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A Content Analysis of Inquiry in Third Grade Science Textbooks

Rebecca Adams Lewis

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of
Master of Arts

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ABSTRACT

A Content Analysis of Inquiry in Third Grade Science Textbooks

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Since the publication of the *National Science Education Standards* in 1996 efforts have been made to include inquiry into school science programs. An addendum on inquiry to these standards was published in 2000 presenting five essential features of classroom inquiry as indicators of the active use of inquiry in a science lesson. The purpose of this content analysis was to examine and identify the presence of these five essential features of classroom inquiry within publisher-identified inquiry activities found in the 2000 and 2010 teacher's editions of the third grade science textbooks published by Scott Foresman. The textbooks were read and coded using each of the five essential features of classroom inquiry as a priori categories. Data from both textbook editions indicated that although these activities were identified as inquiries, only a few contained all five essential features, while about half contained none. Approximately half of the publisher-identified inquiries were partial inquiries, containing less than five of the essential features. Teachers who use these resources should be aware of the presence or lack of the essential features in order to supplement the science curriculum. Publishers need to be more explicit in including these features and further research should be conducted in more textbooks to better understand the quality and quantity of inquiry activities found within these resources.

Keywords: inquiry, five essential features of classroom inquiry, science textbooks

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Chapter 1

Introduction

Over the last several decades, discussions about the nature and substance of science education amongst educators, policy makers, and scientists have focused on making sure all U.S. students receive a quality science education in the nation's schools. The desired outcome of these conversations is concentrated on providing foundational science understandings for every student in America, thus producing a citizenry that is scientifically literate (Bybee, 1997; NRC, 2000). This would not only enhance students' understanding of the nature of science and the world around them, but also position them to compete in and contribute to current global conditions (Committee on Science Engineering and Public Policy, 2006; National Research Council, 1996; Rising Above the Gathering Storm Committee, 2010). These goals have prompted a restructuring of science education and have become a driving force for change in how science is attended to in the school curriculum.

National Science Education Standards

The *National Science Education Standards* (hereafter called the Standards) were developed in cooperation by members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine under the direction of the National Research Council (NRC) and published in 1996. The Standards provide a common framework for science education stakeholders, including “teachers; science supervisors; curriculum developers; publishers; those who work in museums, zoos, and science centers; science educators; scientists and engineers across the nation; school administrators; school board members; parents; members of business and industry; and legislators and other public officials” (NRC, 1996, p. ix).

The Standards are comprised of six basic domains or standards: science teaching, teacher professional development, assessment, content, science education programs, and science education systems (NRC, 1996). Each set of standards focuses on attaining the goal of improving science education and developing scientific literacy in students (Bybee, 1997). While each of these sets of standards addresses a unique aspect of science education, inquiry emerges as a critical key element shared across and throughout all of the standards. Inquiry is identified as fundamental to the way science is done as well as the way science should be taught in classrooms (Bybee, 1997; NRC, 1996; 2000).

Inquiry in Science

Inquiry is a term with multiple meanings, depending on the context. Pertaining to science, Anderson (2002) identified and defined three different usages of the term: (1) what scientists *do* is *scientific inquiry*, (2) how students *learn* science is *inquiry learning*, and (3) how teachers *teach* science is *inquiry teaching*. While each of these usages of inquiry is interrelated, each contains characteristics that make it “fairly distinct from the other two, even though each has various nuances” (p. 2).

Scientific inquiry refers to the abilities and understandings of scientists as they conduct scientific investigations. Inquiry used in this way “refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work” (NRC, 1996, p. 23). This view of inquiry “reflects an understanding of how science proceeds and is independent of educational processes” (Anderson, 2002, p. 2).

Inquiry learning “refers to a learning process in which students are engaged” (Anderson, 2002, p. 2). When students are engaged in inquiry they are describing objects and events, asking questions, posing explanations, testing explanations by comparing them to current scientific

knowledge, and communicating explanations to others (NRC, 2000). Students learn to identify their assumptions, think critically, and consider other explanations as well as their own. In this process students learn how to enact the process of science inquiry as well as use the inquiry process to learn science content (Morrison & Young, 2008). By so doing, “students are actively developing their understanding of science by combining scientific knowledge with reasoning and thinking skills” (NRC, 1996, p. 2). Thus, this particular learning process helps to develop scientific literacy in students because they go through a process similar to the process that scientists use as they explore natural phenomena.

