Connecting your own observations to what others know.
- Values: protect wetlands.

Characteristics of Scientists:

- Children can be scientists. (White boy and girl as main characters. Diverse children in part of book. Hard to tell races. Black, white, Asian, Native American? Male & female,)
- Share expertise with others.

Cultural and Social Values Portrayed:

- Environmental stewardship.
- Community of people working together to understand/protect the natural world.

Potential science to teach about:

- Observation strategies (time of day, time of year, equipment to use—binoculars and field guides, habitat, being quiet, noting physical characteristics, noting wildlife behavior, paying attention to sounds)
- Identification strategies (physical characteristics—size and colors and patterns, behavioral characteristics—hunting strategies)
- Journaling (blend of journal writing, collection of articles, illustrations including large view and magnified views, animal facts…)
- Scientific names
- Related content: wetland habitats; wetland animal natural history, animal adaptations (physical—such as bird beaks, behavior—such as heron hunting strategy), seasonal changes, food chains, ecosystems
- Science facts that make you go, "Wow!"
- Service projects

An Awesome Book!! Inquiry and NOS ideas spread throughout!

*Figure 3.3.* Example of revised note-taking structure for analyzing children's books.

| | Title | What is Matter? (A reader, not a trade book) | The Salamander Room | Snakes, Salamanders, and Lizards | Salamander Rain: A Lake and Pond Journal | Weather by Seymour Simon | Feel the Wind | Weather Everywhere | See for Yourself: Wind | Birds Eat and Eat and Eat: A Let-s-Read-and-Find-Out Science Book | Birds of a Feather | Birds Build Nests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inquiry-Based Science (Check if included.) | Observation | X | | X | X | | X | | X | X | | X |
| | Questioning | | X | | XX | | | | X | | | |
| | Planning investigations | | X | X | X | | X | | X | X | | |
| | Reading books and reviewing information already known on the topic | | | | X | | | | | | | |
| | Gathering data | | | | X | X | X | | X | X | | X |
| | Analyzing and interpreting data | | | | | X | | | X | X | | X |
| | Proposing answers | | | | | | | | | | | |
| | Communicating results | | | | X | | | | | | | |
| Nature of Science (Check if included.) | The world is understandable and scientific knowledge is durable. | X | | X 1 | X 2 | X A 1 | X 3 | | X 4 | X 5 | | X E 1 |
| | Scientific ideas are subject to change and science cannot completely answer all questions. | | | | | X | | | | | | |
| | Science relies on experimental and observational evidence. | | | | X | X | X | | X | X | | X |
| | Science is a blend of logic, creativity, and imagination. | | X | | | | | | | | | |
| | Science does not follow universal recipe-like methods. | | | | X | | | | | | | |
| | Procedures are reported and open to criticism. | | | | X | | | | | | | |
| | Science is a socially embedded human endeavor and is affected by cultural and personal beliefs. | | X | | X | | | | | | | X |
| | Science is guided by ethical practices such as peer review and truthful reporting of information. | | X | | | | | | | | | |

*Figure 3.4.* A portion of the oversized table created from the Analyzing Science Trade Books forms.

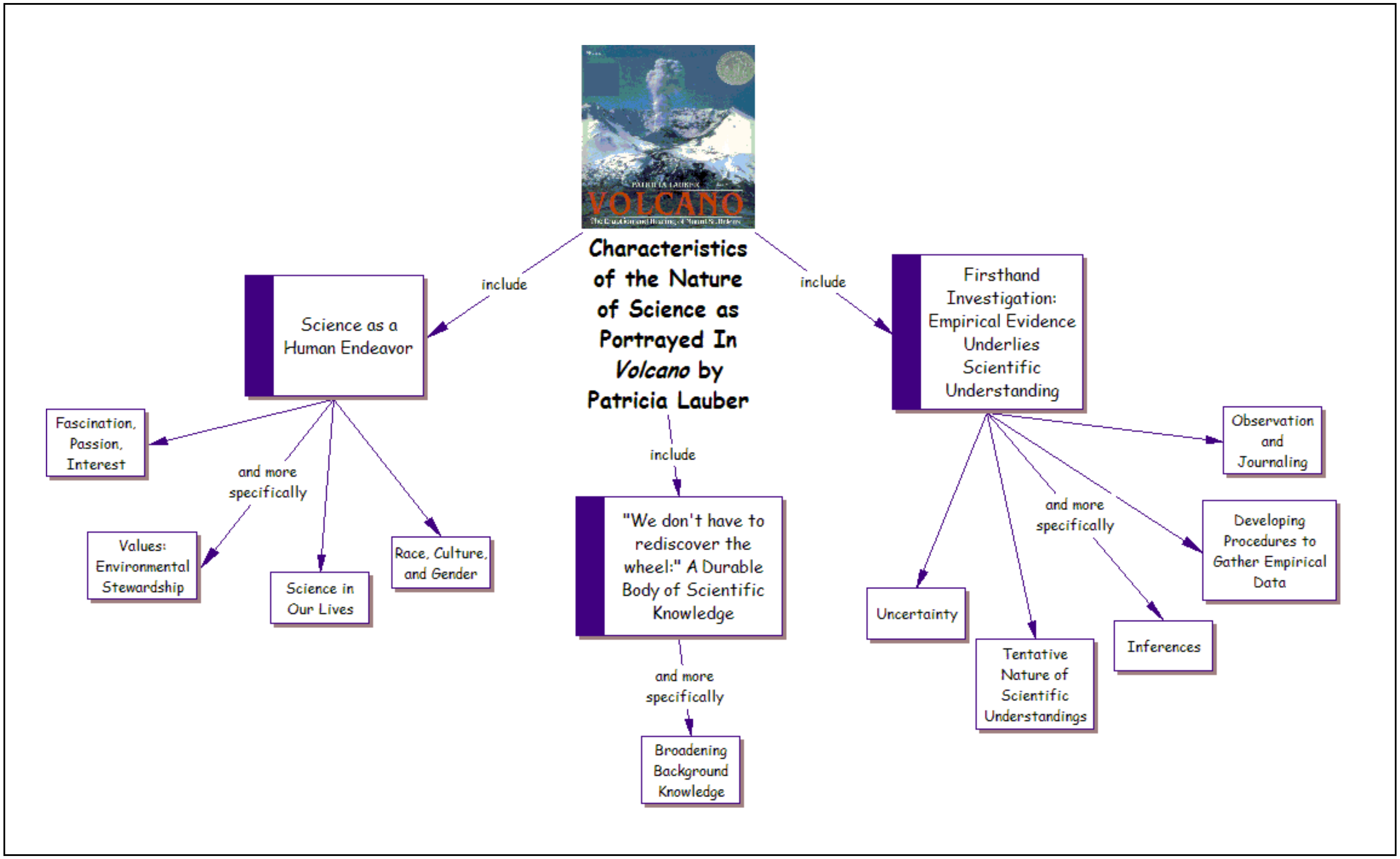



*Figure 3.5.* Illustration of a children's book connecting to multiple aspects of the nature of science.

books included. However, I excluded two readers--short texts written specifically for use in schools, often with controlled vocabulary and oversimplified ideas—because they are more similar to textbooks than to trade books.

4. With all of the data in mind, I searched for patterns that were in the information from the work with the teachers as well as in the children's books. Because this study focuses on the nature of science in the books teachers select and the ways they use them, I only searched for themes that were reflected in both the books and the interviews, documents, or observations. This was a slow process that required significant rereading, reflection, and time away that allowed for a fresh perspective upon return. While I originally planned to identify themes for each teacher as well as themes for the collection of cases, it became clear that this would not have been an authentic way to discuss their work. Because of their ongoing collaboration, it did not make sense to talk about the teachers individually.
5. These patterns led me to originally identify five themes. I went into the data and highlighted sections corresponding to each theme.
6. I began to write the data presentation and analysis section. In a true process of writing-to-learn, drafting helped me see that two of the themes originally identified were actually parts of other themes. As a result, I returned to the data and re-highlighted to reflect this new understanding. For each theme I chose information to illustrate and describe—information including sections of interview transcripts, observation notes, documents, and book descriptions and

quotes. I created data analysis tables for each theme to ensure that I actually had significant data. Each theme had data from each teacher and from interviews, observations, documents, and children's books. These tables are presented in Chapter 4.

7. For each theme I considered the presence of discrepant data. None was found.
8. A draft of the data presentation and analysis chapter was shared with the participants so they could member check. They provided only positive feedback, showing that the information resonated with their understandings.

**Trustworthiness and Quality**

Lincoln and Guba (1990) suggest techniques to ensure trustworthiness in qualitative research, techniques that address credibility, transferability, dependability, and confirmability as criteria that help researchers, especially doctoral students, design research in systematic, conscious ways. With Lincoln and Guba as guiding forces, this study was designed to ensure trustworthiness as described below and as can be seen in Figure 3.1.

Credibility is enhanced through techniques that include prolonged engagement, persistent observation, triangulation, peer debriefing, negative case analysis, and member checking (Lincoln & Guba, 1990). As much as possible, prolonged engagement was part of this research because I agree with Lincoln and Guba in thinking that prolonged engagement is essential to build trust and rapport. Persistent observation is another consideration in the study's design in order to create depth in findings. As described previously in the participant selection section, I developed relationships with these teachers over several years. I visited these classrooms consistently throughout the 2004-2005 school year and as described in the forms of data collection section I observed and interviewed numerous times. This multisite case study allowed for triangulation of data sources by combining interviews, observations, and documents in each of the three cases.

Peer debriefing is another important technique to help establish credibility because it helps the researcher be aware of her process and perspective, test emerging ideas, move forward in methodological design, and clear her mind (Lincoln & Guba, 1990). I had four peer debriefings in the midst of the data collection and analysis process. Several colleagues served one-on-one as peer debriefers: Dr. Rus Binkley, Dr. Katie Ray and Dr. David Strahan. Rus is an elementary and middle grades educator specializing in Social Studies education and with a strong interest in critical theory. He completed his own doctoral work in the summer of 2004. Katie specializes in language arts education and has served on doctoral committees. Dave specializes in middle grades education, has conducted extensive research, and has chaired numerous doctoral committees. I also met several times with a writing group consisting of faculty members from the university where I am employed. These meetings helped me identify strategies for data collection, analysis, and writing. They helped me see beyond my own initial reactions and provided momentum in this work.

In order to ensure that my interpretations are a reasonable rendition of reality, member checks played an important role in this study. Copies of interview transcripts, observation field notes, and thick descriptions were given to participants for verification.

Identified themes and the data presentation and analysis chapter were shared with participants as another measure of trustworthiness. It became clear that the participants were comfortable with this work. Only a few small pieces of feedback were given. The information resonated with the participants to the extent that they would have been comfortable with my using their real names. However, I chose to use pseudonyms to help protect the confidentiality of their colleagues and students.

Dependability and confirmability can be addressed through an audit trail and audit process (Lincoln & Guba, 1990). An audit trail provides a "chain of evidence" (Yin, 1994, p. 98) that links the interviews, observations, and documents to the study's findings and themes. I created an audit trail, adapting the structure used by Foster (1998) in her dissertation. Codes were assigned to every source of data as can be seen in Appendix C. Tables were created matching each theme to its sources of data, sorting the data by participant. These tables are presented in Chapter 4. The peer debriefing described above also helped assure dependability and confirmability.

Trustworthy naturalistic studies provide the data in a way that allows the reader to decide on potential applications (Lincoln & Guba, 1990). Decisions about transferability are not part of a naturalist researcher's work and as a result are not part of this study.

Peshkin (1988) discusses the importance of having a systematic way to pay careful attention to one's own subjectivity and its enabling and disabling potential during the data collection process. He suggests paying attention to and writing notes about "the warm and the cool spots, the emergence of positive and negative feelings, the experiences I wanted more of or wanted to avoid, and when I felt moved to act in roles beyond those necessary to fulfill my research needs" (Peshkin, 1988, p. 18). As I collected and analyzed data, I kept my own reflective notes. This was especially important because of my role as participant-observer.

More recent discussions of quality in interpretive research call for criteria based in constructivism instead of positivism (Lincoln, 1997). These new criteria all recognize the importance of relationships between inquirers, participants, and audiences of research. With these criteria as guiding forces, I intend in this study to help give voice to marginalized teachers in rural settings and to help give attention to the marginalized topic of elementary science education. Values, justice, social action, and power issues play a role in this work. In my analysis of the nature of science in the children's books, I investigated ways we might use the books to portray an inclusive science and help students honor and also move beyond their rural Appalachian experiences.

**Summary**

I bring to this research a social constructivist paradigm that includes concern about issues related to race, culture, class, and gender. This multisite naturalistic case study was conducted in a rural western North Carolina elementary school. Participants included three teachers and I served as an active-member-researcher. Data were collected through 26 classroom and meeting observations, 16 semi-structured and informal interviews, 35 documents and 76 children's books. Analysis included careful reading and rereading of fieldnotes, interview transcripts and documents as well as in-depth review of the children’s books.  Through this process themes were identified.  Mechanisms were built into the study design to address trustworthiness and quality.

# Chapter 4: Data Presentation and Analysis

Using the methods described in Chapter 3, I collected data in order to focus on the overall research question:

> In what ways do three teachers in a western North Carolina rural elementary school use trade books to support inquiry-based science?

Subsequently I processed the data to focus more specifically on the research sub-question for this study:

> What is the nature of science as portrayed in the books selected and in the ways these teachers present them?

This chapter reports on the three themes that I identified. In the presentation and analysis that follows each theme is explained and supported by data. Quotes from interviews, vignettes describing observations, and excerpts from texts bring the data to life. A table matches each theme to its supporting data, noting the teacher and data source, in order to demonstrate a triangulation of data and to promote quality results.

## Theme 1—Science as a Human Endeavor

One significant aspect of the nature of science that surfaced in this study is that science is a human endeavor. The books and the teachers' use of them show that when people do science there is often fascination with the natural world. The roles of imagination, creativity, and values come into view. Diverse ways of understanding the natural world begin to appear. It becomes clear that in many aspects science is part of the lives of people. In the sections that follow the sub-themes of science as a human endeavor are discussed. Following this discussion, there are tables that illustrate the triangulation of data.

*Fascination, Passion, Interest*

A key aspect of science as a human endeavor is that people are often fascinated in and passionate about understanding the natural world. Jody captured this idea when she said that having numerous, high-quality, science-related books available to students supports them when they "want to know everything they can about a topic." She elaborated with a story about a second grade boy interested in tornadoes and inspired by a book he read. The boy surprised Jody by independently deciding to take information from the book and use it to create a big poster that "he wanted to do all by himself."

When guiding their classes to find and build upon outside observations, Charlie and Jody encouraged the students to identify topics and questions that fascinated them. With initial ideas in mind, students dove into books to help them pinpoint areas of interest. Books were used as tools to promote intrigue of the natural world.

At times the teachers referred to specific books to show that science can be interesting. In describing *The Skull Alphabet Book* (Masiello & Pallotta, 2002), Jody said, "That's just a cool book. I mean how could you not buy that and just include it in your collection?"

Jeff illustrated this same idea when talking about the book *Project Ultraswan* (Osborn, 2002). He read aloud sections of this book which is part of the Scientists in the Field series to his fourth grade class. The book explains that while some birds instinctively know migrations routes, trumpeter swans need to be taught them. However, by 1900 hunters had shot all of the trumpeters in the eastern part of North America. The text describes a project focused on trying to teach trumpeters reintroduced to New York to migrate—by encouraging the swans to follow an ultralight hang glider-like flying machine designed and piloted by scientists. An example of the intriguing text follows.

> It sounds like an overgrown mosquito.
>
> But in the dim light just before sunrise, you can see that it's a tiny airplane, flying low, coming toward you. It's much too cold for mosquitoes anyway. This is October in western New York State, and you shiver in the frosty air.
>
> You are standing on a small hill, watching the plane circle. Van headlights bounce along on the rough field below, and you strain to see what is happening. As the headlights stop, the plane circles again, touching down by the van. Then, someone, crouching out of sight, throws open the gate on a small trailer hitched to the van. Five large, pale gray birds scramble out, enormous wings flapping hard—hurrying to follow the plane into the air. (Osborne, 2002, p. 5)

Text like this hooks readers and helps make science appealing. All three teachers talked about many students being highly interested in science-related trade books. As Charlie said, "They were ready to read. They were excited about it." At least part of this interest comes from the attention these teachers give to knowing their students and selecting books that match their interests.

When looking carefully at trade books, we can find that some texts blend direct mention of how interesting the natural world can be with information and art work that less directly yet strongly promote interest. *National Geographic: My First Pocket Guide—Insects* (Bickel, 1996) has a brief line in the beginning of the text that calls insects "fascinating creatures" (p. 4). Throughout the rest of the book every two-page spread has amazing up-close photographs and detailed drawings of insects. The text gives tips on where to find the insects, what to look for, and natural history information that can be intriguing. For example, when reading that butterfly wings have single-color scales that overlap to create patterns, many readers will be interested in looking themselves at wings.

*A Dazzle of Hummingbirds* (Berger, 1995) has a similar blend. Right from the introductory page the text reflects an awe of hummingbirds and tells how they delight and dazzle people. “Humans have long had a passion for these fearless flying gems.” (title page) Amazing facts and photographs fill the pages.

> …it could fly forwards, backwards, up, down, sideways, or sit in sheer space between its blurred wings, calm in the air as a fish in the sea. (p. 2)
>
> They have the most rapid wingbeats of all birds, the largest ratio of heart to body size of any mammal, and a heartbeat—up to 1,260 beats per minute—second only to shrews. Hummingbirds possess both the most densely distributed plumage and the fewest feathers. Their tiny brains, 4.2% of body weight, are proportionately the largest in the bird kingdom. But it is their energy output, the highest per unit of any warm-blooded animal, that impresses us most. Hovering they expend, relative to size, ten times the energy of a man running nine miles per hour. If that same man weighed 170 pounds and wanted to live the life of a hummingbird, he would have to burn 150,000 calories a day and drop 100 pounds per hour in perspiration.” (p. 4-5)
>
> Hummingbirds have to be raised tough to maintain the dashing lives they lead. The species that migrate to the United States travel impressive distances. Many ruby-throateds, for instance, make a 2,000-mile journey each spring from Panama to Ontario, Canada. The trip includes a 500-mile nonstop flight over the Gulf of Mexico, during which the birds average 25 miles per hour for 20 hours. By adjusting the angle of their wings to benefit from prevailing winds, they clear the Gulf on a gram of stored fat. (p. 29)

*Reader’s Digest Pathfinders: Birds* (Brinkley, 2000) includes a recurring sidebar called “That’s Amazing!” The table of contents describes this feature as a place to find "amazing facts, amazing records, (and) fascinating figures." (p. 5) Sample passages follow.

> **That's Amazing!**
> In 1758, a famous English surgeon named John Hunter found that a bird with a blocked windpipe could still breathe if it had a hole in a wing bone or leg bone. This led to the discovery of birds' complex, connected system of lungs, bones, and air sacs. (p. 13)
>
> **That's Amazing!**
> It is difficult to measure how fast a bird can fly because it depends upon the circumstances under which the bird is traveling. Some birds can fly as fast as small airplanes when they are being chased, or are chasing. In 1961, a pilot clocked a male Red-breasted Merganser, startled by his plane, flying up to 80 miles per hour (129 km/h). Peregrine Falcons can reach speeds above 110 miles per hour (180 km/h) when diving for prey." (p. 19)

*Science Works: Light!* (Parker, 1997) has a similar feature they call "Fascinating Facts." This kind of direct attention to science as amazing sends a clear message.

Some books do not directly mention a fascination with science but include information in the text and art work which promotes interest in the natural world. *Birds Build Nests* (Winer, 2002), for example, includes awe-inspiring illustrations of birds and their nests and uses poetic text to describe different kinds of nests and places they are built. *The Other Way to Listen* (Baylor & Parnall, 1978) tells the story of a child learning from an elder how to really hear the natural world. Ideas such as hearing a rock murmur to a lizard, a sky full of stars, and the hills singing encourage readers to be interested in the world around them.