Inquiry teaching is a method of instruction as well as a certain kind of learning activity (Anderson, 2002). Teachers guide students through the inquiry process as they answer questions provided by the teacher or generated from their own observations (see NRC, 2000). An inquiry learning activity is one that takes the student through an inquiry process similar or parallel to the inquiry process used by scientists as they engage in scientific inquiry to answer real-world questions.

In order to help teachers successfully integrate these three aspects of inquiry into science classrooms, the Committee on Development of an Addendum to the *National Science Education Standards* on Scientific Inquiry described five *essential features of classroom inquiry* to identify the active use of inquiry in science lessons (NRC, 2000). These essential features are

1. Learners are engaged by scientifically oriented questions.
2. Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.
3. Learners formulate explanations from evidence to address scientifically oriented questions.

4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.
5. Learners communicate and justify their proposed explanations. (p. 25)

For school science programs to be most successful in developing scientific literacy in students, all five essential features of classroom inquiry must be fully integrated into science inquiry learning activities.

Each of these features is clearly focused on the role of the learner when doing inquiry and prompts students to discover the nature of the scientific enterprise while learning science concepts. In essence, as students develop the skills to conduct scientific investigations, their knowledge of science concepts and processes is enhanced. Thus, “the path from formulating scientific questions, to establishing criteria for evidence, to proposing, evaluating, and then communicating explanations is an important set of experiences for school science programs” (NRC, 2000, pp. 27–28).

Science Textbooks

While there are many resources or instructional materials available to classroom teachers for teaching science, one resource that many teachers have traditionally relied on has been science textbooks (Roseman, Kulm, & Shuttlesworth, 2001). Textbooks are designed to provide complete grade-level programs that include all content and materials that teachers will need to teach a given academic subject (Ball & Feiman-Nemser, 1988; Yager, 1996). In addition, textbooks have traditionally been accessible to most teachers, depending on school funding, to support their science programs and instruction. Access to such comprehensive science programs and materials is especially important for teachers who are new, inexperienced, or lack adequate time to plan quality science lessons. Indeed, some studies have reported that many teachers rely

heavily, if not exclusively, upon textbooks to teach science (Roseman et al., 2001; Schwarz et al., 2008).

Historically, the content and strategies in science textbooks have not attended to inquiry based teaching or learning or the development of scientific literacy (American Association for the Advancement of Science, 1989). In fact, the reform document *Science for All Americans* (American Association for the Advancement of Science, 1989) boldly addresses the drawbacks related to the use of science textbooks:

The present science textbooks and methods of instruction, far from helping, often actually impede progress toward science literacy. They emphasize the learning of answers more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understandings in context, recitation over argument, reading in lieu of doing. They fail to encourage students to work together, to share ideas and information freely with each other, or to use modern instruments to extend their intellectual capabilities. (p. 14)

In short, science textbooks have characteristically focused on low-level cognitive skills, such as the acquisition of facts and knowledge, to the exclusion of developing critical thinking skills such as evaluation and application. As a result, those teachers who have traditionally depended on science textbooks for their curriculum may have failed to adequately address the Standards and the important inquiry focus that permeates them.

Since the publication of the Standards nearly 16 years ago, the emphasis of the science education community has been the inclusion of inquiry in science classrooms. The Standards have called for less emphasis on “focusing on student acquisition of information” and more emphasis on “focusing on student understanding and use of scientific knowledge, ideas, and

inquiry processes” (NRC, 1996, p. 3). They have also asked for less emphasis on “presenting scientific knowledge through lecture, text, and demonstration” and more emphasis on “guiding students in active and extended scientific inquiry” (p. 3). In an effort to promote and secure the purchase of their products, science textbook publishers continually change and adjust their textbooks and materials to appeal to education stakeholders. Thus, knowing the importance of the Standards and the focus on inquiry-based teaching and learning, it seems likely that science textbook publishers would make every effort to align their materials with the current trends in science education.