*Imagination and Creativity*

One of the most common ways Charlie, Jody, and Jeff brought the ideas of imagination and creativity to science was through the reading of fiction and poetry. All three teachers had a consistent drive to find quality fiction that connected to the science topics being studied. This drive came in part from a desire to integrate subjects, but also reflected an understanding that fiction and poetry come with a freedom to think outside the box. This freedom allows authors to be creative and as a result can lead to original interpretations and connections with potential to push our understandings.

Charlie had her fifth grade students create poetry books in which they needed to have ten collected poems and five originals that they wrote. The poems they collected from books served as models for their own writing, as did poems that Charlie wrote to share with them. On a day they went outside, Charlie wrote a cinquain poem on the sidewalk with chalk. Students spread out to different parts of their Outdoor Education Center, observed outside, and used their observations to write their own cinquains. On another day Charlie had collected a stack of nature photographs for students to write diamante poetry. In diamantes, a poem starts out with one subject and works it way to an opposite idea using a predetermined pattern. Charlie, for example, wrote a poem that moved from oak tree (deciduous) to fir tree (evergreen), as can be seen in Figure 4.1. Charlie emphasized that these poems required students to use scientific characteristics and to consider relationships. She also had them write reflections about their poems; hers is seen at the bottom of the figure.

**Diamante**

By Charlie Benson

Oak
Tall, Curvy
Swaying, Calming, Shading
Ancient, Shelter, Young, Fresh
Sapling, Growing, Building
Tender, Green
Fir

This is another nature poem and it's about two trees. One is a very old stately oak and the other is a young Douglas fir tree. While they are both trees, they are very different from one another and make a great topic for this type of poem.

*Figure 4.1.* Charlie's model diamante and reflection.

Jeff described his search for books with original presentations of information and his desire to steer clear of books full of clichés. He chooses to dive into texts with beautiful writing or illustrations and with deeper ideas to push students' thinking. Jeff explained that a class author study of Gary Paulsen and his realistic fiction chapter books allowed students to think about animals, survival and adaptations—all parts of his fourth grade science curriculum—in a "round about way." He went on to say:

> The kids are going, "Oh, that's how a dog lives in the wild. His hair does so and so… and those feet do that… Their ability to make a little igloo for themselves, there's a behavioral adaptation." They just notice all those things.

During a classroom observation Jeff had his students reading different poems. Many, but not all, were about animals.

> The fourth graders sit on the carpet and gather around Jeff. He explains to the students that they will be selecting and reading different poems. Each person will write the poem on one side of a paper he provides and on the other side they will write what the poem means to them. He tells them that when they are done, the students will get "eye to eye, knee to knee" with a partner. Each person will read the poem to his partner and then share what he thinks it means. He encourages them to read the poems to each other a bunch of times, not just once.
>
> Jeff has a stack of different poems in his hands. He allows students to select poems as he describes them one-by-one. They spread out throughout the room as they begin to work. Jeff answers questions and circulates from student to student.
>
> Thirty minutes pass. With Jeff's guidance, students begin to find partners and share with each other. A little while later, all the students meet Jeff back on the carpet for a whole class share. A boy reads his poem aloud and the class discusses it.
>
> A girl asks, "How do trees cry? What does that mean?"
>
> Her classmates share possible interpretations. Maybe it is sap. Perhaps it is raining. Maybe the tree isn't really crying but it is sad. Can trees be sad? (fieldnotes, March 24, 2005)

Students were using their knowledge of the natural world to imagine different interpretations.

Jody talked about poetry that has a nonfiction theme. She uses pairs of related texts such as a poetry book with a nonfiction book to help students see this connection. She wants students to see that observations you make and data you collect in science can spur the writing that you do and that this writing does not need to be just informational text. For example, poetry books in the classroom model one kind of writing she wants children to do.

One aspect of this work involved students in thinking carefully about fictional passages so they could identify realistic scientific information that was included as well as parts that were more likely to have come out of creative license. As an example Charlie discussed her class' work with *The Talking Earth* (George, 1983). In one scene the main character takes a bamboo reed, dives under the water, and snorkels next to a manatee which then touches her. Charlie explained that this sequence of events is unlikely, yet the author's descriptions of the manatee's physical features and behavior are accurate. She had her students analyze additional passages in this way.

In many observations throughout this study, students were involved in choosing science-related questions to investigate, procedures to follow, and data to collect. They were given freedom to imagine possibilities and to create ways to move towards them. Books supported this process, as will be described in Theme 2.

The books demonstrate additional ways that creativity and imagination are parts of science. Imagination can be part of developing hypotheses. For example, Berger (1995) tells a story about scientists who observed a hummingbird with an unusually curved bill.  The scientists speculated about a flower that would match this bill.  Later this flower was actually discovered.

Creativity contributes to the design of procedures to use.  In *Kingfisher Young Knowledge: Birds*, Davies (2003) explains that scientists have developed ways to find out about animals.  A radio tag on a penguin's back can communicate how far the penguin travels and how deep it dives.  A numbered band on a bird's leg can track how long it lives.  A colored ring can help distinguish one individual from another.  Myers (2004) describes the creative way scientists investigated the movement of elephants and Osborne (2002) illustrates the imaginative ways scientists are attempting to learn about and help trumpeter swans.

Scientific models also involve imagination.  In *One Small Square: Swamp* (Silver, 1997), readers are taught how to make models of sphagnum moss, prop roots on mangrove trees, and a swamp.  Models of the human eye are pictured and explained in *Eyewitness Science: Light* (Burnie, 1992).  *How Science Works* (Hann, 1991) includes an activity in which students create and use atom models.

Books can show that creative interpretations are part of science.  A journal entry in *Saguaro Moon: A Desert Journal* (Pratt-Serafini, 2002) includes an unlikely comparison of a spotted bat and chess.  It explains that the bat's back looks like a chessboard and that the bat's echolocation is an excellent strategy to checkmate moths. *Can You Count to a Googol?* (Wells, 2000) shows creative ways to think about numbers and data.  For example it tells readers if you counted every grain of sand on all the beaches in the world, every drop of water in all the oceans, and every star, planet, moon, comet, and asteroid in our galaxy the total would still be much smaller than a googol. Using a bit of a different perspective in *Lifetimes*, Rice (1997) takes scientific information and interprets it in a way that leads to life lessons. He suggests that we learn from the adult mayfly's one day life that we can accomplish a lot in a day. After telling readers that sharks actually help protect some fish that swim near their heads to stay away from enemies, Rice states:

> Sharks remind us that there is some good in everyone. They also remind us not to believe everything we hear about someone. (no page numbers)

There are over 20 interpretations like these in this book. They make me pause to consider if they truly are scientific interpretations and consequently they do provide valuable opportunities for discussion.

*Values: Environmental Stewardship*

At times the teachers' selection and use of books reflected the role of values in science, especially the importance of environmental stewardship. This effort was consciously undertaken from the beginning of their collaborative grant work. Even in their grant proposal they described their wish for students to be maintaining and enhancing the plant and wildlife habitats in the school's Outdoor Education Center.

This vision carried throughout the school year. For example, when a small group of second and fifth graders met with Jody, they expressed a strong desire to do something to help improve the pond. With guidance from Jody, they decided to first find out the history of the pond and create a good inventory of its current status through observations and the use of books. From there they would create a vision for the future by working with experts and by reading and then they would choose one thing to do to move towards this vision. Similar work happened in groups interested in improving the butterfly habitat, growing a garden, and enhancing salamander habitat.

Jeff led his class to think about values while reading a short nonfiction article *A Lifeline for Lions* (Turner, 2004). The article describes challenges faced by lions in the Serengeti wildlife park in Tanzania. A distemper outbreak in the 1990's infected over ninety percent of the lions and approximately one-third of the lions died. Distemper had spread from dogs into the wildlife community. Concerned people from around the world raised money and made it possible to vaccinate dogs in the area. Within three years the lion population had rebounded. Jeff's class read the article one day and returned to it the next day while I was visiting.

> The fourth grade class sits in a circle by the white board on the side of the room. There is a class-made poster sitting on the white board ledge. It has three columns: Important Facts, Questions, Responses. Each section is full of post-it notes with students' writing. Above this chart, Jeff has written, "Important Facts, Questions, Responses, and Author's Purpose?"
>
> Jeff briefly reviews the work the students did yesterday with facts, questions, and responses. He asks the students to now think about what the author's purpose might be in the story. Students pair up and share ideas. After a few minutes, Jeff gathers their attention and he calls on people to begin the class discussion. Several students contribute to the conversation. Collectively the group decides the author may want to provide information that will help keep the lions safe, that she may want to motivate readers to help the lions, and that she may want to encourage readers to have their pets get shots. (fieldnotes, February 25, 2005)

As Jeff later told me, the students seemed genuinely interested and concerned about the health of the lions.

A few weeks later Jeff's class read *The Great Kapok Tree: A Tale of the Amazon Rain Forest* (Cherry, 1990). In this text animals in the rain forest try to convince a man not to cut down the trees. Jeff explained to me that students were quick to agree with the animals and to condemn the destruction of rain forest habitat. In order to deepen their thinking, he pretended to be the person in the story and asked if it might ever be acceptable to cut down the trees. What if he needed money for food or to fix the roof on his family's house? The students started to see that the situation might be more complex than they originally thought.

The books included in this study have numerous calls for environmental stewardship. Many of the books encourage readers to enhance wildlife habitat by planting, creating shelter, or feeding animals. *Eyewitness Explorers: Birds* (Bailey & Burnie, 1992), for example, provides step-by-step directions for creating a birdbath and a simple birdfeeder. Other books direct readers to treat animals kindly. At times books directly tell readers it is their responsibility to be environmental stewards.

> **Who Can Help?**
> It is not someone else's job to clean up and protect our lakes and ponds. We each have the capacity and the responsibility to take action ourselves. Go Wetland Patrol! (Pratt-Serafini, 2000, introduction)

Sometimes the texts show how our values change over time. Such is the case in this excerpt from the *Peterson First Guides: Reptiles and Amphibians* (Conant, Stebbins & Collins, 1992).

> Time was when the only good snake was a dead one. Fortunately, as we have come to understand that every species has a place in the global environment, that attitude is almost a thing of the past. We now know that the fear of reptiles and amphibians is not instinctive, but is learned by children, usually from people who are simply uninformed. The fact is that many of these animals make excellent neighbors because they eat rodents or insects. (p. 4)

When addressing environmental topics, books can at times generate different points of view about complex issues. When discussing dangers birds face, Davies (2003) states, “People are bad news for birds.” Davies goes on to create a case for her statement, but also for the idea that people can be good news for birds. Davies describes wild parrots being caught and sold as pets, oil spills affecting birds, the near extinction of Californian condors, and the effects of deforestation on Philippine eagles. She also tells how people can and have made a difference—by not buying pets taken from the wild, by cleaning birds affected by oil spills, by breeding condors in zoos, and by protecting habitats. Sections like this can be excellent discussion starters.

*Diverse Views of the Natural World and Science*

While not a common occurrence in the data collected, on a few notable occasions we are able to see the teachers’ desire to present diverse views of the natural world and science. Charlie chose to read *The Talking Earth* (George, 1983) with her fifth grade students. She explained that in addition to teaching students about the everglades, the book does important work in exposing students to Seminole culture. The following two passages illustrate how the text promotes questioning of how a person knows about the world. In the first passage the village’s medicine man Charlie Wind is speaking to Billie Wind, the thirteen-year-old main character.

> “You are too practical,” he said. “That is the white man’s trait. There is more to the Earth than only the things you can see with your eyes.” (p. 5)

In the second passage Billie Wind is talking to her older sister Mary Wind. Mary Wind has told Charlie Wind that Billie Wind doubts several Seminole beliefs including the existence of animal gods that talk and the existence of little people who live underground and trick the Seminole people.

> "Why did you tell Charlie Wind on me?"
> "Because you are too scientific. You are realistic like the white men."
> "I see what I see. What I don't see, I don't believe."
> "You were not that way before you went to the school at the Kennedy Space Center when our father worked for the scientists."
> "That's not true. I've always been curious. I want answers, not legends. What is the matter with that?"
> "What is the matter with that? I'll tell you. Someday you will be head of your family and you'll need to know more than facts." (p. 11)

Later in the story Billie Wind begins to understand how these beliefs came to be. This fictional text creates opportunities to discuss what science is and how culture influences our understandings. It would be an effective resource in helping students see the value of drawing upon indigenous knowledge, views, and culture.

Gary Paulsen's *Dogsong* (1985) could be used in a similar way. Jeff read to his fourth grade class this text about an Eskimo boy Russel who is searching to find his way. With initial guidance from the village's shaman, Russel sets off on a journey that allows him to reconnect with the old ways of his people. Russel uses his observations of and experiences in the natural world to survive the harsh elements, to connect to his culture and the environment, and eventually to come to peace.

*Science in Our Lives*

Instead of a portrayal of science as information disconnected from students' experiences, all three teachers presented science as part of people's lives. This was seen in Jeff's classroom when they were studying flight and one of his fourth grade students and her father brought in their pet cockatiel so the class could observe a bird up close. In Jody's work with small groups of students she often encouraged them to ask questions about their immediate surroundings. On one day this led a second grade boy to decide to investigate where "the hidden bird nests around the school" are located. Charlie built lessons around a current event—the eruption of Mount St. Helens volcano. In addition to having small groups of students read up-to-the-minute news articles from the internet, Charlie read aloud *Volcano: The Eruption and Healing of Mount St. Helens* (Lauber, 1986) to help students understand the science of this volcano. The book was written after the eruptions in the 1980's.

> For well over a hundred years the volcano slept. Each spring, as winter snows melted, its slopes seemed to come alive. Wildflowers bloomed in meadows. Bees gathered pollen and nectar. Birds fed, found mates, and built nests. Bears lumbered out of their dens. Herds of elk and deer feasted on fresh green shoots. Thousands of people came to hike, picnic, camp, fish, paint, bird-watch, or just enjoy the scenery. Logging crews felled tall trees and planted seedlings.
>
> These people knew that Mount St. Helens was a volcano, but they did not fear it. To them it was simply a green and pleasant mountain, where forests of firs stretched up the slopes and streams ran clear and cold.
>
> The mountain did not seem so trustworthy to geologists, scientists who study the earth. They knew that Mount St. Helens was dangerous. It was a young volcano and one of the most active in the Cascade Range. In 1975 two geologists finished a study of the volcano's past eruptions. They predicted that Mount St. Helens would erupt again within 100 years, perhaps before the year 2000.
>
> The geologists were right… (p. 2-4)

Clearly this text is more interesting to read when the volcano is once again erupting and impacting people's lives.

Similarly, as previously mentioned, Charlie's class read *The Talking Earth* (George, 1983) during hurricane season. In this fictional text the main character, Billie Wind, is a Seminole girl who experiences a hurricane while away from her family and village. Scenes in the text helped students understand the phenomenon of a hurricane as well as the potential impact. The author describes wind-gusted rain stinging Billie Wind's face, a fast-paced mission to find high land to escape rising tides, and a panicked search for shelter in the midst of the storm.

Charlie also discussed her idea about reading aloud *How Groundhog's Garden Grew* (Cherry, 2003) and having students use information from the book to grow their own vegetable garden. This fantasy picture book tells the story of a groundhog who is taught by a squirrel to grow his own garden. While the text is clearly fictional, the story is embedded with considerable usable information about gardening—information about gathering seeds and tubers in the fall, planting in the spring, the needs of plants, the importance of pollination, and how seeds turn into plants and grow flowers and fruits. The following passage, for example, contains information about how to arrange a garden so plants' needs are met.

> Squirrel told Little Groundhog, "Plants need lots of sun. We'll plant taller vegetables in the back so they won't case a shadow over the shorter ones."
>
> So behind the row of root crops, they planted seeds of tomatoes, peppers, and leafy greens.
>
> "Some vegetables grow on vines," said Squirrel. She pounded sticks into the ground for peas and bean plants to climb.
>
> "Some plants grow very big," said Squirrel. They planted the seeds of pumpkins, zucchini, yellow squash, sunflowers, corn, and artichokes far apart to give them lots of room to grow." (no page numbers)

When students plan their own garden to grow, they can use this book as a reference. Real world connections to the lives of people make these books and science topics especially meaningful.

One of the most frequent ways the teachers portrayed the role of science in our lives was by having students actively engaged in learning about the natural world. As will be shown in the themes that follow, students regularly used books as part of firsthand investigation and as resources to help learn what others have already discovered about the natural world. They were doing the work that scientists do and consequently directly experiencing that science is something people, themselves included, do.

Books help show that scientific understandings are created by people. In *Volcano: The Eruption and Healing of Mount St. Helens*, Lauber (1986) paints a picture of scientists collecting information and seeking to understand.

> Geologists were hard at work on the waking volcano. They took samples of ash and gases, hoping to find clues to what was happening inside. They placed instruments on the mountain to record earthquakes and the tilting of ground. They kept measuring the bulge. (p. 5)

Texts also share stories of specific people doing science, such as in *Fast Elephants* (Myers, 2004).

> Dr. John Hutchinson went to Thailand with a team of scientists to study a question about fast-moving elephants: are they running, or are they just walking fast?... The team was able to study 42 elephants. First, they used a harmless paint to mark spots on the elephants' bodies, as you can see in the photo. That way, videos would show how their feet, legs, hips, and shoulders were moving. The scientists marked off a course of 30 meters (about 30 yards) long. It was easy for a mahout to use a little coaxing and cheerleading to get his elephant hurrying over the course. Once the elephant got up to speed, the scientists took videos and timed the elephant." (p. 8-9)

*Race, Culture and Gender*

When looking at the set of books in this study, it is important to consider issues connected to race, culture and gender. Almost seventy-five percent of the texts include people, reinforcing the idea that science is a human endeavor. As shown in Figures 4.2 and 4.3, just under half of these books with people include different races and just over seventy percent include both females and males. In the books with only one race represented, eighty percent have only white people. The other races represented in the texts include Native people, Hispanics, and African Americans.

Despite these numbers one is hard pressed to find in these books portrayals of people other than white men as leaders in the field of science. The scientists photographed in Lauber's *Volcano: The Eruption and Healing of Mount St. Helens* (1986) all appear to be white men, although it is hard to see the details for people in the distance. The famous scientists referred to in *Science Verse* (Scieszka & Smith, 2004) are Newton and Darwin. Poems in *Flicker Flash* (Graham, 1999) mention Thomas Edison and Benjamin Franklin. *Eyewitness Science: Light* (Burnie, 1992) refers to approximately 40 white men who are scientists, discoverers, and inventors. Other than these men, I found reference to only two additional people in the text, white women. One is shown in an illustration in a section of the book describing how telephones work. Her feet are up and she is leaning on a table while leisurely talking on the phone. The other is in an illustration of an advertisement from the early 1900's. She is carrying a birthday cake with electric lights.