Statement of the Problem

While efforts have been made over time to support the teaching of science in the classroom, it is unclear how science textbooks have attended to the use of inquiry in science instruction. Although some studies have been conducted to determine how closely current science textbooks align with the Standards, such as the inclusion of specific content (Davis, 2006; Stern & Roseman, 2004), there has been little research conducted to determine the inclusion of inquiry, as emphasized in the Standards, in science textbooks (Roseman et al., 2001), especially at the elementary level.

Given the likelihood that many teachers use textbooks as their science curriculum (Rillero, 2010; Yager, 1996), it becomes imperative that the textbooks they use and the accompanying teaching materials are aligned with the Standards. Further, with the overarching emphasis on inquiry to promote science understanding and literacy, it is important to know how much inquiry-based teaching and learning is provided through those resources.

Purpose and Question of the Study

Little is known about the inclusion of the five essential features of classroom inquiry in elementary science textbooks since the publication of the Standards in 1996 and the Addendum in 2000. Therefore, the purpose of this study was to explore the inclusion of the five essential features of classroom inquiry in activities identified as inquiries by the publisher in an elementary science textbook.

Two questions guided my research and aligned with the purpose of the study: “How do science textbooks attend to the five essential features of classroom inquiry in the 2000 and 2010 editions of third grade texts produced by one publisher?” and “How do these editions of the third grade science textbooks compare in the way they attend to the five essential features of classroom inquiry since the publication of *Inquiry and the National Science Education Standards* in 2000?” This investigation allowed me to gain insights into how the five essential features of classroom inquiry were attended to in science textbooks produced by one publisher prior to the *Inquiry and the National Science Education Standards* (NRC, 2000), and then ten years following the publication.

Limitation of the Study

This study will examine science textbooks from only one publisher, for two publication years, and only for one grade level. Therefore, the results of this study will not be generalizable across all publishers, publication years, or grade levels.

Chapter 2

Review of the Literature

A review of the literature was conducted to support my exploration into the inclusion of inquiry in the 2000 and 2010 teacher's editions of third grade science textbooks published by one publisher. The following sections contain an overview of the inception and purpose of the Standards, followed by discussions of inquiry in science education, the five essential features of classroom inquiry, and science textbooks. This review situates this study relative to the research literature in science education.

National Science Education Standards

During the early 1990s, the National Science Teachers Association, the National Academy of Science, and the NRC collaborated to establish a common vision for science education in the United States. The result of this long-term collaboration was the creation of the Standards (NRC, 1996). These standards address six major areas (teaching, professional development, assessment, content, education programs, and education systems), which encompass all key aspects of science education. The Standards were developed not just for public school science educators, but also for all those who take part in furthering science education.

The framers of these standards understood that the implementation of the Standards throughout the nation would be time consuming, expensive, and, at times, uncomfortable (NRC, 1996) for educators on all levels and for textbook publishers attempting to attend to the new standards in their publications. The Standards called for all parties involved to maintain the shared vision of science education promoted in the standards and to diligently work toward the common goal of implementing all aspects of the standards into the nation's educational system.

Since their publication in 1996, the Standards have been widely adopted by school districts, institutions of higher education, and accrediting bodies of teacher preparation programs. The implementation of the Standards has been an extremely slow process, but the goal is for these standards to become the cornerstone for science education in the United States.

Each of the six standards identified in the Standards are independent of each other. However, a prominent feature of the Standards is a focus on inquiry. Indeed, the Standards call for an increased emphasis on inquiry in science classrooms. Inquiry in science education is reviewed in the following section.

Inquiry in Science

According to Anderson's (2002) review of the use of inquiry in science education as defined by the Standards, there are three main usages of the term inquiry: scientific inquiry, inquiry learning, and inquiry teaching. While there are distinct differences between each of these usages, all are closely linked. According to the Standards, scientific inquiry is the real work of scientists; it is what they do. Inquiry learning should reflect the essence of what is accomplished through scientific inquiry—how scientists learn about the natural world. While inquiry learning may be present in the school context, it may also take place outside of the classroom. Inquiry teaching “refers to the activities of students in which they develop knowledge and understandings of scientific ideas, as well as an understanding of how scientists study the natural world” (NRC, 1996, p. 23). Inquiry learning and inquiry teaching occur in the classroom, typically at the same time, and are often referred to as *classroom-based inquiry* (Southerland, Smith, Sowell, & Kittleson, 2007).

After the publication of the Standards, there was a need to delve further into the concept of inquiry and what it might look like in science classrooms. Therefore, the Committee on

Science Education K-12, a standing board within the Center for Science, Mathematics, and Engineering Education at the NRC, commissioned the Committee on the Development of an Addendum to the *National Science Education Standards* on Scientific Inquiry. This committee was charged with “producing a document that would help educators improve the quality of teaching, learning, and assessment through the use of inquiry” (NRC, 2000, p. xvii). While the Standards had provided “a vision of science education that [would] make scientific literacy for all a reality in the 21st Century” (NRC, 2000, p. xv), the new document, *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* (hereafter called the Addendum), would serve as “a practical guide for teachers, professional developers, administrators, and others who wished to respond to the Standards’ call for an increased emphasis on inquiry” (NRC, 2000, p. xvi). One of the major purposes of the Addendum is to focus on inquiry in the classroom (inquiry-based teaching and learning), as distinguished from inquiry as practiced by scientists. Thus, it includes a background discussion of inquiry, a summary of pertinent research describing the value of inquiry in science education, specific actions that teachers and other stakeholders need to take, and resources for planning and implementation of inquiry.

Five Essential Features of Classroom Inquiry

Considering the importance of classroom-based inquiry in science education, the Committee proposed that inquiry teaching and learning include five essential features that apply across all grade levels (NRC, 2000). While teaching approaches “that make full use of inquiry” include all five of these features, each feature can vary in the “amount of structure provided by the teacher” and “the extent to which students initiate and design” their own investigations (p. 28). As stated earlier, the five essential features of classroom inquiry and their variations are

provided to assist science educators in creating inquiry-based learning experiences that align with the Standards. I discuss each of the five features in the following paragraphs.

The learner engages in scientifically oriented questions. The first of the essential features focuses on a scientifically oriented question that precedes and drives the activity (Asay & Orgill, 2009). In other words, the question provides the driving purpose for pursuing the investigation. There are two main kinds of scientifically oriented questions or questions that lend themselves to empirical investigation: *existence* questions and *causal/functional* questions (NRC, 2000). Existence questions are the “why” questions that seek to understand the origins of a given phenomenon. Some examples of existence questions would be “Why do objects fall towards the earth?” “Why do some rocks contain crystals?” or “Why do humans have chambered hearts?” (p. 24). Many of these types of questions “cannot be addressed by science” (p. 24)

In contrast, causal/functional questions are the “how” questions that “probe mechanisms” (NRC, 2000, p. 24). For example, “How sunlight help plants to grow?” or “How are crystals formed?” (p. 24) are causal/functional questions that probe into how nature works. This type of question is best used in classroom settings as it is more easily answered scientifically.

The learner gives priority to evidence in responding to questions. The second essential feature is that learners collect and evaluate evidence, which allows them to develop and evaluate explanations that address the initial scientifically oriented question(s). Empirical evidence is the element that sets science apart from other subjects of inquiry. Scientists seek accurate data from observations of a given phenomenon. Evidence is drawn from these observations and from measurements taken from natural settings (e.g., a forest), as well as from contrived settings (e.g., laboratories) (Asay & Orgill, 2009). Observations are made using the five senses, using instruments (e.g., a microscope) to enhance the senses, or using instruments

that measure what the senses cannot observe (e.g., magnetic fields). To ensure accurate data, scientists verify evidence through checking the measurements, repeating observations, or gathering different kinds of data about the same phenomenon (NRC, 2000).

In classroom settings, students may be afforded opportunities to gather evidence to develop explanations for scientific phenomena. They could make observations of natural things (e.g., plants, animals, rocks) and then describe the characteristics they observed. They could take measurements of temperature, time, or distance and carefully record them over time to document change. Students could also “obtain evidence from their teacher, instructional materials, the Web, or elsewhere, to ‘fuel’ their inquiries” (NRC, 2000, p. 26).