Throughout the text *Science Works! Light* (Parker, 1997) describes the work of 25 different scientists—all men. Where illustrations of the scientists do exist, the people appear to be white. The book does have pictures of both boys and girls doing

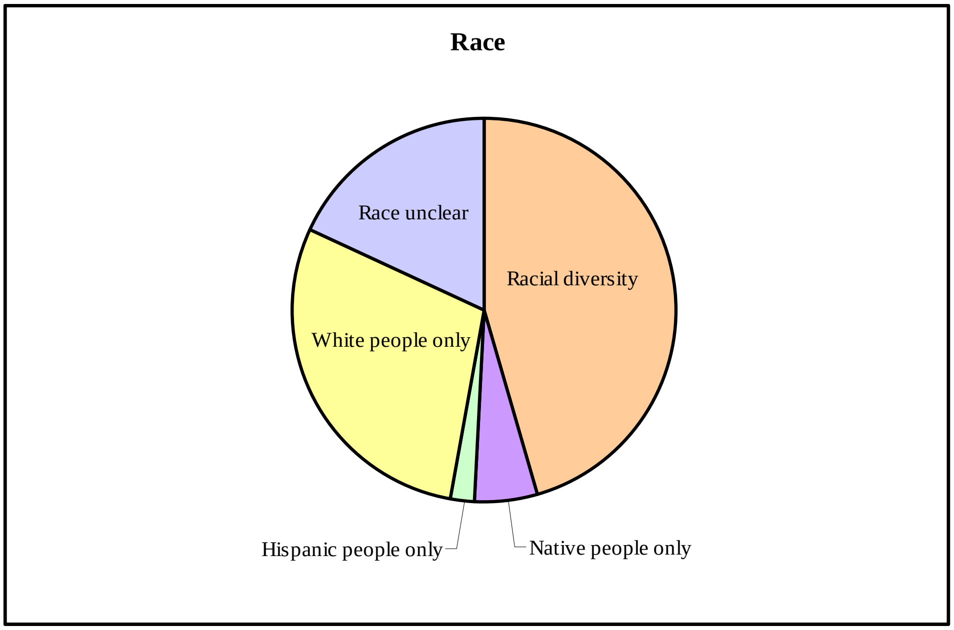



*Figure 4.2.* Racial representation in the trade books from this study that include people.

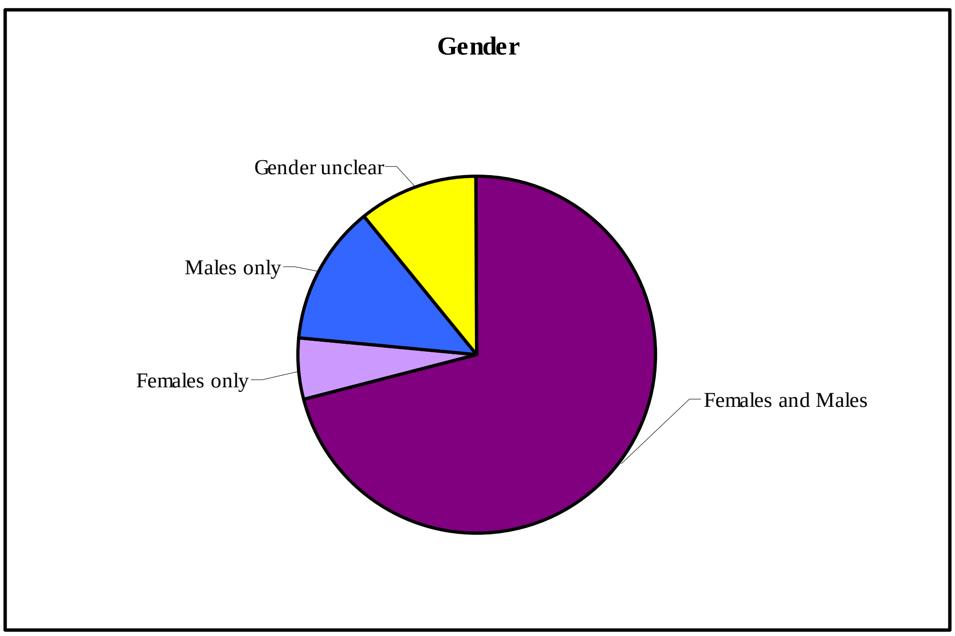



*Figure 4.3.* Gender representation in the trade books from this study that include people.

experiments described in the "Do-It-Yourself" panels. It includes one illustration of a woman of color sitting next to an oil lamp and sewing. The caption says:

> Long ago, people used water-filled bowls as magnifying lenses for detailed tasks such as sewing and lacemaking. This device became known as a lacemaker's condenser. (p. 35)

In the previously mentioned *Reader's Digest Pathfinders: Birds* (Brinkley, 2000), there are seventeen *Inside Stories* that tell about people who have committed their lives to studying birds. While ten of these stories focus on white men, five do focus on white women. In them we learn about:

- Roxie Laybourne, an expert in identifying bird species from just a few feathers
- Marie Reed, who has successfully photographed birds in their natural surroundings
- Rose Ann Rowlett, who has organized birding expeditions around the world for over 20 years
- Rachel Carson, who wrote about the effects of insecticides on the food chain
- Marjorie Stoneham Douglas, who worked to conserve the Everglades

One *Inside Story* that does show different cultures begins by telling about tribes in Papua New Guinea who kill birds and use the feathers for decoration. The accompanying photograph shows a man ornately decorated with these feathers. The text gives credit to tribes that leave younger birds to reproduce and instead only kill a few older male birds. It goes on to say that other cultures are not as responsible. The rest of the inside story tells of large numbers of birds being shot in the 1800's due to feathers being fashionable and praises the American Audubon Societies for their work to protect birds. I hope the text encourages readers to think carefully about which people are being portrayed as irresponsible and which people are portrayed as the protectors of birds.

The *Inside Story* called *A Journey of Discovery* tells of Lewis and Clark's expedition to find a way to get to the Pacific Ocean from the Mississippi River. This story mentions the help they received from Sacagawea, a Shoshoni guide who is illustrated in the accompanying drawing with Lewis and Clark. The passage explains that Lewis and Clark were careful wildlife observers, that they shared their discoveries with people back east, and that two bird species were named after them. While the story does mention Sacagawea, she plays a small role in the text—one that seems like a side note. The true focus is on Lewis and Clark.

Sections like these cause me to pause and contemplate how race, culture, and gender are represented in science and in these books. There is considerable opportunity to encourage critical thought.

Information about the number of books addressing the different aspects of science as a human endeavor can be found in Table 4.1. Triangulation of data for the theme is demonstrated in Table 4.2. As seen in the data presented and analyzed for this theme, the books and the teachers' uses of them have portrayed science as a human endeavor.

**Theme 2—Firsthand Investigation: Empirical Evidence Underlies Scientific Understanding**

While books helped portray science as a human endeavor, they also were used to support firsthand investigation of the natural world and the idea that observable empirical

Table 4.1: *Number of Books Addressing Elements of Science as a Human Endeavor*

| **Element of Science as a Human Endeavor** | **# of Texts** |
|---|---|
| Fascination, passion, interest | 60 |
| Imagination and creativity | 39 |
| Values: Environmental stewardship | 36 |
| Diverse views of the natural world/science | 3 |
| Science in our lives | 60 |

Table 4.2: *Triangulation of Data Analysis for Theme 1—Science as a Human Endeavor**

| Case | MO | O | I | D | T |
|---|---|---|---|---|---|
| **1: CB** | 2 | 2, 14, 24 | 1, 11, 13, 16 | 1, 27, 35 | 3, 4, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 33, 34, 35, 36, 37, 38, 39, 40, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 69, 70, 71, 72, 73, 74, 75, 76 |
| **2: JS** | 2 | 1, 5, 13, 21 | 3, 5, 9, 12, 15 | 1, 3, 5, 17 | 9, 39, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68 |
| **3: JW** | 2 | 2, 10, 14, 17, 19, 22, 23, 24 | 2, 14 | 1, 21 | 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30, 31, 33, 34, 35, 36, 37, 38 |
| *Using Codes from the audit trail (See Appendix C.)<br>MO: Meeting Observation<br>O: Observation of Teaching<br>I: Interview<br>D: Document<br>T: Trade Book | | | | | |

evidence underlies scientific understanding. The books and the teachers' use of them promoted observation and journaling, identification of questions to investigate and procedures to use, reasonable interpretations of results, and application of inferential thinking as elements of empirical evidence.

*Observation and Journaling*

The importance of observation and journaling surfaced early in the school year when the three participants met to discuss their grant work. Charlie pulled out a stack of books as examples and Jeff asked how the books might be used. They brainstormed ideas that included teaching about careful observation of the natural world, recording of details, and the role of illustrations. They decided that some of the books might prompt writing and drawing in science journals.

A few months later the teachers met again and shared their work with observation and journaling. All participants had been using examples of journal entries from *Keeping a Nature Journal* (Leslie & Roth, 2000) and from their own personal journals. Charlie and Jody's classes had been working together on helping students sketch an overall picture and then drawing a magnified view of a section. I observed Charlie and Jody using ideas directly from *Keeping a Nature Journal* to teach drawing techniques to their classes. They encouraged students to try sketching the outside edge of an object first and to keep their pencils on the paper as they did this. Then students were prompted to add details such as leaf veins and colors with more than just one shade of green or red. Jeff did similar work as can be seen in the following vignette.

Jeff gathers his students in the front of the room where they sit on the floor near five new handwritten charts about nature journals. The charts describe data to observe, written observations to make, drawings to include, and reflection questions to consider. Several of Jeff's students have copied the information from charts in Charlie's room. Charlie adapted them from charts Jody originally created.

Jeff points out the chart about detailed drawings. He discusses the need to include detailed, accurate drawings that include magnified views and color. He displays a page from *Keeping a Nature Journal* (Leslie & Roth, 2000) on the overhead. It has numerous sketches of different objects along with handwriting. Jeff describes the sketch of leaves and a bud. He points out the veins in the leaves, the texture as represented by black dots, the point at the end of the leaf, and lines on buds. He asks students to discuss another sketch of a leaf on the overhead. They see several things such as veins, points, shading, and curved stems. Jeff talks about the materials they'll need for their drawings—sharp colored pencils.

The lesson moves onto the charts about data to collect and record when observing: the date, time, place, weather conditions, and written observations. Jeff talks about using your senses and writing both qualitative and quantitative information. He encourages them to count, compare, measure and describe—reinforcing the need for detailed drawing and providing examples along the way.

Students move and gather around the horseshoe table where Jeff models a journal entry. He has a curled up a leaf, colored pencils and a regular pencil. He shows his entry from a previous day. As he draws the leaf, Jeff talks about the stem really needing to be represented as 2 lines, not just one. He explains how he looks back and forth from the leaf to his drawing as he sketches. He asks students about words to add. Students say that they can write the place the leaf was collected, the weather conditions including temperature, cloud cover and wind, and the questions they have about the leaf. Jeff reinforces the need to be good observers. He tells them that scientists are good observers. Observations lead to questions which lead to research.

Following Jeff's directions, the students gather up Ziploc bags, magnifying glasses, colored pencils, and science journals. The class lines up by the door. Jeff takes a moment to shares a student's entry from the previous day as another model. She has included observation data, questions, and a small drawing. He notes that they might make their new pictures larger so they can add detail.

Jeff tells them he is about to enter the "fussing part." He tells the students it is not lunch time and that there should not be a pack of wandering boys. They each need to find a place "just for you" and sit down and look carefully. He tells them this is not lunch and not recess. It is "thinking deeply about something time."

The class walks outside to the meadow. Tall wildflowers, 3 to 4 feet tall, fill the field. Black-eyed Susans, Queen Anne's lace and pokeweed are

> blooming. Jeff tells students they can share at the end of their outside time during the last 10 minutes. Now they should spread out, find their own space, observe and record.
>
> Soon most students are sitting down and settled in, observing, and drawing. Some are collecting plants and seeds. Some pick many (10+) seeds off a plant. Some pick whole plants. Others pick flowers. Jeff does his own observation and journal entry and also checks in with students. He has some add more details to pictures. A girl focuses in on a seedpod. She peels back a papery layer and finds a berry-like structure inside. She tells me it seems like a tomato. She opens up this "berry" and finds tiny seeds inside. She looks intently at her findings and then draws and writes in her journal. A few people see a cricket and try to catch it.
>
> Jeff gathers the group together in the shorter grassy area surrounding the meadow. He reminds them to make sure they have both words and pictures in their entries. He asks them to work on having scientific questions. Students then go back into the meadow to share what they found with each other.
>
> Ten minutes pass. The class gathers again and returns to the classroom. Jeff reads aloud parts of the chart about data to record—date, time, place, weather. He reminds students to make sure they have these things written in their journals. They look over their work and make additions as needed. (fieldnotes, October 6, 2004)

Later in the year Jody used *Salamander Rain: A Lake and Pond Journal* (Pratt-Serafini, 2000) to give a small group of students interested in salamanders ideas for journal writing. This informational text blends nonfiction and realistic fiction and encourages the gathering and recording of data. The book's pages are collages of large illustrations, illustrations of magnified views, hand written journal entries on what appears to be notebook paper, newspaper articles, interview excerpts, and natural history facts. The journal entries include observations, reflections, and questions. For example:

> May 9
> This afternoon I went to check on the animals at Salamander Rain pool again. It's much bigger now from all the rain, and so are the baby salamanders! The Bullfrog tadpoles in our pond are just getting their front legs now, but the Woodfrog tadpoles are almost finished turning into frogs already. They still have tails like fish, but now they also have powerful jumping legs like land animals. Why are they in such a big hurry to jump around the land?

> P.S. I also noticed some small sparkly animals called Fairy Shrimp. They were floating on their backs and paddling along like tiny boats. What are shrimp doing in fresh water? I thought they lived in the ocean! (no page numbers)

Journal entries such as this one demonstrated possible ways to observe and to capture observations in writing, guiding students in the gathering and recording of empirical data. The text creates opportunities to discuss observation strategies such as when to observe, equipment to use, the benefits of paying attention to both physical characteristics and behaviors of animals, the need to observe quietly, and the value of paying attention to sounds. It also opens the door to discuss identification strategies such as noting physical characteristics including size, color and patterns and behavioral characteristics such as hunting strategies.

Pratt-Serafini also wrote *Saguaro Moon* (2002) in this style. Charlie used it several times to remind students to include accurate detail in their journaling, both in words and illustrations. This happened in an observation of Jody and Charlie’s class during a “reading buddy” session.

> Charlie holds up the *Saguaro Moon* book and shows the students an example of a drawing with a magnified view. She talks about making things the right color and drawing exactly what they see. She reminds them that they are not making things up as they might sometimes. Instead they are recording what is really there. Charlie tells the students that they will be doing outside observations and journal entries next week. (fieldnotes, March 11, 2005)

Similarly Charlie used *One Small Square: Swamp* (Silver, 1997) to model detailed observation. Silver takes readers on a close-up look of one small square of several kinds of swamps, encouraging them to slow down and look closely.

> What’s sparkling in the small square? If you were on the boardwalk, you could kneel down for a closer look. It’s a sundew plant with very odd leaves. At the

> end of their thin stalks they are covered with clear, gooey drops that glisten in the sunlight.
>
> A fly circling a leaf senses that the drops are as sweet as honey. It lands, hungry for a meal, only to find that the drops are as sticky as glue.
>
> The fly tries to free itself, but it is too late. The drops just won't let go. The harder the fly tries to escape, the more drops it touches. Soon the stalks and leaf slowly curl in over the helpless insect. Say good-bye, fly! Over the next week the leaf will give off juices that turn the fly's insides into a liquid it can soak up. (Fly By or Bye Fly)

In this text illustrations of big picture views are accompanied by magnified views of some components. For example a two-page spread showing a Cyprus swamp includes a close-up view of bald cypress knees and roots, once again showing possibilities for students own journals.

At times books were used prior to firsthand investigation in order to prepare the students for this work. Jeff helped his students develop observation skills using the introductory section of the *Peterson First Guides: Birds* (Peterson, 1986). He has many copies of the book so students could work with two people per book. With the whole class Jeff read through the introduction including the sections on parts of the bird and how to identify them. This helped the students think about the bird's size, shape, wing patterns, tail, bill, field marks, wing bars, crests, eye-stripes and eye-rings, silhouettes, mode of travel and overall behavior. After reading the book, Jeff's class went out and looked for birds on several occasions.

Other times books were used to teach into a need discovered in the midst of firsthand investigation. At one point Jody and Charlie recognized that their students could use help with including both qualitative and quantitative data in their observations and journals. Charlie attended a workshop at the National Science Teachers Association annual conference that prompted the following lessons.

> Jody has several books picked out that she'll be using with the students. They include *Biggest, Strongest, Fastest* (Jenkins, 1995), *Is a Blue Whale the Biggest Thing There Is?* (Wells, 1993), *What's Faster Than a Speeding Cheetah?* (Wells, 1997), and *What's Smaller Than a Pygmy Shrew?* (Wells, 1995). Jody makes a chart and puts it on the white board by their meeting area. They chart has two columns: Using Your 5 Senses and Measuring & Counting.
>
> Jody tells the students to get their science journals and to sit on the carpet in their meeting areas. She has students turn to the pages where they cut out pictures last week. Jody asks the students to look up at her. She points to the chart on the board. She tells them that "Using Your 5 Senses" is often qualitative and "Measuring and Counting" is quantitative. A boy tells her she has it backwards. Jody tells him that she is right. She remembers quantitative by the word quantity.
>
> Jody asks the class to name the 5 senses. They raise their hands and she calls on one student at a time. As they share, she writes on the chart: Hearing, Tasting, Seeing, Touching, Smelling. She asks students what pictures they put and what sense they match. They are eager to share. A boy put a fish for smell. Someone put potato chips for taste. Another person put a leaf for touch, elaborating by saying that crunchy for a leaf that fell off and leathery for one you take off a tree. A student put a van for hearing the motor. A girl shares about a picture with two girls holding hands and swimming. She said that they can feel each other's hands, feel the water, and feel their goggles.
>
> They move onto measuring and counting. "What did you get?" asks Jody. A boy put an inflatable boat and said he could measure how much air it could hold, how far it could go, how many people it could hold, and how long the boat is. A girl put a road. JW asks what she could measure. They share ideas: How many motorcycles pass, how long the road is, how many hours it would take to pave it… Jody adds, "That's interesting." A girl put a house. They discuss that they might want to know how big it is if people are moving in. Are there enough bedrooms? A boy put a dresser. He said that he would measure it with a long ruler.
>
> "What would you measure?"
>
> "The length."
>
> "Why?"
>
> "To see if it would fit through a door."
>
> "To see how many clothes could fit in it."
>
> "Okay, one more."
>
> A girl shares that you could measure a tooth. She adds that maybe you could tell if it is a baby tooth or an adult tooth. Jody shares that on the fox skull she has they sometimes look at the teeth to tell how old the fox is.

Jody tells students to close their journals. She reads the title of the book—*Biggest, Strongest, Fastest* (Jenkins, 1995). She explains that she will read a part aloud and they'll think about if it is qualitative or quantitative. She starts with the elephant page.

> The African elephant is the biggest land animal. The largest elephant ever measured was more than 13 feet tall and weighed 22,000 pounds. An African elephant eats over 300 pounds of grass or leaves every day.

With Jody's prompting they decide that 13 feet tall, weighing 22,000 pounds, and eating over 300 pounds of grass are all quantitative measures.

They move onto the ant page. Jody instructs students to listen carefully. "The strongest animal for its size is the ant. An ant can carry five times its own weight. A strong man can carry something that weighs about as much as he does." They talk about how the ant can lift 5 ants but a person could not lift 5 people. Students react aloud.

The giraffe page comes next. Someone shares that you could measure the legs and the tail. Jody asks, "What could you measure about them?" Students reply how long the legs are and how much the giraffe weighs.

This class reads one more page, a page about the blue whale. Without prompting, students say that you can measure how long it is. They notice that the picture goes over several pages. Jody reads how long blue whales are and how much they weigh. A boy says that is as far as here to that wall. Jody tells him that it is a lot longer than just to the wall. She reads a sentence that compare the blue whale to dinosaurs, saying that the blue whale is bigger than even the largest dinosaurs were.

Jody asks students to fix in their journals the labels qualitative and quantitative because some students put the words on the wrong sides. She asks students to clear their desks except for their journals. She has two students pass out scissors and glue to students who look ready. They continue to add pictures cut out from magazines, place them on the qualitative or quantitative side, and write what could be observed, counted, or measured.