The learner formulates explanations from evidence. The third essential feature describes the path from evidence to explanation. Forming explanations is the way an individual learns about something unfamiliar or unknown by relating the evidence they gather to what they already know. Thus, forming evidence-based explanations pushes students’ current knowledge further and proposes new understandings. The underlying idea behind this essential feature is that drawing explanations from evidence deepens students’ current understanding so they better see and know the natural world around them (NRC, 2000).

The learner connects explanations to scientific knowledge. The fourth essential feature is that learners evaluate their explanations in light of existing scientific knowledge. Once a scientific explanation is developed, it must be evaluated. Doing so may lead to revision or elimination of the explanation. In evaluating an explanation, the learner may ask themselves questions such as, “Does the evidence support the proposed explanation?” “Does the explanation adequately answer the questions?” “Are there any apparent biases or flaws in the reasoning connecting evidence and explanation?” or “Can other reasonable explanations be derived from

the evidence?” (NRC, 2000, p. 27). Learners then review alternative explanations as they engage in dialogues with each other, compare results, or check their results with those proposed by the teacher, other experts, or instructional materials. Through the process of evaluation, an explanation that is commonly agreed upon by all learners emerges.

What is important to remember with this essential feature is that learners connect their results to the scientific knowledge appropriate to their level of development. Thus, learners should reach conclusions that are “consistent with currently accepted scientific knowledge” (NRC, 2000, p. 27).

The learner communicates and justifies explanations. Lastly, the fifth essential feature is that learners communicate and justify their proposed explanations. Scientists are expected to communicate their explanations clearly and articulately so that others can conduct the same study and conclude with the same results. This sharing allows for further review of an explanation and “the opportunity for other scientists to use the explanation in work on new questions” (NRC, 2000, p. 27). In having students share their explanations, others can “ask questions, examine evidence, identify faulty reasoning, point out statements that go beyond the evidence, and suggest alternative explanations” (p. 27). By sharing their explanations, students eventually become more confident with their conclusions.

All five of the essential features of classroom inquiry are critical components of classroom-based inquiry (NRC, 2000). Teaching strategies and instructional materials may include all five of the essential features of classroom inquiry or may include only some of the features. Inquiries are labeled as *full* or *partial*; an inquiry is said to be full if all five essential features are included and partial if fewer than five features are present.

Benefits and Constraints of Elementary Science Textbooks

Many science educators, especially those who are new or feel unprepared, rely heavily upon textbooks for acquiring content knowledge, planning lessons, teaching resources, and activities (Rillero, 2010; Roseman et al., 2001). Textbooks have guided curriculum, teaching practices, and student learning “ever since the commencement of schooling in the United States (Villaverde, 2003, p. 64).

For many science educators, textbooks offer a predefined scope and sequence of science content, access to scientific concepts and principles, and ways to present these concepts to their students (Ball & Feiman-Nemser, 1988). In fact, “science textbooks are often used as the primary organizer of the subject matter that students are expected to master and provide detailed explanations of topics to be taught” (Chiappetta & Fillman, 2007, p. 1847–1848).

Although some research has been conducted on elementary science textbooks, almost no research was found regarding the inclusion of inquiry in elementary science textbooks. The majority of the research on science textbooks has examined topics such as text structures and content, the nature of science knowledge, American science textbooks compared to those of other countries, and teachers’ use of science textbooks (Ghaderi, 2010; Link-Pérez, Dollo, Weber, & Schussler, 2010; Shim, Young, & Paolucci, 2010).

However, in an analysis of science textbooks conducted by Chiappetta and Fillman (2007), some positive changes in science textbooks over time were reported. Since the introduction of science textbooks in the late 1800s, the instructional format has generally been the same: “Textbook authors first [state] the principles, definitions, and laws and then, sequencing the problems, [ask] students to work them out as an exercise” (Stinner, 1992, p. 1). However, Chiappetta and Fillman (2007) found some changes in the traditional format and

content of some science textbooks in recent years. These changes included “discussions on the nature of science; activities to engage students in gathering information and conducting laboratory investigations; illustrations of the relationships among science, technology and society, and so on” (p. 1848). The changes in the text format of the science textbooks may be evidence of inclusion of the Standards and classroom-based inquiry, but were not identified as such by the researchers.

Summary

The Standards, along with the Addendum, provide the expectations and explanations for quality science education for all students. Threaded throughout the Standards is the key element classroom-based inquiry. This element constitutes the basis of science and science education. For science educators, selecting textbooks is a major decision as the texts may significantly influence the quality of their science instruction and, perhaps more importantly, impact the level of students’ interest and learning during science experiences (Brown, 1965). While textbooks have historically been the most readily available and utilized teacher resource in science education (Rillero, 2010; Yager, 1996), the quality of science textbooks, based on their alignment with the Standards and the inclusion of the five essential features of classroom inquiry, must be addressed when considering how useful textbooks are in achieving the goals of a quality science education (NRC, 2000).

Due to the important role that science textbooks play at all levels, including the elementary grades, there is a need to investigate and understand current trends in science textbooks regarding classroom-based inquiry. Thus, this study will provide useful information by exploring the inclusion of the five essential features of classroom inquiry in the 2000 and 2010

teacher's editions of third grade science textbooks published by Scott Foresman (Scott Foresman, 2000; 2010).

Chapter 3

Methods

The purpose of this study was to explore how inquiry-based teaching and learning activities have been included in elementary science textbooks since the 1996 Standards' emphasis on inquiry and the publication of the Addendum in 2000. The questions guiding this study were, "How do science textbooks attend to the five essential features of classroom inquiry in the 2000 and 2010 editions of third grade texts produced by one publisher?" and "How do these editions compare since the publication of the Addendum in 2000?" The following sections discuss the research design and procedures that were used to conduct this research.

Content Analysis Design

To address my research question, I conducted a content analysis to identify the inclusion of inquiry in elementary science textbooks. Content analysis is a "systematic research method for analyzing textual information in a standardized way that allows evaluators to make inferences about that information" (United States General Accounting Office, 1996, p. 6). Krippendorff (2004) further notes that content analysis allows researchers to better understand textual information and the "contexts of their use" (p. 18). For purposes of this study, this method allowed me to identify the frequency of inquiry activities among those that were identified as inquiries by the publisher in the third grade text materials published by Scott Foresman for the years 2000 and 2010. In conducting a content analysis, three elements must be present: *objectivity*, *system*, and *generality* (Holsti, 1969). The following sections will address each of these elements.

Objectivity. To establish *objectivity*, according to Holsti (1969), each step in the research process must be carried out according to specific predetermined rules and procedures. In order to

ensure that these rules and procedures were consistently attended to, measures to establish trustworthiness were put in place. For this study, these measures included having an expert in the field of science education and I separately analyze a sample data set using the pre-established rules and procedures. The results were compared to determine the reliability of coding prior to beginning this content analysis. In so doing, the trustworthiness of the analysis was enhanced by establishing inter-rater reliability (Armstrong, Gosling, Weinman, & Marteau, 1997) with a science education expert.

System. When content analysis is *systematic*, the content or categories used in the study are chosen according to consistently applied rules (Holsti, 1969). In fact, systematic reading distinguishes a content analyst from any other reader in that the content analyst narrows the scope by which a text is interpreted due to the consistently applied rules predetermined by the analyst (Krippendorf, 2004). This process is intended to limit researcher bias and promote accuracy of analysis.

Generality. Lastly, *generality*, not to be mistaken for *generalization*, means that the findings of the study have relevance to the study itself. This relevance is determined by comparing the results of the text analysis with “other attributes of the documents, with documents produced by other sources, with characteristics of the persons who produced the documents, or the times in which they lived, or the audience for which they were intended” (Holsti, 1969, p. 5). In other words, the researcher must situate the analysis within a more holistic context, or else the findings will lend only a limited understanding of the issue being studied and have little value.

Procedures

In this section, I discuss the procedures for meeting the three requirements of content analysis—objectivity, system, and generality. These requirements are addressed by defining the data sources and establishing the protocol for data analysis.