Soon Charlie's class arrives. Her students find their buddies and sit down with them. Some sit on the floor. Others pull up chairs. She reviews the assignment with the two classes and returns to *Biggest, Fastest, Strongest.* She reads about the shrew. She models with her fingers how long the shrew is (2.5 inches long). It weighs less than a teaspoon. She continues on to the hummingbird page, reads it aloud and asks which of the pieces of information is quantitative. Students correctly say $1/30^{th}$ of an ounce. Similar read aloud and discussion happens for several more pages.

Students continue their work finding pictures and adding them to their journals in the correct spots. Charlie and Jody remind students to write sentences and to be specific. "Write exactly what you see." Instead of just writing, "I see a flower" Charlie encourages a sentence that says "There are blue irises." Students move around the room gathering magazines and catalogs. Charlie encourages a girl to not just say "I can measure the number of strings." She wants her to say,

> "The guitar has 6 strings." Once again she reminds the students to write specific observations. (fieldnotes, April 6, 2005)

In future work with students Charlie and Jody referred to this lesson as a way to prompt more detailed observations and science journal writing that includes both qualitative and quantitative information.

In our final interview I asked Charlie to share ways she saw the books influence her students' thinking. She replied:

> I think their writing. Their observations. I think that influenced them on being more detailed in their drawings because we used those books so much early on and I think that was the biggest influence… We really tried to center on that for them. (interview transcript, May 12, 2005)

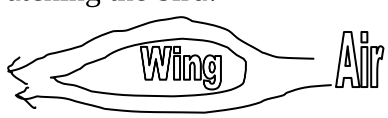
*Sparking Interest in Firsthand Investigation*

Rather than teaching specific strategies for gathering empirical evidence, books were sometimes used to build interest and content knowledge in a topic that would be studied through observation and experimentation.

Jody worked with her intern Melissa to teach a unit about weather. Most every lesson in this unit began with reading a book aloud to students in order to spark interest and introduce or reinforce ideas and then continued on to involve the students in an investigation. The books and investigations were accompanied by discussions, journal writing and drawing, and data analysis. *Rain* (Palmer, 1995) and *Rain, Snow, and Ice* (Merk & Merk, 1994) taught about precipitation and were part of lessons that involved making, using and analyzing data from rain gauges. *Feel the Wind* (Dorros, 1989), *Weather Everywhere* (Casey, 1995) and *See for Yourself: Wind* (Davies & Oldfield, 1996) were all used in lessons that focused on what wind is and ways we observe and measure it.  Students made their own wind vanes and anemometers and used them to collect data outside their classroom.

As described earlier, Charlie was able to use *The Talking Earth* (George, 1983) to introduce a study of hurricanes.  In the text the main character is alone outside when a hurricane hits and she needs to deal with all its elements.  Her students read this book in the fall during a particularly harsh hurricane season.  The book naturally led into weather monitoring and hurricane tracking.

Jeff began a unit on flight by reading aloud books about the Wright brothers (Joseph, 1997; Parker, 1995).  These books, along with looking at related websites, built students interests and gave them knowledge that helped in building scale models of the Wright brothers' plane and in conducting inquiries related to paper airplanes.  As students were building their model planes, I asked Jeff if they would be test flying them. Jeff asked a nearby student to tell me why they would not be.  She explained that the wings and the bars between the wings in the model are not the right shape to catch the wind.  When I asked Jeff how she knew this, he said they discussed it while reading aloud.   The books describe problems the Wright brothers had in creating lift, controlling their glider, and powering it.  The brothers gathered all the information they could—from what other people had already discovered, by looking at boats, and by studying birds. They used this information to design and build their plane.  Warped wings created a lift when air flowed over them, rudders helped with control, and a propeller helped with power.  These ideas became even clearer to students when they were able to observe a bird up close. As previously mentioned, I visited the class when a girl's father brought in her pet cockatiel.

> Cheeky is 26-year old pink and white cockatiel. When he arrives, Jeff pauses a math lesson and the class gathers on the carpet near the bird. Students sit in a circle. Most watch the bird intently while smiling. Jeff explains to the class that Cheeky is visiting today because of their work with flight. He asks students what they have been learning about wings and flight. Students share ideas about tails helping to steer and about needing a curved wing to help with flight. Jeff has students put their hands out in a curved way to model a hill on the wing. The parent explains that Cheeky is a bit agitated from the ride over. He doesn't want to get out. Jeff reminds students that the round shape they see in the wing gives you lift. He asks the students how the Wright brothers figured out the need for the round shape. A girl shares that the Wright brothers studied birds. Jeff affirms her answer and adds on that they were bird watchers for a long time. Jeff reminds the class that the Wright brothers had a propeller to help with lift.
>
> "What does the bird do instead?"
>
> Student answers that they flap their wings. They laugh at the idea of a plane with wings that flap.
>
> The bird whistles and chatters. Students watch Cheeky closely. They all are smiling. Jeff draws a picture on the board of a wing and how the air flows around it. He directs the class to look at the board as he explains, as they are all watching the bird!
>
> 
> 
>
> Jeff has students look at the bird's tail. They model the movement of the bird's tail with their hands. Jeff says that their model plane would not fly right and asks why. A girl responds that the plane is not quite right because it has flat wings and flat poles between the wings. Jeff asks for students to look at the bird's rounded parts like its head. He asks how that helps the bird. They say it helps the birds slip through the air.
>
> The parent, Jeff and the students realize the cockatiel does not want to come out. Jeff tells the students they can go up close to look for a few minutes. The parent explains that he would have liked to show the bird's wings but he is too agitated today. The students suggest they go to the other side of the room and maybe the bird will calm down. They return to their original locations from the math lesson and Jeff goes on with his lesson about division and estimation. Some students watch him. Others continue to look towards the bird. In about 3 minutes, the bird relaxes and comes out of the cage. The dad holds him for a minute and then puts him on top of the cage. Most students are now watching the math lesson which continues for about 10 minutes. Meanwhile the bird has

> calmed down. The parent spreads the bird's wing so students can see it. Jeff tells the girl whose bird is visiting that she can call a few students at a time to observe the cockatiel. (fieldnotes, January 19, 2005)

The original books about the Wright brothers built interest that guided and informed the model building, paper airplane inquiries, and bird observations. They also prompted additional reading related to flight. Jeff read aloud *Amelia and Eleanor Go For a Ride* (Ryan, 1999) to help set aviation in United States history and sections of *Project Ultraswan* (Osborn, 2002) to reinforce ideas about flight and animal adaptations.

On another occasion Jeff seized a teachable moment when his class was reading the nonfiction article *Fast Elephants* (Myers, 2004). The article tells about research conducted on elephant biomechanics. Elephants have a unique way of moving that blends characteristics of walking and running. To help put the elephants' movement into context, the author describes how people and horses move when walking and when running.

> It all seems so easy, but some big changes take place when you start to run. Without thinking, you change the way your feet hit the ground. In walking, one foot is always on the ground. In running, there is a short period of time when you are "coasting through the air" and neither foot is on the ground. Also, your up-and-down motion changes. In walking your body is highest when only one foot in on the ground. In running, your body is lowest when a foot is on the ground. (p. 8)

As students discussed this part of the article, a boy asked what this means. Jeff used his fingers to model walking compared to running. As they read on, the author describes elephants' movement as captured on video.

> Elephants always kept at least one foot on the ground and never changed the up-and-down footfall pattern shown by the videos. The easiest way to describe their movement is to say that when an elephant is moving fast, its hips and hind legs seem to be running but its shoulders and front legs seem to be walking. (p. 9)

Again this prompted questions so Jeff modeled the motion with his hands. When they finished discussing the article, he decided to take the students outside to the track so they could observe their own foot placement and movement and body height while walking and running. Several students decided to try moving like an elephant as well.

*Identifying Questions and Developing Procedures to Gather Empirical Data*

The teachers used books as a way to follow-up on firsthand observations and to give students ideas to pursue for ongoing investigations in their areas of interest. Charlie shared this work in one of our interviews.

> Jody and I had our kids come together and think about all the different places they've observed because we just let them have a lot of freedom in observing and going to different places. "What is the thing that you like the most that you think you'd like to study?" And then they have the books, right now they're in tubs by category. And they started looking through those to see if they found something they'd really like. So they're starting to formulate where they are going to focus. (interview transcript, January 4, 2005)

This idea came to life one day when Jody and Charlie's classes were working together. The previous week small groups of students had identified questions they were interested in investigating about their self-selected areas.

> Charlie's students have just returned to their classroom from lunch. The twelve students are sitting at four tables. As usual, evidence of ongoing projects fills the classroom. Tubs and tubs of books are piled on tables. They are labeled with different science topics such as birds, reptiles and amphibians, and pond/river.
>
> Charlie explains to her class that they will be looking through the questions they generated last week to identify a few questions they could actually test or experiment or observe to answer.
>
> "Think about things you can actually do outside here at school. On the back of your sheet record your questions—2 or 3 that you can actually work on."
>
> Charlie goes on to tell them that they actually only need one question for their project.

"If you have time, you'll also think about where you'll do this and what materials you'll need."

Charlie explains that she and Jody will look over their questions and work with them to get projects started over the next week or so. Charlie tells them that she has chosen to keep things open on purpose, as long as their ideas are manageable to do in school.

A student asks if they can start researching if they are reading today. Charlie says yes. She tells them to let her know if they need resources including books because she will be ordering some over the next week.

Jody's class arrives, and the students find their buddies. They enter quietly but start talking once they find their partners. Once quieted down, Charlie explains to the second graders what they'll be doing, sharing the same ideas she just told the fifth graders. Charlie reminds the students to write down the questions they are choosing and to write down materials they will need, if they have time.

The students break into groups. Some are at tables and others sit on the floor. They chat and read over their notes. After just a few minutes, several groups have picked questions. Students start getting books from the nearby tubs to help them plan their experiments.

A smiling girl runs up to me with the book *Gardens for Birds, Hummingbirds, and Butterflies*. The prior week I visited Jody's class while she met with a small group that talked about birds. The girl tells me that this is the book that she told me about then, the one that helped her identify plants for hummingbirds.

Soon all of the students have books out and are looking for information connected to their topics. They get books from the many tubs and from another shelf in the room with Charlie's guidance. Some flip quickly through pages while others read more slowly.

The girl from above returns to show me a picture of a hummingbird feeder. She tells me she would like to have one of those too—to put water and sugar and red food coloring in for the birds. I tell her that sounds like a good idea and share that I have heard you do not need the red coloring. We talk about how it might be interesting to compare red and clear liquid in two different feeders.

The volume increases in the room. Many students are moving around the room, looking through books, and talking to each other. As their work time winds down, Jody, Charlie and I ask the students to stack up the books they used today to help them plan. The twenty books include informational texts about plants, animals, ecosystems, gardening, nature watching, and journaling as well as field guides. We want to see what they chose to read.

The second graders leave and the volume decreases rapidly. Charlie's students return to their desks. She tells her class that she and Jody will meet with the groups next week to plan more carefully. (fieldnotes, February 25, 2005)

At the end of this lesson, Charlie and I asked her students if anyone found books to be especially helpful in identifying their questions and planning their investigations. Several did. Lenny used *Take-Along Guide: Snakes, Salamanders, and Lizards* (Burns, 1995) to get tips for finding and attracting salamanders including where they live, what they eat, and what they look like. Jeff found similar information about salamanders in *Watching Nature* (Russo, 1998). Ed looked up beetles in *A Golden Guide: Insects, Revised and Updated* (Zim & Cottam, 2001). The maps helped him figure out which species live in the area and as a result might be studied in the schoolyard. *One Small Square: Swamp* (Silver, 1997) led Nick to think about the different plants and insects that live in water and to wonder if any birds lay eggs beside the creek near the school and how many different kinds of fish live in their pond. From *Stokes Butterfly Book: The Complete Guide to Butterfly Gardening, Identification, and Behavior* (Stokes et al., 1991), Pam learned how to create a butterfly garden, the need to grow lots of nectar plants, and the top ten nectar plants to attract butterflies. She told me that her next step is to see which of these plants are currently in their gardens and to try to get some of the ones they do not have, as long as they can grow in the area. Particularly striking in these examples is the students' abilities to choose their own directions given the open nature of this work.

I was able to observe Jody with several small groups of students the following weeks as they continued on with this work. In the next example you will see how Pam and her group moved forward.

> Jody is sitting in the schoolyard right outside her classroom door with three students when I arrive. Mary and Kelly are second graders and Pam is in fifth

> grade. They brought chairs outside, arranged them into a small circle and are now discussing their inquiry project questions. They have two:
>
> 1. What kind of plants do butterflies like and are most attracted to?
>
> 2. What causes the butterfly to be attracted to it and like it?
>
> With help from Charlie and the butterfly book, they have decided to plant milkweed and butterfly bush. Jody leads the students to generate ideas for their next steps. They decide to research the two plants they are interested in and to observe the garden. They want to draw the garden and copy the drawing to make maps. They plan to record butterfly observations, locations, and behaviors on them. (fieldnotes, March 14, 2005)

On the same day another small group met. Their interest was plants and seeds and they considered growing a garden. Once again, Jody guided them in planning.

> "What are the first things to do?" asks Jody.
>
> Lisa replies, "Be prepared."
>
> Kris shares that they need to learn how to grow a vegetable garden. She suggests they look in books, on the internet, on TV, and ask people like her mom for help.
>
> The group decides to plan, plant, take care of the garden, and observe. (fieldnotes, March 14, 2005)

A few weeks later a group builds on their interest in salamanders. In this example, fifth grader Lenny and his second grade partner John return to *Take-Along Guide: Snakes, Salamanders, and Lizards* (Burns, 1995).

> In the hallway outside her classroom, Jody meets with John and Lenny. She restates what she things they want to do.
>
> "You're wanting to build an environment that you think a salamander might come to. Then you want to check and see if salamanders are there. Right?"
>
> They agree. Jody tells them to write their question and think about the next step they need to do. They talk and decide the next step is to observe outside, to look at the creek, and to see if they can find any salamanders. But they realize they need to know where to look.
>
> So, the boys go back into the *Snakes, Salamanders, and Lizards* book. I remind Lenny that we have looked at this book before. John says that the animals

> in the book are not in this area, that they are in Florida. I tell him that is probably right for some of the salamanders but not for them all.
>
> We turn to the page about two-lined salamanders. I ask John to read the section about where it lives. The text says it lives in the Appalachian Mountains in the southeastern United States. Jody and I ask the boys if we can find them here. They say yes, that is where we live.
>
> I explain to Lenny that he might need to help John think about what the text says about where the salamanders live in order to figure out if they might be around here. He can use what he has been learning in social studies about the United States. With guidance, Lenny and John mark some of the pages for salamanders that can be found around here. They also read the tips for finding them.
>
> John reads that salamanders are active at night and says that they might not be able to find them during the school day. I ask him where he thinks they might be during the day.
>
> Lenny says, “Under rocks.”
>
> I tell them they might look there.
>
> When reading about the red eft page, Lenny and John learn that some salamanders have a sticky substance on their skin that could be harmful to other animals. They worry about finding these salamanders and think it might help to wear gloves. I suggest that they be careful and wash their hands very well with soap and water after looking for them. Jody suggests that they don’t have to catch the animals---they might just look for them.
>
> Jody tells the boys they will go look outside this afternoon, if it is not raining. I ask Lenny where he’ll look for the salamanders.
>
> He answers, “By the creek and under rocks.”
>
> As the group winds down their work for the morning, Jody tells John and Lenny she will copy the pages marked in the book for them to use as references. I ask if they had a chance to look at all the different salamanders to see which ones are in this area. They haven’t yet. Logan takes the book to look at it some more. (fieldnotes, March 28, 2005)

Books clearly played a role in helping students build on their initial firsthand observations and plan their continuing investigations. In our final interview, Jody shared that this use of books was in her mind one of the most satisfying. She appreciated:

> …actually seeing the students really using the books… knowing that they could just grab a book if they needed one… wanting to read them… (interview transcript, May 10, 2005)

*Reasonable Results*

A different approach was possible with *June 29, 1999* (Wiesner, 1992). This fantasy picture book was able to get the students thinking about experiments and reasonable results.

> Charlie and Jody's classes gather in Jody's room. The second grade students are sitting at their desks. Fifth graders are near their buddies, some sitting on chairs and others on the floor. Even though a buzz fills the school because of a recently announced early dismissal due to snow, the students' attention is on Charlie as she reads aloud *June 29, 1999*.
>
> As Charlie reads, she stops and asks questions or shares a thought. "It's about a girl doing an experiment… Look at the picture. It's got balloons with all kinds of plants and cups with seeds in them."
>
> In the text Holly sends off baskets of vegetable seedlings into the sky using balloons to see what would happen. Soon huge vegetables begin to appear on earth. Many students comment as Charlie reads. Whoa! Wow. Eat it…
>
> The girl in the text sees on a television report that giant arugula has been found and is puzzled. Eggplant, avocado, and rutabaga also appear—all vegetables that the girl did not use in her experiment. Charlie says, "She didn't start off with these things so should she have these things?" Several students say no.
>
> Holly wonders what happened to her experiment. The story moves to an alien spaceship where their food supply was accidentally jettisoned and the aliens wonder what they will have to eat. In float several small baskets of vegetables tied to balloons.
>
> At the end, many students laugh. Charlie says, "So we're going to do our experiments. Hopefully no aliens will take over ours! But she knew enough to know those big vegetables weren't hers." Students talk about results needing to make sense. (fieldnotes, March 11, 2005)

*Inferences*

One aspect of firsthand investigation and the use of empirical evidence is the analysis of data—which can require valid inferences. While this kind of work was not common in the data collected, I did have the opportunity to hear about and observe part of a lesson Jeff taught that guided students in this kind of inferential thinking.

> When I arrive for an observation, Jeff tells me that earlier today they worked on an activity with *The Skull Alphabet Book* (Pallotta & Masiello, 2002). Each page has clues about the animal described but doesn't say the animal's name exactly. Jeff copied the pages and students highlighted the clues on the pages. Using these clues they predicted the animal represented and called these predictions opinions. Then they went into the computer lab and looked for nonfiction sources online that could help confirm their predicted animal (opinion). They printed out information found online and again highlighted the parts that helped them "turn their opinions into facts." Their work is displayed in the classroom.
>
> A girl tells Jeff that no one did the "I page". He says that is because he doesn't know what it is. They show it to me. The skull looks similar to a deer or antelope and has horns or maybe antlers. The text says:
>
> > I is for… This fast and graceful African animal has eye sockets on the sides of its skull. It has monocular vision. Each eye sees something different. It is always on the lookout because it does not want to get eaten by hungry predators. (no page numbers)
>
> I guess that it is an ibis. We look in the dictionary on the table near us. Ibis is a bird! Ibex, right before ibis in the dictionary, is a wild goat—the animal I was thinking about. The girl looks at the picture in the dictionary and is not convinced we have the correct animal. She thinks the horn curves are not quite right. She is eager to look online for more evidence. Jeff tells her that first she needs to work on another assignment. Then she can look for more evidence on the computer.
>
> After some time passes, the girl tells Jeff that she is ready to check the "I animal" information. He looks at her other work and then lets her go to the computer lab. She comes back in a few minutes and excitedly shares what she found. She has printed out information from the Enchanted Learning website about the impala. She reads it aloud and tells why she believes it is the right animal. At first she explains that it is because it is from Africa. Then she shares about the horns. A nearby person says that the horns do not seem the right shape. The girl responds that maybe the females have the different shaped horns. She quickly reads aloud the anatomy section of the online information she printed and realizes that females don't have horns. She suggests that maybe the males' horns grow and look like different shapes. (fieldnotes, March 24, 2005)

This experience is a powerful example of how books and a teacher's guidance can lead students to understand that inferences are part of science.

*Additional Insights from the Books*

It is possible to gain additional insight into this theme by looking more carefully at the books teachers selected. Particularly noteworthy are places that the authors make it clear that scientific understandings are discovered and created by scientists through firsthand investigations that may include observations, expeditions, comparisons, and monitoring. *Reader's Digest Pathfinders: Birds* (Brinkley, 2000) does this in many places.

> INSIDE STORY: **Seeding the Fruit**
> Cassowaries are large, flightless birds that move quickly along rain forest floors. They eat large amounts of fruit, and can, after digesting, disperse seeds a long way from the parent tree. Dr. David Westcott, who works for the Tropical Forest Research Center in north Queensland, Australia, studies these birds to measure the effect they have on rain forest tree populations. To monitor a bird, Dr. Westcott catches it. He feeds it and notes how long it takes food to travel through its digestive system. Then he attaches a radio transmitter and releases the bird into the wild. Dr. Westcott tracks the birds and notes where they drop seeds in their waste. He learns more about how cassowaries live, and can measure the way they affect the rain forest's ecology. (p. 20)

> INSIDE STORY: **Seeing in the Dark**
> Rose Ann Rowlett of the United States of America has been organizing birding expeditions worldwide for more than 20 years. She is skilled in locating birds that are seldom seen. Some live hidden in heavily forested regions, while others are shy and secretive or only come out at night.
>
> To find night birds such as the Nocturnal Curassow in South America, or the Feline Owlet-Nightjar in New Guinea, Rowlett uses her knowledge of their habits, habitats, and sounds. She has a tape recorder with a sensitive microphone for recording sounds and a strong flashlight for illuminating the birds. Her work has led to exciting discoveries. In Panama, she and her colleagues made the first sound recording of the Crested Owl. (p. 38)

An additional area to note is the way some books address the need to draw conclusions carefully. Along these lines *Stokes Bird Feeder Book* (Stokes, 1987) cautions people about making assumptions.

**The "Little Feathered People" Assumption**
Do not assume that birds are like people or that they have motives and emotions like ours. Instead, just watch what they actually do and see how they do it.

For example, a blue jay at your ground feeder may pick up a seed, hop over to another blue jay that is fluttering its wings, and feed it the seed.

Some people might describe this scene by saying that a mother jay fed a seed to a young jay which was begging. But this description makes several assumptions: that the action took place between a parent and young bird; that the young bird was begging; and that the adult was the mother.

In fact, you cannot be sure of any of these conclusions with blue jays. You cannot tell male from female by appearance; the birds that was fed may have been demanding food rather than begging; and after a few weeks out of the nest, young blue jays look like the adults. It is true that the behavior of a parent blue jay and its young as the parent feeds it is extremely similar to this, but so is blue jay courtship, in which the male feeds the female.

Therefore by making assumptions about birds—assumptions that are in part based on human interactions—we may misinterpret bird behavior; this keeps us from seeing what birds are *really* like. (p. 19)

Russo (1998) addresses the need to draw conclusions carefully as well.

**Be Objective**
Write down details that you actually see. Don't assume you immediately know what is happening. A human interpretation of what an animal is doing can sometimes be entirely incorrect! You may have to observe an animal several times, before you understand what it is actually doing.

Here's an example. You've just seen a pair of sparrows scratching away in a dusty patch of ground in your garden. They must have scratched the ground bare, right? Maybe not! Birds like to take dust-baths in the summer. This may help to get rid of mites and lice in their feathers. Or, there cold be an anthill in that spot, and the sparrows were "anting." That means the birds deliberately squat down near an ant colony, spread their feathers out, and allow the ants to crawl all over their feathers. The ants leave a chemical trail which seems to repel mites and lice. You need to watch the sparrows more closely or on more occasions to find out what is really going on! (p. 75)

Of course *June 29, 1999* (Wiesner, 1992) as described previously would fall into this category as well in its more creative fictionalized approach. At first we may think the enormous vegetables falling from the sky belong to the girl who sent seedlings into the air, but do we know for sure? When vegetables appear that were not parts of her original experiment we realize that we had better not jump to conclusions.

As with the other themes, the books address this theme to varying degrees—some a great deal and others just briefly. For example, *Watching Nature* (Russo, 1998) is focused on the observation of the natural world and collecting empirical data, as can be seen in the following quote.

> From birdwatching in your own backyard to taking a whale-watching cruise, this book will increase your enjoyment of nature. Whether you're working in a garden, relaxing on vacation, or hiking and camping you'll discover how to develop your observation skills. And you'll make a lasting personal record of everything you've seen.
>
> This book has been designed to show beginners how to:
>
> - look for clues to animal activities
> - remember bird songs
> - attract birds, butterflies, and other wildlife to your backyard
> - develop the skills needed to identify wildflowers
> - look for distinctive field marks on wildlife
> - keep an accurate journal of your outdoor discoveries
> - make on-the-spot field sketches and take outdoor photos (p. 6)

Other books including several of the poetry collections have what I consider to be more of an inferred connection. Reading them makes me want to observe and to gather and analyze data, even if this is not directly stated in the texts. Take *Marsh Music* (Berkes, 2000) for example.

> Longer notes. Shorter notes.
> Listen to the quarter notes.
>
> *Woink-woink-woink*
> *Woink-woink-woink*
> Three-quarter time.
>
> *Gronk-gronk-gronk*
> *Gronk-gronk-gronk*

Music sublime. (no page numbers)

Passages like these encourage me to look for and listen more carefully to frogs and night sounds. So does the information in *All About Frogs* (Arnosky, 2002), which just briefly mentions the author observing and counting frogs.

These classroom stories, interview excepts and book passages help us see the ways books have helped with observation, collection of different kinds of data, inferring, and recording information—all with the idea of firsthand investigation leading to empirical evidence to help us understand the natural world. The theme is further corroborated by noting the number of books addressing this theme as seen in Table 4.3 and by noting the triangulation of data as seen in Table 4.4.

**Theme 3—"We don't have to rediscover the wheel:" A Durable Body of Scientific Knowledge**

As stated in *Science for All Americans* (AAAS, 1989), the majority of scientific knowledge is durable and science is characterized in part by continuity, stability, and confidence. In this vein, Charlie, Jody, and Jeff all see books as content resources for their students and for themselves. Jeff explained this idea well in one of our interviews.

> Let's say you wanted to study birds. You could go out and look at birds a lot and do all kinds of observation and generate questions and answer your own questions but there comes a time when someone else has probably already thought of a bunch of stuff so you can go and see a book, oh I can learn these things a lot quicker this way, and so books become another tool for your own personal research. You have your own active research and then books are active research too because you're just quickly learning what others have already learned and we're lucky that they're out there. We don't have to rediscover the wheel. (interview transcript, January 6, 2005)

Table 4.3: *Number of Books Addressing Elements of Empirical Evidence*

| **Element of Empirical Evidence** | **# of Texts** |
|---|---|
| Observe, experiment and/or measure | 54 |
| Use of equipment, tools, and /or technology | 39 |
| Collect, identify, analyze, and/or record data | 47 |
| Infer carefully.  Avoid assumptions and jumping to conclusions. | 4 |
| Direct attention to science as discovered by scientists through firsthand investigation | 15 |
| Indirect promotion of observation and gathering and analyzing data | 15 |

Table 4.4: *Triangulation of Data Analysis for Theme 2—Empirical Evidence Underlies Scientific Understanding**

| Case | MO | O | I | D | T |
|---|---|---|---|---|---|
| **1: CB** | 1, 2 | 2, 6, 14, 18, 24 | 1, 4, 13, 16 | 1, 27 | 3, 4, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 69, 70, 71, 72, 73, 74, 76 |
| **2: JS** | 1, 2 | 1, 4, 5, 13, 21 | 3, 12 | 1, 3, 5, 17, 30, 31, 33 | 9, 39, 53, 54, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68 |
| **3: JW** | 1, 2 | 2, 10, 14, 17, 18, 19, 22, 23, 24 | 6, 10, 14 | 1, 6, 20, 21, 22, 23, 24 | 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38 |

*Using Codes from the audit trail (See Appendix C.)
MO: Meeting Observation
O: Observation of Teaching
I: Interview
D: Document
T: Trade Book

The durable body of scientific knowledge in books was used by these teachers and their students to build background knowledge on topics and as references after firsthand investigations.

*Broadening Background Knowledge*

At times Jeff used books "largely as resources to broaden background knowledge" on topics such as rocks and minerals and animal adaptations. In one unit Jeff started by talking with students about a lot of different animals and their adaptations. After the class created an imaginary mystery animal complete with student-generated adaptations, each student used trade books to research and become an expert on a different animal. Students presented their newfound knowledge to each other in 5-10 minute lessons. Jeff shared, "And so I tried to get them to be animal experts on something and it was using literature to broaden awareness of particular animals." Jeff also used feature articles from *Highlights for Children* (Myers, 2004; Turner, 2004) to build students' science knowledge, as well as their reading skills, by having them identify important facts in the pieces.

Jody refers to "books where kids can get information about a topic" and elaborates by saying that when learning about lifecycles, for example, she wants her students to have books that show lifecycles of different animals such as ladybugs. Jody and her intern read aloud books to teach content related to states of matter, weather, and salamanders. Similarly, Charlie read aloud books about electricity, energy cycles, and volcanoes. This is illustrated in the following vignette describing a lesson in Charlie's classroom using *Switch On, Switch Off* (Berger, 1989).

> Seven girls and six boys sit at their tables with their journals out. Charlie reminds them that yesterday they talked about electricity and how it gets to their houses. She begins to read aloud *Switch On, Switch Off*. The text discusses how lights go on and off by flipping a switch which seems magical but in fact is electricity. It explains electricity as a type of energy. Students interact with Charlie and the text as she reads. After the first page she says, "Right?" They say, "Right." She has them fill in words sometimes. Charlie says, "The light goes…" raising her voice at the end and students say, "Off." The students laugh when she expressively reads that sometimes they even use their energy to clean their rooms. As she reads a part about making electricity with coiled wire and magnets she explains to the students that they will do that next week. When talking about using a compass she mentions that she wouldn't put her real compass on the overhead because it would mess up the electricity. The text explains how electricity moves through wires.
>
>> The wire is made up of billions of tiny bits, or particles. They are called atoms. Each atom is much too small to be seen. But each atom has even smaller particles. Some of these move in paths around the atom's center. They are the electrons.
>>
>> Moving the magnet near the wire makes the electrons move out of their paths. They speed from atom to atom. The speeding electrons are what we call electricity.
>>
>> The opposite works, too. Moving a coil of wire near a magnet also makes electricity flow. (p. 14-15).
>
> This double-page spread has two diagrams—a drawing of an atom with electrons labeled and a drawing of wire with a magnet passing by and electrons moving. Charlie explains the pictures and points to the different parts. "See how they move around?" She reads on. (fieldnotes, January 21, 2005)

Throughout my work with these teachers, books played a key role in presenting topic-driven content but served additional valuable purposes as demonstrated in the preceding themes. During this research period, Jody, Jeff, and Charlie never taught an entire unit or even the majority of a unit through the reading of content information in books.

*Referring to the Durable Body of Knowledge After Firsthand Investigation*

While some lessons or portions of lessons did focus on reading books to learn accepted science content, it was much more common for the books to be presented as one part of a unit that involved multiple uses of books and that involved students in science in diverse ways. Along these lines, the durable body of scientific knowledge as represented in books played a role in explaining students' firsthand investigations. The books helped students understand what was happening in their experiments and observations and also elaborated on their experiences.

In one such case, Charlie's students did a series of experiments about light. At four different centers, they conducted hands-on explorations to investigate their ability to see color in the dark, how different colors of light mix, the ways prisms affect light, and how light travels. They worked on creating their own explanations of what happened.

Take for instance a group working on how light travels. Following the directions provided, they set up a series of index cards with holes in them. They shined the light towards the cards and saw that it traveled through the holes and onto a piece of wood behind the cards. Charlie asked them what happened when they moved a card. A student replied that the light did not travel through. Charlie asked what that means about light.

A student said, "Light travels through holes."

Another student said, "Light travels in straight lines."

Their next step was to connect their observations and explanations to information published in books, that already known and accepted knowledge on their topics. The books used included *Science Works! Light* (Parker, 1997), *Eyewitness Science: Light* (Burnie, 1992), and *How Science Works* (Hann, 1991). Charlie encouraged her students to think of their science experiments and "the science behind them." She marked places in the books for students to look. Small groups focused on different topics and served as expert groups. They discussed the ideas in their groups based on their own experiments and what they read. Then they talked as a whole class and finally students wrote conclusions as small groups. Charlie explained that these steps gave students a chance to process the information in different ways.

Jeff did similar work in his unit on rocks and minerals. At first they did many hands-on activities. They made metamorphic, sedimentary and igneous rocks out of clay and created volcanoes. They observed and sorted rocks and investigated their properties. Then Jeff gave the students topics to write about and they went into books. As Jeff put it:

> We did lots of hand-on things so they had big background knowledge and they had an idea what rocks felt like in their hands. They could relate to the book. They used the knowledge they gained from the hands-on experiences and the knowledge the gained from the books and kind of produced their own text, their own book about rocks. (interview transcript, May 11, 2005)

Their initial hands-on experiences helped the students understand the information presented in the texts, the generally accepted body of knowledge.

### *Additional Insights from the Books*

When analyzing the selected science-related trade books themselves it became clear that many of them present scientific information as a durable body of knowledge. The texts provide large quantities of content about the natural world and the ways it works. However the books do present this body of knowledge using different structures, as illustrated in Table 4.5.

Some of the chosen books present science as a durable body of knowledge in most, if not all, of the text. From these books readers get the sense that a lot of information is known about scientific topics. These books are written in a way that at least on the surface appears to be value-free and independent of context. Despite this appearance, values and context do play a role in them—in decisions about the content considered worthy of publication. This can be seen, for example, in *Weather* (Simon, 1993) and *Rain, Snow and Ice* (Merk & Merk, 1994).

> Earth's weather is driven by the intense heat of the sun. The sun's energy travels through space in the form of visible light waves and invisible ultraviolet and infrared rays. About one third of the energy reaching Earth's atmosphere is reflected back into space. The remaining two thirds is absorbed during a process called insolation (from *in*coming *so*lar radi*ation*). (Simon, 1994, ¶ 4)

> Snow begins to form in cold, upper air when water vapor freezes. As it freezes, water vapor makes tiny beads of ice. Beads of ice stick together forming snowflakes. Snowflakes are like clouds and fingerprints—no two are exactly alike. Snow falls for short periods in snow showers or flurries. Heavy, windblown snowstorms are called blizzards. (Merk & Merk, 1994, p. 14)

Other texts blend the portrayal of science as a durable body of knowledge with additional aspects of the nature of science, giving the text as a whole a broader representation of what science is. As might be expected, this blending occurs in different amounts and styles and may or may not occur consistently throughout the text. The following passage from *Take-Along Guide: Snakes, Salamanders and Lizards* (Burns, 1995) illustrates science as a durable body of knowledge in a book that uses this kind of blending.

Table 4.5: *“We don’t have to rediscover the wheel” Children’s Books*

| **Nature of Science** | **# of Texts** |
|---|---|
| Most, if not all, of the text presents the nature of science as a durable body of knowledge | 8 |
| Science as a durable body of knowledge blended with other NOS characteristics throughout the text | 38 |
| Science as a durable body of knowledge comprises most, if not all, of the body of the text; other NOS characteristics in the introduction | 6 |
| Science as a durable body of knowledge presented through endnotes | 3 |
| **Total** | **55** |

> Salamanders are animals known as amphibians. Amphibians have smooth skin. They can live on land and in water. About 135 kinds of salamanders live in the United States. They have long tails and long bodies. Most salamanders have 4 legs. Others have only 2 legs. Some have no legs. Most are active at night. They have 4 toes on each front foot. Most salamanders have 5 toes on each hind foot. The toes do not have claws. All salamanders avoid the sun. They can repair almost any injury to their bodies. They can regrow new tails, legs, and feet. (p. 16)

Yet Burns also encourages firsthand observation of the natural world and an interest in and appreciation of wildlife, aspects of science that move beyond the durable body of knowledge. The next passage illustrates other aspects of the nature of science in this text.

> Be kind to all animals… Use the ruler on the back of this book to measure what you find… Pay attention to everything around you. (p. 16-18)

Another example helps demonstrate this idea, this time from *Science Works! Light* (Parker, 1997).

> Light bounces off most objects. This is how we see them. Light from the Sun or another source bounces from their surfaces and enters our eyes.
>
> However, most surfaces are rough and not shiny. So the light bounces off them in a random way. But a very smooth, shiny surface allows light to bounce off it very precisely, with the same pattern that it had before it arrived at the surface. This arriving light pattern represents a picture of image of whatever it had bounced off before. So a smooth, shiny surface such as a mirror simply passes on, or reflects, the image of the previous object straight into your eyes. (p. 24)

In addition to passages such as these, Parker includes many "Do-It-Yourself" science experiments for readers to try, examples illustrating that scientific ideas change over time, and sections that show how science is embedded in our lives.

Sometimes authors, or perhaps their editors, choose to separate out the presentation of the durable body of knowledge. Many field guides dedicate the body of the text to the acceptable knowledge base about the species and use the introduction to discuss other aspects of the nature of science such as how to go about observing and identifying animals and promoting a passion and concern for the species (Behler, 1988; Conant *et al.*, 1992; Peterson, 1980, 1986; Zim & Cottam, 2001). While the use of empirical evidence to identify organisms and specimens is inherent to a field guide, much of the information in the guide is presented as a durable body of knowledge. Often the other aspects of the nature of science are destined to be in a few introductory pages. Samples from the body of field guides follow.

> RED-HEADED WOODPECKER 8½"—9½"
> The *entire head is red* in this unmistakable woodpecker of the shade trees, orchards, and groves of farms and villages. Its large white wing patches make the lower back look white. The note, coming from the oaks, is a loud *queer* or *queeah*. Redheads range from southern Canada to the Gulf of Mexico and west to the Great Plains, but are absent from New England. (Peterson, 1986, p. 64)
>
> **Painted Turtle** *Chrysemys picta*
> This is North America's most widespread turtle. In spring during early morning and afternoon scores can be seen sunning together on a favorite log. In between times, they re-enter the water to forage for tiny animals and aquatic plants. Basking raises the turtle's body temperature activating its digestive enzymes. Identification: 4-10". Low, oval upper shell smooth and unkeeled, olive-green to black; marginal plates accented by red bars or crescents. Lower shell light yellow to deep red, plain or intricately patterned. Yellow and red stripes on head and legs. (Behler, 1988, p. 70)

On the other hand some books present the scientific facts in notes at the back of the text. While *Birds Build Nests* (Winer, 2002) is largely a creative poetic presentation, a two page nest identification guide at the end provides numerous facts about the species included in the main body of text. In similar manners, Yolen (1996) and Berkes (2000) include natural history notes about the animals in their poems.

> Ruby-Throated Hummingbird
> *Archilochus colubris*
> United States

> This is the only hummingbird that breeds east of the Mississippi river, from southern Canada to the Gulf coast, and winters mainly in the tropics. These tiny birds are particularly attracted to red flowers such as salvia, trumpet creeper, and hibiscus. Hummingbirds are the only birds that can fly backwards and hover in one spot like insects. They lay two white eggs in a woven nest of plant down held together with spider silk and decorated with lichens. (Winer, 2002, Nest Identification Guide)
>
> *Page 5* ANEMONES, though they look like flowers, are hollow, jellylike animals belonging to the same group as jellyfish and corals. What looks like petals are actually tentacles equipped with stinging cells. With these cells the anemones poison their prey. (Yolen, 1996, p. 32)
>
> **Spring Peepers** (¾ to 1 3/8 inches/1.9 to 3.5 cm) are small, slender brown or olive-gray frogs with pointed heads. They breed in swamps and live in low bushes and plants. When they sing in full chorus, their sharp, high-pitched series of whistles and trills, pe-ep, pe-ep, pe-ep, can be deafening! (Berkes, 2000, The Cast, ¶ 2)

While different book structures and different uses of texts exist, the data presented in this theme is tied together by the idea that there is a durable, relatively stable body of scientific knowledge. The data analysis in this section is supported by the triangulation information in Table 4.6.

**Summary**

Three themes were identified related to the nature of science and the selection and use of children's books in the case study classrooms. In the first theme presented we see how the teachers' use of books portrayed science as a human endeavor. In the second theme we see the role of books in firsthand investigation and the idea that empirical evidence underlies scientific understanding. In the final theme we see how books and their use supported the idea that a durable body of scientific knowledge exists.

Table 4.6: *Triangulation of Data Analysis for Theme 3—A Durable Body of Scientific Knowledge**

| Case | MO | O | I | D | T |
|---|---|---|---|---|---|
| **1: CB** | Not Applicable | 6 | 8, 11, 13 | 7, 27 | 3, 4, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 33, 35, 36, 37, 38, 40, 41, 42, 45, 47, 48, 49, 50, 51, 52, 72, 73, 74, 75, 76 |
| **2: JS** | Not Applicable | 13 | 3, 5, 9, 15 | 5, 17 | 9, 53, 56, 58, 59, 62, 63 |
| **3: JW** | Not Applicable | 3, 10 | 2, 14 | 6, 20 | 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37, 38 |

*Using Codes from the audit trail (See Appendix C.)
MO: Meeting Observation
O: Observation of Teaching
I: Interview
D: Document
T: Trade Book

# Chapter 5: Reflections

I began the introduction of this study with a quote from Wendy Saul, a quote that expresses her worry that educators are trying to oversimplify the integration of literacy and science instruction. Because I hear and agree with her concern, it is particularly valuable to recognize the complex ways in which the three teachers in this study approach science education and the use of children's books to help teach about the nature of science.

As you read through these reflections, you will see how the complexity of science education is revealed in this work of Charlie, Jeff, and Jody. To begin I consider the multiple diverse aspects of the nature of science presented to elementary students through the thoughtful selection and use of children's books. The data presented and analyzed in Chapter 4 shows us the potential to teach about science as a human endeavor that involves fascination, creativity, imagination, values, and culture. It shows that children's books can be part of teaching the role of empirical evidence. It shows us that books can play a valuable role in presenting science as a durable body of knowledge. Jody, Jeff, and Charlie artfully balanced these aspects of the nature of science in their book selection and presentation. I move on to point out some unique aspects of the work of these teachers, aspects that have caused me pause and think hard because of the possibilities. I consider additional aspects of the nature of science that were not addressed in the themes presented in Chapter 4, aspects that might leave us wanting more. I discuss issues of race, culture and gender in the books in this study, how they reveal the crucial need for critical ways of thinking, and how they have profoundly influenced me. I share my thinking about the implicit versus explicit debate in regards to teaching about the nature of science. Throughout these reflections I raise questions and point to areas with promise for future study.

**An Artful Balance**

It is significant to note that the teachers balanced different aspects of the nature of science in their selection and use of children's books. Science educators, myself included, can be highly concerned with the prevalence of teacher-centered instruction that focuses predominantly on lectures, textbooks, notes, and tests. As a result, we may have a tendency at first to go to the opposite extreme in which science education becomes almost exclusively open exploration. Instead of moving from one extreme to another, these case studies allow us to see a more balanced and complex perspective.

- The teachers demonstrated ways in which books can help guide and model inquiry related to the gathering of empirical evidence rather than relying primarily on open exploration. This kind of scaffolding of students' inquiry is important.
- The books and the teachers remind us of the importance of processing firsthand investigations. It is not enough to do hands-on activities. We must think about them in mindful ways. Books and language play critical roles in this processing.
- They help us see the value in using books as sources of information about the natural world. We cannot teach some information through firsthand

investigation with elementary students and, as Jeff said, we do not need to rediscover the wheel. We want our students to have access to the durable knowledge of scientific knowledge and children's books are one important way to do this.

- The teachers' selection and use of books acknowledges the need and ability to teach students about the human aspects of science.

*New Questions*

As a teacher educator, how do I help teachers develop the abilities and dispositions to artfully balance the teaching of different aspects of the nature of science? In the elementary education program at the university where I am currently a faculty member, students take one elementary science education course. What is possible in this one course? What can be done when collaborating with faculty who teach science courses? Is it possible for our students to enter education courses with a stronger understanding of the nature of science, understanding developed through their science courses as Akerson and her colleagues (2000) suggest?

**Particularly Striking Ideas**

In terms of the human aspects of science, I am particularly struck by the potential demonstrated by these teachers and their work to use fiction and poetry to promote connections between imagination, creativity and science. How did this happen?

- The teachers consciously selected science-related children's books that included fiction and poetry.
- The teachers selected science-related children's books that demonstrated the roles of imagination and creativity in science. These texts include references to imagination as part of developing hypotheses, designing scientific procedures, creating models, and interpreting data.
- By reading poetry in children's books, students learned features of the genre. They subsequently wrote their own poems integrating observations of the natural world with characteristics of poetry.
- In reading fiction, students noticed and discussed ways scientific ideas were embedded in the texts. At times this happened spontaneously in a classroom environment that promoted discussion of texts. At times this happened intentionally with teacher guidance. Students were encouraged to think about the aspects that reflected accurate, imaginative portrayal of the natural world and aspects that involved creative license.
- Students read poems and were asked to interpret them. In discussions of what poems mean, students shared their thinking about unusual ideas such as how trees can cry.

*New Questions*

In a way I wonder if some of these examples are about imagination and creativity in science or if they are about imagination and creativity in reading and writing. Then I remember that I am the person creating boundaries between these fields. I want students experiencing science and imagination and creativity in a connected way and all of these examples helped students live these connections. There are possibilities here that are worth our attention. In what additional ways can we use fiction and poetry to teach about the nature of science?

I also see great potential in the innovative use of books to help students interpret data and make inferences as discussed in the theme about empirical evidence. In thinking about data analysis, we could stick to nonfiction texts directly talking about these issues. Instead in this research we see examples of teachers thinking beyond a narrow focus. When Charlie and Jody read aloud *June 29, 1999* (Wiesner, 1992), a fantasy picture book, they were able to introduce the idea of reasonable scientific results and at the same time students were intrigued by a creative story. Jeff's students were hooked into inferential thinking by *The Skull Alphabet Book* (Pallotta & Masiello, 2002). Instead of allowing the thinking about the unknown skulls to be a guessing game, Jeff had students thoughtfully analyze the data and use additional sources of information to intelligently infer. Again, these are not obvious uses of books; they are innovative, motivating, and complex. I suspect there are more children's books that could help teach about data analysis in these ways and I believe this is a worthwhile area to pursue further.

**Hungry for More**

At the same time, there are aspects of the nature of science that are not identified in this study's research themes. One such aspect is the tentative nature of knowledge. Some of the books selected did address this aspect of science to at least some extent. For example, in *Field Guide to the Birds of North America* (1987), the text states that some names of bird species have changed because of new understandings. Some subspecies are now thought of as different species. On the other hand, some separate species have been combined into one species with different forms. We learn in *Stokes Butterfly Book: The Complete Guide to Butterfly Gardening, Identification, and Behavior* (Stokes & Stokes, 1991) that at one time people thought that caterpillars and butterflies were separate kinds of creatures. In *Volcano: The Eruption and Healing of Mount St. Helens* (Lauber, 1986), readers are told that earth scientists used to think that the earth's crust was one piece similar to an egg shell but now think it is made up of large pieces called plates. Despite places like these in the books, the teachers did not address this idea of the tentative nature of scientific knowledge in the observations, interviews, or documents.

Another aspect of the nature of science addressed in the books but not in the teachers' use or discussion of them is that we do not know everything about the natural world, creating a sense of mystery. *Reader's Digest Pathfinders: Birds* (Brinkley, 2000), for example, informs us that no one knows for sure what creature had the first feathers or why some birds do not fly. In *One Small Square: Swamp* (Silver, 1997), we learn that people have ideas about the function of knees on cypress trees but do not have evidence to support their ideas. While I do not definitively know why the tentative nature of science and the scientific mysteries that exist were not addressed by the teachers, I suspect their agendas were full with other goals and objectives and that these characteristics were not on their priority list. There is potential to do more with the children's books in these areas.

While I did not find places that discuss scientific laws, the books studied in this research do have places that refer to scientific beliefs. In *What's Faster than a Speeding Cheetah* (Wells, 1997), the author tells us, "Most scientists believe that nothing can travel through space faster than light." (no page numbers) We learn in *Science Works: Light!* (Parker, 1997) that there have been many theories about what light is. *Lifetimes* (Rice, 1997) tells us different ideas about why dinosaurs became extinct. These books do not however discuss beliefs next to the concept of scientific theories. In other words, they do not address scientific theories as inferred explanations *based on large amounts of indirect evidence*—which stands in definite contrast to the common use of the word theory or belief which often implies a conjecture based on limited information. Left unaddressed this is problematic. However by bringing up theories these books create opportunities for teachers to intentionally address the concept of scientific theories more thoroughly. We can encourage our students to ask questions such as:

- What evidence exists to support this theory?
- How much evidence exists to support this theory?
- What evidence, if any, contradicts this theory?

*New Questions*

I do wonder about the developmental appropriateness of this kind of thinking about tentativeness, unknown information, and scientific theories. My experiences as a fourth and sixth grade teacher lead me to believe that upper elementary students are able to begin thinking in these ways. I suspect that younger students can as well, especially when teachers believe in them. This is an area for further study.

**Diversity and Habits of Mind**

I clearly see the need to think carefully about diversity issues connected to this research. As described in Chapter 4, the teachers were able to present diverse views of science and the natural world on a few important occasions. Both examples involved reading realistic fiction chapter books with Native American characters. They demonstrated effective ways to help students think about indigenous knowledge, views, and culture. These kinds of experiences are incredibly important and need to happen more often, begging the question—why aren't they? Is there a shortage of children's books that represent diverse views of science and the natural world? While this needs to be studied more carefully, my strong hunch is that this is the case. If so, in what ways might we encourage the writing and publication of books with diverse scientific perspectives? Creating a demand would certainly help. Of course we should remember that children's books are only one resource in this effort to show diverse views of science. We need to consider additional strategies to teach in ways that demonstrate the cultural, social, and ethical aspects of science.

There is the related issue of race, culture and gender as represented in the children's books. While women, people of color, and different cultures were represented in the book collection, they were not represented well. Looking at these books through the lenses of race, culture, and gender has been a powerful and angering experience for me. What shocked me most is that my first reads of several books left me excited about what they had to offer. In *Reader's Digest Pathfinders: Birds* (Brinkley, 2000), for example, I saw sidebars that focused on amazing science, hands-on activities for children, and inside stories about the work of scientists. I saw intriguing photographs and illustrations and an overall attractive layout. I even wrote in my notes, "I love this book." It was only when I returned to the book to look specifically at race, culture, and gender that I saw that the majority of stories about the work of scientists were about white men. Only 2 out of 17 inside stories included people from diverse cultures and these portrayals were questionable and superficial. I was equally shocked with *Science Works! Light* (Parker, 1997). Twenty-five scientists, all male, are discussed in the text and all of the scientists who are illustrated appear to be white. One woman of color sewing "long ago" adds insult to injury. The fact that both boys and girls are illustrated in the "Do-It-Yourself" illustrations does not make up for these gaps. Similar concerns surface in *Eyewitness Science: Light* (Burnie, 1992) which includes approximately 40 white men who are scientists, discoverers, and inventors. Two women are illustrated in the text. One is talking on the phone and the other is carrying a birthday cake! How can publishers let this happen? How can I need to revisit these books several times before noticing?

*New Questions*

What does a person do when confronted with such surprises and anger? In describing the work of Piaget, Duckworth (1991) explained that when people encountered surprises and discovered possibilities they wanted to explore, to do, and to think more. This certainly has been my reaction, especially in regards to habits of mind. I know that when I approach new books I will now consciously consider race, culture and gender before drawing conclusions. Questions that fill my mind include:

- What people are represented in this book? How are they represented?
- In what ways are these representations accurate and fair? In what ways are they inaccurate and biased?
- Do I want this book in my collection? Why? How do I imagine using it with elementary or middle school students? How do I imagine using it with teachers?

The surprises in this research have engrained this way of thinking for me. They are pushing me to dig deeper in order to more fully engage the question of how diversity or lack of diversity shapes our curriculum. As I imagine sharing my discoveries, surprises, and questions with other people, I am glad that I own these troublesome books so I can use them as examples. I worry though that it is not enough to share my experiences and questions with others and that attempts to address diversity sound like broken records to my teacher education students. Sometimes it seems that our students hear these ideas but do not *feel* them in ways that makes a difference. I wonder and worry about how we help teachers, both preservice and inservice, habitually think in these critical ways.

**Implicit or Explicit?**

Discussions about teaching the nature of science frequently address explicit versus implicit teaching (Akerson et al., 2000; Scharmann et al., 2005). At times the teachers did directly connect to work of scientists, especially in terms of observation and journaling strategies. Yet, as illustrated in Chapter 4, much of the instruction around the nature of science in these case studies was indirect. To really know how effective this implicit instruction is we need to study the elementary students and their understandings of the nature of science. I do think that students would benefit from more direct teaching about the nature of science. We could borrow ideas from literacy education. In writing workshop we talk about teaching strategies that writers use, ways writers think, and conventions that writers use in order for their ideas to be shared with the world (Ray, 2001). In the teaching of reading, we talk about teaching reading strategies and helping students reflect on their own ways of reading (Calkins, 2001). In applying these ideas to science education, we can imagine ongoing investigations in which students consider strategies scientists use to answer questions about the natural world and characteristics of scientific work. Imagine class-created charts with these titles, charts that develop throughout the school year as new nature of science ideas are discovered and discussed. Imagine these charts being created through authentic investigations with teachers and students talking and thinking together. Imagine books as one resource in this effort. At first, teachers might point out significant ideas in books related to the nature of science so students do not miss them. Through this modeling, students will begin to notice and share these sections more independently.

*New Questions*

Would small yet consistent investments of time throughout the school year to make the implicit teaching about the nature of science more explicit be worthwhile? What learning consequences would there be?

## Final Thoughts

Eleanor Duckworth (1991) has written about the importance of keeping teaching and learning complex in order to create deep understanding. She reminds us how easy it is to dismiss a topic or idea and to move on, but that real understanding comes from recognizing complexities and confronting them.

> Most areas of study that are at all worth our attention entail far more complexity than is acknowledged in our curriculum; and, further, people's intellectual engagement, when they are given the chance to pursue these complexities according to their own lights, is extraordinary. (p. 23)

As seen from this study, there are many dimensions of using children's books for teaching the nature of science. This work is not just about books and is not just about what teachers do in the classroom; the blending of book selection and use is the key. A book with excellent content might stand well on its own, but students might miss valuable ideas without the teacher's guidance. On the other hand, a book with questionable information might provide excellent opportunities for critical thinking. Although it is important to consider individual books, we also need to consider the collection of texts we share with children and the messages sent through the collection as a whole. These dimensions expand when thinking about using children's books for teaching the overall science curriculum and explode when thinking about elementary education as a whole.  To make it even more complex, I would never suggest the teaching of the nature of science only through books, just as these teachers did not and would not.

It is my hope that in learning the stories of Charlie, Jeff, and Jody you have seen possibilities, encountered surprises, and grown to embrace the complexities of teaching. I certainly have.  I hope that these possibilities, surprises, and complexities open doors for you and your colleagues to question, to explore, and to think.  Then I hope you will share your stories so we can learn from them as well.

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# Appendices

# Appendix A: A Semi-Structured Interview About the Use of Trade Books in Elementary Science Inquiry

Questions are designed to help guide the interview but are not a script to follow exactly.

When recording, start with the following information: date, time, location, interviewee identification, interviewer, and interview number.

1. What is it like to be a teacher at ____?
2. Tell me about your work with the Literacy, Learning and Loving Nature grant and why you choose to be part of this work.
3. What are your hopes for the project?
4. What are your worries, if any, for the project?
5. Think about a time when you felt successful in science teaching. Describe it to me.
6. What do you think is important in teaching science? Why?
7. How would you describe your science teaching in practice?
8. What challenges do you face in teaching science?
9. What goals do you have for your own science teaching?
10. What does inquiry-based science mean to you?
11. How does inquiry-based science fit into your thinking about teaching?
12. In what ways do you currently use trade books in your classroom?
13. How do you select trade books? What processes and criteria do you use?
14. Why are you interested in using trade books to support science inquiry?
15. What do you think is important in choosing trade books specifically to support science inquiry?
16. What leads you to reject some trade books?
17. Up to this point how have you been able to use trade books to support inquiry-based science?
18. What successes and challenges have you faced in this work?
19. Have you noticed any limitations in science trade books as you think about using them for inquiry-based science? If so, tell me more about them.
20. How do you imagine in the future using trade books to support inquiry-based science?
21. Is there anything else about the topics we've discussed that you'd like to tell me?

*Thank you for your time and help!*

# Appendix B: Participant Consent Form

Implementing a Collaborative Grant-Funded Project to Integrate Science, Literacy, and Nature Education in an Elementary School

I understand that the purpose of this study is to describe what elementary teachers are able to accomplish when they receive a science education grant for a collaborative project to integrate science, literacy, and nature education. I know that this research is designed to help others see the impact of this grant and to illustrate teaching methods that can be implemented in schools.

My participation will involve being observed in my classroom and school setting during 2003/2004 and 2004/2005, being observed in meetings about this grant, and participating in conversations and interviews with Patricia Bricker. The initial and final interviews will last approximately 1 hour, or as long as I want to talk. The study will involve giving Patricia copies of documents such as lesson plans, teacher-created charts, overhead transparencies, teacher journals, and other classroom materials related to this grant work. Patricia and I will arrange observation times in advance and the observations will average approximately two hours per week throughout the school year. I know that during observations Patricia will take notes.

I understand that I will receive copies of interview transcripts and observation notes and that I will have the opportunity to make sure they are accurate accounts. I will make any changes, mark out sections that I do not want included, and add any further comments I have. I can discuss these with the Patricia as well as any questions I may have.

I know that interviews and meetings will be audiotaped and transcribed. The tapes will be destroyed when transcription is complete. The only people with access to these tapes will be Patricia, her faculty advisor, and a transcriber who will sign a confidentiality form. Transcripts and field notes will be kept in locked file cabinets and pseudonyms will be used. The signed consent form will be kept in a locked cabinet separate from the location where the tapes, transcripts, and field notes are stored.

I understand that all of my responses and actions will be held in confidence by the investigator, with pseudonyms used instead of real names to identify me or other people in the school, unless my explicit permission is obtained. I understand that every effort will be made to maintain confidentiality yet that the public nature of the grant may uncover the identity of the school. I understand that my participation is completely voluntary, that I can refuse to participate without penalty, and that I may withdraw from participation at any time without penalty. I may also choose not to answer any question or not to share any materials that make me uncomfortable.

I know that it is possible that this study, when completed, will be published or presented in a public forum such as a professional conference. By signing this form, I am consenting not only to participate but also to allow this research to be used in a publication or presentation.

I realize that this study is considered a human research project; however, the risk to me for being involved is minimal. The benefit to me may be in the process of reflecting and responding to the ongoing research process and may also be in the knowledge gained from the study's findings.

I understand that I may contact the principal investigator, Patricia Bricker, at any time if I have further questions about the project or my participation in it, and that I may contact Ms. Brenda Lawson at The University of Tennessee Office of Research if I have any questions about my rights as a research participant.

Patricia Bricker
[Phone Number] office
[email address]

Brenda Lawson
[Phone Number]

If, after beginning, I want to stop participating at any time, I can tell Patricia directly or ask [Name], the school principal, to tell her if that is more comfortable for me.

Participant Name (printed) ________________________________________________

Participant Signature _____________________________________________________

Date __________________________

Co-Participant/Researcher Patricia Bricker

Co-Participant/Researcher Signature _____________________________________________

Date __________________________

# Appendix C: Audit Trail

**Explanation of Codes:**
Each piece of data is assigned a code. The letter(s) represents the source of data (Document, Interview, Meeting, Observation, Trade book). The second digit represents the number of the specific data source.

| Code | Participant(s) | Description | Date(s) |
|---|---|---|---|
| D-1 | JS, CB, JW | Toyota Tapestry Grant Application | 5/01/04 |
| M-1 | JS, CB, JW | Meeting to Plan Grant Work | 8/11/04 |
| M-2 | JS, CB, JW | Meeting to Organize and Sort Books | 10/05/04 |
| O-1 | JS | Nature Journals: Observation Data & Detailed Drawing | 10/06/04 |
| O-2 | CB, JW | Drawing Leaves with Book Buddies | 10/08/04 |
| D-2 | CB | Journal Posters (digital pictures) | 10/08/04 |
| I-1 | CB | CB Initial Semi-Structured Interview | 1/04/05 |
| I-2 | JW | JW Initial Semi-Structured Interview | 1/05/05 |
| I-3 | JS | JS Initial Semi-Structured Interview | 1/06/06 |
| O-3 | JW | Matter | 1/12/05 |
| O-4 | JS | Airplane Test Flights | 1/12/05 |
| O-5 | JS | Building Wright Brother Planes | 1/19/05 |
| D-3 | JS | Plane Flight Data Sheet | 1/19/05 |
| O-6 | CB | Switch On, Switch Off | 1/21/05 |
| D-4 | CB | Electrical Connections: Path Finders | 1/21/05 |
| I-4 | CB | Book Browsing | 1/27/05 |
| I-5 | JS | JS Book Log Meeting 1 | 2/14/05 |
| D-5 | JS | JS Book Log 1 | 2/14/05 |
| O-7 | JS | VCV Spelling, Star Reading, and Gary Paulsen | 2/14/05 |
| I-6 | JW | JW Book Log Meeting 1 | 2/16/05 |
| D-6 | JW | JW Book Log 1 | 2/16/05 |
| O-8 | CB | Gandhi and MLK | 2/16/05 |
| I-7 | CB | Book Sharing | 2/16/05 |
| I-8 | CB | CB Book Log Meeting 1 | 2/18/05 |
| D-7 | CB | CB Book Log 1 | 2/18/05 |
| D-8 | CB | Energy Transfer Diagram (digital photos) | 2/18/05 |
| O-9 | CB | Light Centers | 2/18/05 |
| D-9 | CB | Light and Color Center #1 Direction Sheet | 2/18/05 |
| D-10 | CB | Light Paths Center #2 Direction Sheet | 2/18/05 |
| D-11 | CB | Prisms Center #3 Direction Sheet | 2/18/05 |
| D-12 | CB | What Colors Make Up Light? Center #4 Direction Sheet | 2/18/05 |
| D-13 | CB | In the Dark Center #5 Direction Sheet | 2/18/05 |
| O-10 | JW | Bird Questions | 2/18/05 |

| Code | Participant(s) | Description | Date(s) |
|---|---|---|---|
| O-11 | CB, JW | Book Buddies Generate Questions | 2/18/05 |
| O-12 | CB | Water Monitoring | 2/23/05 |
| D-14 | CB | Water Monitoring Directions | 2/23/05 |
| O-13 | JS | A Day with JS and His Class | 2/25/05 |
| D-15 | JS | Fast Elephants, *Highlights for Children*, June 2004 | 2/25/05 |
| O-14 | CB, JW | Book Buddies: Questions and Books! | 2/25/05 |
| O-15 | CB, JW | Book Buddies KTL Posters | 3/04/05 |
| D-16 | CB, JW | KTL Posters (digital pictures) | 3/04/05 |
| I-9 | JS | JS Book Log Meeting 2 | 3/09/05 |
| D-17 | JS | JS Book Log 2 | 3/09/05 |
| O-16 | JS | Train Track Geometry | 3/09/05 |
| D-18 | JW | Book Buddy Inquiry Groups | 3/09/05 |
| D-19 | CB | The Force of Multimedia Slideshows, *Science & Children*, Marcy 2004 | 3/09/05 |
| I-10 | JW | JW Book Log Meeting 2 | 3/11/05 |
| D-20 | JW | JW Book Log 2 | 3/11/05 |
| D-21 | JW | Rain Gauge Lesson Plan | 3/11/05 |
| D-22 | JW | Creating Wind Anemometers Lesson Plan & Reflection | 3/11/05 |
| D-23 | JW | Wind Vane Creation Lesson Plan & Reflection | 3/11/05 |
| D-24 | JW | Experimenting with Wind Vanes Lesson Plan & Reflection | 3/11/05 |
| D-25 | JW | Graphing/Researching Weather Lesson Plan & Reflection | 3/11/05 |
| D-26 | JW | Observation Notes on Anemometer Lesson | 3/11/05 |
| O-17 | JW | Finding A Focus For Pond Study | 3/11/05 |
| I-11 | CB | CB Book Log Meeting 2 | 3/11/05 |
| D-27 | CB | CB Book Log 2 | 3/11/05 |
| D-28 | CB | *Topping Off Mount Saint Helens* | 3/11/05 |
| O-18 | CB, JW | Early Dismissal Outside Observation Detour | 3/11/05 |
| O-19 | JW | Small Groups: Butterfly Garden & Plants/Seeds | 3/14/05 |
| O-20 | JS | Play Preparation | 3/18/05 |
| D-29 | CB | RL Bryan Co Book Receipts | 3/19/05 |
| O-21 | JS | Skull Alphabet Book, Planes, Plays, and Poems | 3/24/05 |
| D-30 | JS | Skull Alphabet Posters (digital photos) | 3/24/05 |
| D-31 | JS | Planes (digital photos) | 3/24/05 |
| D-32 | CB, JS, JW | Journaling Kits (digital photos) | 3/24/05 |
| O-22 | JW | Salamander Small Group | 3/28/05 |
| O-23 | JW | Quantitative and Qualitative | 4/06/05 |
| O-24 | CB, JW | Quantitative and Qualitative with Buddies | 4/06/05 |

| **Code** | **Participant(s)** | **Description** | **Date(s)** |
|---|---|---|---|
| I-12 | JS | JS Book Log Meeting 3 | 4/27/05 |
| D-33 | JS | JS Book Log 3 | 4/27/05 |
| I-13 | CB | CB Book Log Meeting 3 | 4/27/05 |
| I-14 | JW | JW Final Semi-Structured Interview | 5/10/05 |
| I-15 | JS | JS Final Semi-Structured Interview | 5/11/05 |
| I-16 | CB | CB Final Semi-Structured Interview | 5/12/05 |
| D-34 | CB, JS, JW | JV Trade Book Database | 4/04/05 |
| D-35 | CB | CB Diamante | 10/09/05 |
| T-1 | JW | *What is Matter?* (Trumbauer, 1997) | 1/12/05 |
| T-2 | JW | *The Salamander Room* (Mazer, 1991) | 2/16/05 |
| T-3 | CB, JW | *Take-Along Guide: Snakes, Salamanders, and Lizards* (Burns, 1995) | 2/16/05 |
| T-4 | CB, JW | *Salamander Rain: A Lake & Pond Journal* (Pratt-Serafini, 2000) | 2/16/05 |
| T-5 | JW | *Birds Eat and Eat and Eat* (Gans, 1963) | 2/18/05 |
| T-6 | JW | *Birds Build Nests* (Winer, 2002) | 2/18/05 |
| T-7 | JW | *Eyewitness Explorers: Birds* (Bailey & Burnie, 1992) | 2/18/05 |
| T-8 | JW | *Blackbirds* (Walker, n.d.) | 2/18/05 |
| T-9 | JS, JW | *Peterson First Guides: Birds* (Peterson, 1986) | 2/18/05 |
| T-10 | CB, JW | *National Audubon Society Pocket Guide: Familiar Reptiles and Amphibians of North America* (Behler, 1988) | 2/25/05 |
| T-11 | CB, JW | *Peterson First Guides: Reptiles and Amphibians* (Conant, Stebbins & Collins, 1992) | 2/25/05 |
| T-12 | CB, JW | *National Geographic: My First Pocket Guide—Insects* (Bickel, 2001) | 2/25/05 |
| T-13 | CB, JW | *All About Frogs* (Arnosky, 2002) | 2/25/05 |
| T-14 | CB, JW | *Beginners' Guide to Hummingbirds* (Stokes & Stokes, 2002) | 2/25/05 |
| T-15 | CB, JW | *A Dazzle of Hummingbirds* (Berger, 1995) | 2/25/05 |
| T-16 | CB, JW | *Gardens for Birds, Hummingbirds & Butterflies* (Harris, 2002) | 2/25/05 |
| T-17 | CB, JW | *A Golden Guide: Insects, Revised and Updated* (Zim & Cottam, 2001) | 2/25/05 |
| T-18 | CB, JW | *Pick, Pull, Snap! Where Once a Flower Bloomed* (Schaefer, 2003) | 2/25/05 |
| T-19 | CB, JW | *Birds in Your Backyard* (Herkert, 2001) | 2/25/05 |
| T-20 | CB, JW | *Reader's Digest Pathfinders: Birds* (Brinkley, 2000) | 2/25/05 |
| T-21 | CB, JW | *Kingfisher Young Knowledge: Birds* (Davies, 2003) | 2/25/05 |

| **Code** | **Participant(s)** | **Description** | **Date(s)** |
|---|---|---|---|
| T-22 | CB, JW | *Bird Feeder Book: The Complete Guide to Attracting, Identifying and Understanding your Feeder Birds* (Stokes & Stokes, 1987) | 2/25/05 |
| T-23 | CB, JW | *Plant It and They Will Come… Using Native Trees and Shrubs to Attract Wildlife in Eastern North Carolina* (Dunn & Shearin, 1994) | 2/25/05 |
| T-24 | CB, JW | *Field Guide to the Birds of North America, 2nd Edition* (author not listed, 1987) | 2/25/05 |
| T-25 | CB, JW | *One Small Square: Swamp* (Silver, 1997) | 2/25/05 |
| T-26 | CB, JW | *Watching Nature* (Russo, 1998) | 2/25/05 |
| T-27 | CB, JW | *Stokes Butterfly Book: The Complete Guide to Butterfly Gardening, Identification, and Behavior* (Stokes, Stokes & Williams, 1991) | 2/25/05 |
| T-28 | JW | *Weather* (Simon, 1993) | 3/11/05 |
| T-29 | JW | *Feel the Wind* (Dorros, 1989) | 3/11/05 |
| T-30 | JW | *See for Yourself: Wind* (Davies & Oldfield, 1996) | 3/11/05 |
| T-31 | JW | *Rain* (Palmer, 1995) | 3/11/05 |
| T-32 | JW | *Rain, Snow and Ice* (Merk & Merk, 1994) | 3/11/05 |
| T-33 | CB, JW | *Saguaro Moon: A Desert Journal* (Pratt-Serafini, 2002) | 3/11/05 |
| T-34 | CB, JW | *June 29, 1999* (Wiesner, 1992) | 2/16/05<br>3/11/05 |
| T-35 | CB, JW | *Biggest, Strongest, Fastest* (Jenkins, 1995) | 2/16/05<br>4/06/05 |
| T-36 | CB, JW | *Is a Blue Whale the Biggest Thing There Is?* (Wells, 1993) | 2/16/05<br>4/06/05 |
| T-37 | CB, JW | *What's Faster than a Speeding Cheetah?* (Wells, 1997) | 2/16/05<br>4/06/05 |
| T-38 | CB, JW | *What's Smaller than a Pygmy Shrew?* (Wells, 1995) | 2/16/05<br>4/06/05 |
| T-39 | CB, JS | *Keeping a Nature Journal, 2nd Edition* (Leslie & Roth, 2000) | 10/05/04 |
| T-40 | CB | *Pass the Energy, Please!* (McKinney, 2000) | 2/18/05 |
| T-41 | CB | *Switch On, Switch Off* (Berger, 1989) | 2/18/05 |
| T-42 | CB | *Volcano: The Eruption and Healing of Mount St. Helens* (Lauber, 1986) | 3/11/05 |
| T-43 | CB | *The Frog Wore Red Suspenders* (Prelutsky, 2002) | 4/27/05 |
| T-44 | CB | *Spectacular Science: A Book of Poems* (Hopkins, 2002b) | 4/27/05 |
| T-45 | CB | *Marsh Music* (Berger, 2000) | 4/27/05 |
| T-46 | CB | *The Other Way to Listen* (Baylor & Parnall, 1978) | 4/27/05 |

| **Code** | **Participant(s)** | **Description** | **Date(s)** |
|---|---|---|---|
| T-47 | CB | *Wonderful Nature, Wonderful You* (Ireland, 1996) | 4/27/05 |
| T-48 | CB | *Science Verse* (Scieszka & Smith, 2004) | 4/27/05 |
| T-49 | CB | *Science Works! Light* (Parker, 1997) | 4/27/05 |
| T-50 | CB | *Eyewitness Science: Light* (Burnie, 1992) | 4/27/05 |
| T-51 | CB | *How Science Works* (Hann, 1991) | 4/27/05 |
| T-52 | CB | *How Big?* (Harris, 2004) | 4/27/05 |
| T-53 | JS | *The Wright Brothers* (Joseph, 1997) | 2/14/05 |
| T-54 | JS | *The Wright Brothers and Aviation* (Parker, 1995) | 2/14/05 |
| T-55 | JS | *Amelia and Eleanor Go For a Ride* (Ryan, 1999) | 2/14/05 |
| T-56 | JS | *Project Ultraswan* (Osborn, 2002) | 2/14/05 |
| T-57 | JS | *Dogsong* (Paulsen, 1985) | 2/14/05 |
| T-58 | JS | Fast Elephants in *Highlights for Children* (Myers, 2004) | 3/09/05 |
| T-59 | JS | A Lifeline for Lions in *Highlights for Children* (Turner, 2004) | 3/09/05 |
| T-60 | JS | Learning from a Baby Bear in *Highlights for Children* (Brown, 2005) | 3/09/05 |
| T-61 | JS | *The Great Kapok Tree: A Tale of the Amazon Rain Forest* (Cherry, 1996) | 3/09/05 |
| T-62 | JS | *The Skull Alphabet Book* (Pallotta & Masiello, 2002) | 3/24/05 |
| T-63 | JS | *Sea Watch: A Book of Poetry* (Yolen, 1996) | 4/27/05 |
| T-64 | JS | *Laughing Tomatoes and Other Spring Poems/Jitomates Risuenos y Otros Poemas de Primavera* (Alarcon, 1997) | 4/27/05 |
| T-65 | JS | *Home to Me: Poems Across America* (Hopkins, 2002a) | 4/27/05 |
| T-66 | JS | *Poetry by Heart: A Child’s Book of Poems to Remember* (Attenborough, 2001) | 4/27/05 |
| T-67 | JS | *Flicker Flash* (Graham, 1999) | 4/27/05 |
| T-68 | JS | *Little Dog Poems* (George, 1999) | 4/27/05 |
| T-69 | CB | *Zin! Zin! Zin! A Violin* (Moss, 1995) | 3/11/05 |
| T-70 | CB | *The Talking Earth* (George, 1983) | 1/04/05 |
| T-71 | CB | *How Tall, How Short, How Faraway* (Adler, 1999) | 2/16/05 |
| T-72 | CB | *How Do You Lift a Lion?* (Wells, 1996) | 2/16/05 |
| T-73 | CB | *Can You Count to a Googol?* (Wells, 2000) | 2/16/05 |
| T-74 | CB | *Lifetimes* (Rice, 1997) | 2/16/05 |
| T-75 | CB | *Agatha’s Feather Bed: Not Just Another Wild Goose Story* (Deedy, 1991) | 2/16/05 |
| T-76 | CB | *How Groundhog’s Garden Grew* (Cherry, 2003) | 1/04/05 |

# Appendix D: Books Supporting Theme 1—Science as a Human Endeavor

| Code | Title | Fascination, Passion, Interest | Imagination and Creativity | Values: Environmental Stewardship | Diverse Views of the Natural World/Science | Science in Our Lives |
|---|---|---|---|---|---|---|
| T-2 | *Salamander Room* | X | X | X | | X |
| T-3 | *Take-Along Guide: Snakes, Salamanders, and Lizards* | X | | X | | X |
| T-4 | *Salamander Rain: A Lake & Pond Journal* | X | | X | | X |
| T-5 | *Birds Eat and Eat and Eat* | | | | | X |
| T-6 | *Birds Build Nests* | X | X | | | |
| T-7 | *Eyewitness Explorers: Birds* | | | X | | X |
| T-9 | *Peterson First Guides: Birds* | X | | X | | X |
| T-10 | *National Audubon Society Pocket Guide: Familiar Reptiles and Amphibians of North America* | X | | | | X |
| T-11 | *Peterson First Guides: Reptiles and Amphibians* | | | X | | X |
| T-12 | *National Geographic: My First Pocket Guide—Insects* | X | | | | X |
| T-13 | *All About Frogs* | X | | X | | X |
| T-14 | *Beginners' Guide to Hummingbirds* | X | | X | | X |
| T-15 | *A Dazzle of Hummingbirds* | X | X | X | | X |
| T-16 | *Gardens for Birds, Hummingbirds & Butterflies* | X | | X | | X |
| T-17 | *A Golden Guide: Insects, Revised and Updated* | X | | X | | X |
| T-18 | *Pick, Pull, Snap! Where Once a Flower Bloomed* | X | X | | | X |
| T-19 | *Birds in your Backyard* | X | | X | | X |
| T-20 | *Reader's Digest Pathfinders: Birds* | X | | X | | X |
| T-21 | *Kingfisher Young Knowledge: Birds* | X | X | X | | X |
| T-22 | *Bird Feeder Book: The Complete Guide to Attracting, Identifying and Understanding Your Feeder Birds* | X | | X | | X |
| T-23 | *Plant It and They Will Come… Using Native Trees and Shrubs to Attract Wildlife in Eastern North Carolina* | X | | X | | X |
| T-24 | *Field Guide to Birds of North America, 2nd Edition* | X | | X | | X |
| T-25 | *One Small Square: Swamp* | X | X | X | | X |
| T-26 | *Watching Nature* | X | | X | | X |

| Code | Title | Fascination, Passion, Interest | Imagination and Creativity | Values: Environmental Stewardship | Diverse Views of the Natural World/Science | Science in Our Lives |
|---|---|---|---|---|---|---|
| T-27 | *Stokes Butterfly Book: The Complete Guide to Attracting, Identifying and Understanding Your Feeder Birds* | X | | X | | X |
| T-29 | *Feel the Wind* | | | | | X |
| T-30 | *See for Yourself: Wind* | | | | | X |
| T-31 | *Rain* | | | | | X |
| T-33 | *Saguaro Moon: A Desert Journal* | X | X | X | X | X |
| T-34 | *June 29, 1999* | X | X | | | X |
| T-35 | *Biggest, Strongest, Fastest* | X | | | | |
| T-36 | *Is a Blue Whale the Biggest Thing There Is?* | X | | | | |
| T-37 | *What's Faster than a Speeding Cheetah?* | X | | | | |
| T-38 | *What's Smaller than a Pygmy Shrew?* | X | X | | | |
| T-39 | *Keeping a Nature Journal, 2nd Edition* | X | X | X | | X |
| T-40 | *Pass the Energy, Please!* | X | X | X | | |
| T-41 | *Switch On, Switch Off* | | | | | X |
| T-42 | *Volcano: The Eruption and Healing of Mount St. Helens* | X | | X | | X |
| T-43 | *The Frogs Wore Red Suspenders* | | X | | | |
| T-44 | *Spectacular Science: A Book of Poems* | X | X | | | X |
| T-45 | *Marsh Music* | X | X | | | |
| T-46 | *The Other Way to Listen* | X | X | X | | X |
| T-47 | *Wonderful Nature, Wonderful You* | X | X | X | | |
| T-48 | *Science Verse* | X | X | | | X |
| T-49 | *Science Works! Light* | X | | | | X |
| T-50 | *Eyewitness Science: Light* | | X | | | X |
| T-51 | *How Science Works* | | X | X | | X |
| T-52 | *How Big?* | X | | | | |
| T-53 | *The Wright Brothers* | X | X | | | X |
| T-54 | *The Wright Brothers and Aviation* | X | X | | | X |
| T-55 | *Amelia and Eleanor Go For a Ride* | X | X | X | | X |
| T-56 | *Project Ultraswan* | X | X | X | | X |
| T-57 | *Dogsong* | X | X | X | X | X |
| T-58 | *Fast Elephants (Highlights for Children)* | | X | | | X |
| T-59 | *A Lifeline for Lions (Highlights for Children)* | X | | X | | X |

| Code | Title | Fascination, Passion, Interest | Imagination and Creativity | Values: Environmental Stewardship | Diverse Views of the Natural World/Science | Science in Our Lives |
|---|---|---|---|---|---|---|
| T-60 | *Learning from a Baby Bear (Highlights for Children)* | X | | | | X |
| T-61 | *The Great Kapok Tree: A Tale of the Amazon Rain Forest* | X | X | X | | X |
| T-62 | *The Skull Alphabet Book* | X | X | | | |
| T-63 | *Sea Watch: A Book of Poetry* | X | X | | | |
| T-64 | *Laughing Tomatoes and Other Spring Poems/Jitomates Risuenos y Otros Poemas de Primavera* | X | X | | | X |
| T-65 | *Home to Me: Poems Across America* | X | X | | | X |
| T-66 | *Poetry by Heart: A Child's Book of Poems to Remember* | X | X | | | X |
| T-67 | *Flicker Flash* | X | X | | | X |
| T-68 | *Little Dog Poems* | X | X | | | X |
| T-69 | *Zin! Zin! Zin! A Violin* | | X | | | X |
| T-70 | *The Talking Earth* | X | X | X | X | X |
| T-71 | *How Tall, How Short, How Faraway* | X | | | | X |
| T-72 | *How Do You Lift a Lion?* | X | | | | X |
| T-73 | *Can You Count to a Googol?* | X | X | | | X |
| T-74 | *Lifetimes* | X | X | X | | X |
| T-75 | *Agatha's Feather Bed: Not Just Another Wild Goose Story* | X | X | X | | X |
| T-76 | *How Groundhog's Garden Grew* | X | X | X | | X |

## Appendix E: A Look at Race and Gender in the Children's Books

| Code | Title | | Race | | | | | Gender | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No Specific People in Text | At Least Some Racial Diversity | Native People Only | Hispanic People Only | White People Only | Race Unclear | Females and Males | Females Only | Males Only | Gender Unclear |
| T-2 | *Salamander Room* | | | | | X | | X | | | |
| T-3 | *Take-Along Guide: Snakes, Salamanders, and Lizards* | X | | | | | | | | | |
| T-4 | *Salamander Rain: A Lake & Pond Journal* | | X | | | | | X | | | |
| T-5 | *Birds Eat and Eat and Eat* | | | | | X | | | | X | |
| T-6 | *Birds Build Nests* | X | | | | | | | | | |
| T-7 | *Eyewitness Explorers: Birds* | | | | | X | | X | | | |
| T-9 | *Peterson First Guides: Birds* | X | | | | | | | | | |
| T-10 | *National Audubon Society Pocket Guide: Familiar Reptiles and Amphibians of North America* | X | | | | | | | | | |
| T-11 | *Peterson First Guides: Reptiles and Amphibians* | X | | | | | | | | | |
| T-12 | *National Geographic: My First Pocket Guide—Insects* | | | | | X | | | X | | |
| T-13 | *All About Frogs* | X | | | | | | | | | |
| T-14 | *Beginners' Guide to Hummingbirds* | X | | | | | | | | | |
| T-15 | *A Dazzle of Hummingbirds* | X | | | | | | | | | |
| T-16 | *Gardens for Birds, Hummingbirds &* | | | | | X | | | | | X |
| T-17 | *A Golden Guide: Insects, Revised and Updated* | X | | | | | | | | | |
| T-18 | *Pick, Pull, Snap! Where Once a Flower Bloomed* | | X | | | | | X | | | |
| T-19 | *Birds in your Backyard* | | X | | | | | X | | | |
| T-20 | *Reader's Digest Pathfinders: Birds* | | X | | | | | X | | | |
| T-21 | *Kingfisher Young Knowledge: Birds* | | | | | X | | | | | X |
| T-22 | *Bird Feeder Book: The Complete Guide to Attracting, Identifying and Understanding Your Feeder Birds* | | | | | | X | | | | X |

| Code | Title | No Specific People in Text | Race | | | | | Gender | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | At Least Some Racial Diversity | Native People Only | Hispanic People Only | White People Only | Race Unclear | Females and Males | Females Only | Males Only | Gender Unclear |
| T-23 | *Plant It and They Will Come… Using Native Trees and Shrubs to Attract Wildlife in Eastern North Carolina* | X | | | | | | | | | |
| T-24 | *Field Guide to Birds of North America, 2nd Edition* | X | | | | | | | | | |
| T-25 | *One Small Square: Swamp* | X | | | | | | | | | |
| T-26 | *Watching Nature* | | | | | X | | X | | | |
| T-27 | *Stokes Butterfly Book: The Complete Guide to Attracting, Identifying and Understanding Your Feeder Birds* | X | | | | | | | | | |
| T-28 | *Weather* | | | | | | X | | | | X |
| T-29 | *Feel the Wind* | | X | | | | | X | | | |
| T-30 | *See for Yourself: Wind* | | X | | | | | X | | | |
| T-31 | *Rain* | | | | | X | | X | | | |
| T-32 | *Rain, Snow and Ice: Weather Report* | X | | | | | | | | | |
| T-33 | *Saguaro Moon: A Desert Journal* | | X | | | | | X | | | |
| T-34 | *June 29, 1999* | | X | | | | | X | | | |
| T-35 | *Biggest, Strongest, Fastest* | X | | | | | | | | | |
| T-36 | *Is a Blue Whale the Biggest Thing There* | X | | | | | | | | | |
| T-37 | *What's Faster than a Speeding Cheetah?* | | X | | | | | X | | | |
| T-38 | *What's Smaller than a Pygmy Shrew?* | X | | | | | | | | | |
| T-39 | *Keeping a Nature Journal, 2nd Edition* | | X | | | | | X | | | |
| T-40 | *Pass the Energy, Please!* | | X | | | | | X | | | |
| T-41 | *Switch On, Switch Off* | | | | | X | | X | | | |
| T-42 | *Volcano: The Eruption and Healing of Mount St. Helens* | | | | | X | | | | X | |
| T-43 | *The Frogs Wore Red Suspenders* | | X | | | | | X | | | |
| T-44 | *Spectacular Science: A Book of Poems* | | X | | | | | | | | X |
| T-45 | *Marsh Music* | X | | | | | | | | | |
| T-46 | *The Other Way to Listen* | | X | | | | | X | | | |
| T-47 | *Wonderful Nature, Wonderful You* | | | | | | X | | | | X |
| T-48 | *Science Verse* | | X | | | | | X | | | |

| Code | Title | No Specific People in Text | Race | | | | | Gender | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | At Least Some Racial Diversity | Native People Only | Hispanic People Only | White People Only | Race Unclear | Females and Males | Females Only | Males Only | Gender Unclear |
| T-49 | *Science Works! Light* | | X | | | | | X | | | |
| T-50 | *Eyewitness Science: Light* | | | | | X | | X | | | |
| T-51 | *How Science Works* | | X | | | | | X | | | |
| T-52 | *How Big?* | | X | | | | | X | | | |
| T-53 | *The Wright Brothers* | | | | | X | | | | X | |
| T-54 | *The Wright Brothers and Aviation* | | | | | X | | | | X | |
| T-55 | *Amelia and Eleanor Go For a Ride* | | | | | X | | | X | | |
| T-56 | *Project Ultraswan* | | | | | X | | X | | | |
| T-57 | *Dogsong* | | | X | | | | X | | | |
| T-58 | *Fast Elephants (Highlights for Children)* | | | | | | X | | | X | |
| T-59 | *A Lifeline for Lions (Highlights for Children)* | | | | | | X | X | | | |
| T-60 | *Learning from a Baby Bear (Highlights for Children)* | | | | | | X | X | | | |
| T-61 | *The Great Kapok Tree: A Tale of the Amazon Rain Forest* | | | X | | | | | | X | |
| T-62 | *The Skull Alphabet Book* | | | | | | X | | | X | |
| T-63 | *Sea Watch: A Book of Poetry* | X | | | | | | | | | |
| T-64 | *Laughing Tomatoes and Other Spring Poems/Jitomates Risuenos y Otros* | | | | X | | | X | | | |
| T-65 | *Home to Me: Poems Across America* | | X | | | | | X | | | |
| T-66 | *Poetry by Heart: A Child's Book of Poems to Remember* | | X | | | | | X | | | |
| T-67 | *Flicker Flash* | | X | | | | | X | | | |
| T-68 | *Little Dog Poems* | | X | | | | | X | | | |
| T-69 | *Zin! Zin! Zin! A Violin* | | X | | | | | X | | | |
| T-70 | *The Talking Earth* | | | X | | | | X | | | |
| T-71 | *How Tall, How Short, How Faraway* | | | | | | X | X | | | |
| T-72 | *How Do You Lift a Lion?* | | X | | | | | X | | | |
| T-73 | *Can You Count to a Googol?* | | X | | | | | X | | | |
| T-74 | *Lifetimes* | | | | | X | | X | | | |

| Code | Title | No Specific People in Text | Race: At Least Some Racial Diversity | Race: Native People Only | Race: Hispanic People Only | Race: White People Only | Race: Race Unclear | Gender: Females and Males | Gender: Females Only | Gender: Males Only | Gender: Gender Unclear |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T-75 | *Agatha's Feather Bed: Not Just Another Wild Goose Story* | | | | | | X | X | | | |
| T-76 | *How Groundhog's Garden Grew* | | | | | | X | | X | | |

# Appendix F: Books Supporting Theme 2—Firsthand Investigation: Empirical Evidence Underlies Scientific Understanding

| Code | Title | Observe, experiment and/or measure | Use of equipment, tools, and/or technology | Collect, identify, analyze, and/or record data | Infer carefully. Avoid assumptions and jumping to conclusions. | Direct attention to science as discovered by scientists through firsthand investigation | Indirect promotion of observation and gathering and analyzing data |
|---|---|---|---|---|---|---|---|
| T-3 | *Take-Along Guide: Snakes, Salamanders, and Lizards* | X | X | X | | | |
| T-4 | *Salamander Rain: A Lake & Pond Journal* | X | X | X | | | |
| T-5 | *Birds Eat and Eat and Eat* | X | X | X | | | |
| T-6 | *Birds Build Nests* | | | | | | X |
| T-7 | *Eyewitness Explorers: Birds* | X | | X | | | |
| T-9 | *Peterson First Guides: Birds* | X | | X | | | |
| T-10 | *National Audubon Society Pocket Guide: Familiar Reptiles and Amphibians of North America* | X | | X | | | |
| T-11 | *Peterson First Guides: Reptiles and Amphibians* | X | | X | | | |
| T-12 | *National Geographic: My First Pocket Guide—Insects* | X | X | X | | | |
| T-13 | *All About Frogs* | X | | | | | X |
| T-14 | *Beginners' Guide to Hummingbirds* | X | X | X | | | |
| T-15 | *A Dazzle of Hummingbirds* | X | X | X | | X | |
| T-16 | *Gardens for Birds, Hummingbirds & Butterflies* | X | X | X | | | |
| T-17 | *A Golden Guide: Insects, Revised and Updated* | X | X | X | | | |
| T-18 | *Pick, Pull, Snap! Where Once a Flower Bloomed* | | | | | | X |
| T-19 | *Birds in your Backyard* | X | X | X | | | |
| T-20 | *Reader's Digest Pathfinders: Birds* | X | X | X | | X | |
| T-21 | *Kingfisher Young Knowledge: Birds* | X | X | X | | | |
| T-22 | *Bird Feeder Book: The Complete Guide to Attracting, Identifying and Understanding Your Feeder Birds* | X | X | X | X | X | |
| T-23 | *Plant It and They Will Come… Using Native Trees and Shrubs to Attract Wildlife in Eastern North Carolina* | | | | | | X |
| T-24 | *Field Guide to Birds of North America, 2nd Edition* | X | X | X | | | |
| T-25 | *One Small Square: Swamp* | X | X | X | | | |
| T-26 | *Watching Nature* | X | X | X | X | | |
| T-27 | *Stokes Butterfly Book: The Complete Guide to Attracting, Identifying and Understanding Your Feeder Birds* | X | X | X | | | |
| T-28 | *Weather* | | X | X | | | |

| Code | Title | Observe, experiment and/or measure | Use of equipment, tools, and/or technology | Collect, identify, analyze, and/or record data | Infer carefully. Avoid assumptions and jumping to conclusions. | Direct attention to science as discovered by scientists through firsthand investigation | Indirect promotion of observation and gathering and analyzing data |
|---|---|---|---|---|---|---|---|
| T-29 | *Feel the Wind* | X | X | X | | | |
| T-30 | *See for Yourself: Wind* | X | X | X | | | |
| T-31 | *Rain* | X | X | X | | | |
| T-33 | *Saguaro Moon: A Desert Journal* | X | X | X | | | |
| T-34 | *June 29, 1999* | X | | X | X | | |
| T-35 | *Biggest, Strongest, Fastest* | X | X | X | | | |
| T-36 | *Is a Blue Whale the Biggest Thing There Is?* | X | X | X | | | |
| T-37 | *What's Faster than a Speeding Cheetah?* | X | | X | | X | |
| T-38 | *What's Smaller than a Pygmy Shrew?* | X | X | X | | | |
| T-39 | *Keeping a Nature Journal, 2nd Edition* | X | X | X | | | |
| T-41 | *Switch On, Switch Off* | X | X | | | | |
| T-42 | *Volcano: The Eruption and Healing of Mount St. Helens* | X | X | X | | X | |
| T-43 | *The Frogs Wore Red Suspenders* | | | | | | X |
| T-44 | *Spectacular Science: A Book of Poems* | X | X | | | | |
| T-45 | *Marsh Music* | | | | | | X |
| T-46 | *The Other Way to Listen* | X | | | | | |
| T-47 | *Wonderful Nature, Wonderful You* | | | | | | X |
| T-48 | *Science Verse* | X | | X | | | |
| T-49 | *Science Works! Light* | X | X | X | | X | |
| T-50 | *Eyewitness Science: Light* | X | X | X | | X | |
| T-51 | *How Science Works* | X | X | X | | X | |
| T-52 | *How Big?* | X | X | X | | | |
| T-53 | *The Wright Brothers* | X | | | | X | |
| T-54 | *The Wright Brothers and Aviation* | X | | | | X | |
| T-56 | *Project Ultraswan* | X | X | X | | X | |
| T-57 | *Dogsong* | X | | X | | | |
| T-58 | *Fast Elephants (Highlights for Children)* | X | X | X | | X | |
| T-59 | *A Lifeline for Lions (Highlights for Children)* | X | X | X | | X | |
| T-60 | *Learning from a Baby Bear (Highlights for Children)* | X | X | X | | X | |
| T-61 | *The Great Kapok Tree: A Tale of the Amazon Rain Forest* | | | X | | | |
| T-62 | *The Skull Alphabet Book* | X | | | X | | |
| T-63 | *Sea Watch: A Book of Poetry* | | | | | | X |

| Code | Title | Observe, experiment and/or measure | Use of equipment, tools, and/or technology | Collect, identify, analyze, and/or record data | Infer carefully. Avoid assumptions and jumping to conclusions. | Direct attention to science as discovered by scientists through firsthand investigation | Indirect promotion of observation and gathering and analyzing data |
|---|---|---|---|---|---|---|---|
| T-64 | *Laughing Tomatoes and Other Spring Poems/Jitomates Risuenos y Otros Poemas de Primavera* | | | | | | X |
| T-65 | *Home to Me: Poems Across America* | | | | | | X |
| T-66 | *Poetry by Heart: A Child's Book of Poems to Remember* | | | | | | X |
| T-67 | *Flicker Flash* | X | | | | | X |
| T-68 | *Little Dog Poems* | | | | | | X |
| T-69 | *Zin! Zin! Zin! A Violin* | | | | | | X |
| T-70 | *The Talking Earth* | | | | | | |
| T-71 | *How Tall, How Short, How Faraway* | X | X | X | | | |
| T-72 | *How Do You Lift a Lion?* | X | X | X | | | |
| T-73 | *Can You Count to a Googol?* | X | | X | | X | |
| T-74 | *Lifetimes* | X | X | X | | | |
| T-76 | *How Groundhog's Garden Grew* | X | | | | | X |

# Appendix G: Books Supporting Theme 3—"We don't have to rediscover the wheel:" A Durable Body of Scientific Knowledge

| NOS | Trade Books |
|---|---|
| Most, if not all, of the text presents the nature of science as a durable body of knowledge | Harris, N. (2004). *How big?* Flying Frog.<br>Jenkins, S. (1995). *Biggest, strongest, fastest*. Boston: Houghton Mifflin Company.<br>Merk, A., & Merk, J. (1994). *Rain, snow and ice*. Vero Beach, FL: The Rourke Corporation.<br>Simon, S. (1993). *Weather*. New York: Morrow Junior Books.<br>Wells, R. E. (1996). *How do you lift a lion?* Morton Grove, IL: Albert Whitman & Company.<br>Wells, R. E. (1993). *Is a blue whale the biggest thing there is?* Morton Grove, IL: Albert Whitman & Company.<br>Wells, R. E. (1995). *What's smaller than a pygmy shrew?* Morton Grove, IL: Albert Whitman & Company.<br>Wells, R. E. (1997). *What's faster than a speeding cheetah?* Morton Grove, IL: Albert Whitman & Company. |
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# Vita

Patricia Lynn Bricker was born in Cold Springs, New York on May 4, 1967. She was raised in Mohegan Lake, New York and graduated from Yorktown High School in 1985. She earned her Bachelor of Science degree in Natural Resources from Cornell University in 1989. As an environmental educator, Patricia worked at Trailside Nature Museum in Pound Ridge, New York and for Cornell Cooperative Extension in Oswego County, New York. Realizing her passion for teaching, Patricia earned a Masters of Science degree in Teaching and Curriculum from the University of Rochester in 1993. From 1993 to 1995 she taught 6th grade in Delhi, New York. For the next five years she taught 4th grade at Concord Road Elementary in Ardsley, New York. While teaching at Concord Road, Patricia participated in professional development opportunities and teacher leadership groups that were part of the Reading and Writing Institute at Teachers College, Columbia University. Her related teacher-researcher experiences focused on differentiating the teaching of reading and on nonfiction reading. In 2000 Patricia moved to North Carolina and taught 4th grade at Isaac Dickson Elementary in Asheville. Since 2001 she has been a faculty member in the Department of Elementary and Middle Grades Education at Western Carolina University in Cullowhee, North Carolina. She has taught courses in science education, language arts education, adolescent literature, and issues and trends in elementary education, in addition to supervising interns. Patricia is currently the department's program coordinator for elementary education. She began work on her Doctorate of Education at the University of Tennessee in 2002.