Data sources. The data for this study were teacher's editions of two third grade science textbooks published by Scott Foresman (Scott Foresman, 2000; 2010). I chose these particular science textbooks over other publishers for several reasons. First, I chose Scott Foresman because it ranks above other third grade science textbooks according to the bestseller rankings on Amazon.com, the largest bookseller in the United States (Brynjolfsson, Smith, & Hu, 2003). A bestseller ranking indicates the relative location of a given text on a list of all the books sold by that bookseller, arranged in order of most copies sold to fewest copies sold. Thus, it is assumed based on this ranking that more third grade classrooms use Scott Foresman science textbooks than those published by any other company. I also selected the 2000 and 2010 editions of this science textbook so I could determine whether or not the five essential features of classroom inquiry were evident in the science textbooks prior to the publication of the Addendum and then ten years after the publication of the Addendum. Finally, I chose to investigate third grade-level textbooks because I currently teach third grade and believe this information will be particularly helpful to me in my own teaching.

Each teacher's edition is divided into separate instructional units that address the three major branches of science: life science, physical science, and earth science. The 2000 edition includes a unit on the human body, a domain not present in the 2010 edition, while the domain of space and technology is unique to the 2010 edition. For this study, I limited my analysis to lessons and units from the three major branches of science included in both of the Scott

Foresman teacher's editions for 2000 and 2010 so that a comparison could be made across the science textbooks.

The format of the teacher's editions allows the teacher to view student textbook pages, teacher instructions, and additional resource information for every lesson and chapter. In each of the teacher's editions is a variety of information, activities, and assessments for the topics and concepts being taught. Some of these are optional, or *do-at-home*, while others are identified by the publisher as critical to lesson development and student understanding. Activities and assessments specifically identified by the publisher as inquiries in the teacher instructions, student text pages, and additional resource information found in the margins of the teacher editions were included in the analysis. Additionally, any outside-of-class activities or suggestions for further investigation were also included in the analysis.

Data analysis. In conducting a content analysis, data are analyzed in steps or phases. In this section, I discuss the procedures for meeting the three requirements of content analysis—objectivity, system, and generality—which are embedded in the five phases of data analysis that were used in this content analysis. These phases are described in the following sections.

Phase I: Establishing coding categories. The first phase of data analysis for this study focused on establishing rules for coding the data to insure objectivity (see Appendix A). Since the coding of the data must be accurate and consistent, I used a priori categories to code the data. When dealing with a priori coding, the pre-determined categories are based upon some theory (Weber, 1990). In my study, the five essential features of classroom inquiry, described by the NRC as indicators of classroom-based inquiry (NRC, 2000), provided the theory upon which my a priori codes were founded. Based on the five essential features, the a priori codes, or coding categories, for this content analysis are described in Table 1.

Table 1

Essential Features, Categories, and Codes

Essential Features of Classroom Inquiry	Category	Code
Learner engages in a scientifically oriented question.	Question	EF1
Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.	Evidence	EF2
Learners formulate explanations from evidence to address scientifically oriented questions.	Explanation	EF3
Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.	Compare	EF4
Learners communicate and justify their proposed explanations.	Communication	EF5

Phase II: Determining recording units. I identified each of the essential features of classroom inquiry according to *recording units*. According to Krippendorf (2004), recording units are “units that are distinguished for separate description, transcription, recording, or coding” (p. 99). In other words, a recording unit is “the specific segment of content that is characterized by placing it in a given category” (Holsti, 1969, p. 116). The recording units for this study were units of meaning. These units included words, phrases, and sentences that communicated each of the essential features of classroom inquiry within a single inquiry-learning activity identified by the publisher. The publisher specifically identified the following as inquiry activities in the 2000 edition (Scott Foresman, 2000): *Extended Inquiry*, *Inquire Further*, *Explore Activity*, *Inquiry: Additional Activity*, *Investigate Activity*, and *Experiment Activity*. Scott Foresman identified all inquiries in the 2010 edition (Scott Foresman, 2010) as *Directed Inquiry*, *Guided Inquiry*, *Full Inquiry*, and *Take-Home Activity*.

Phase III: Creating coding procedures. A textbook analysis coding form was created for this study using the five essential features of classroom inquiry as a priori categories (see Appendix B). The year of text publication, branch of science, and page number of the activity were recorded on the forms for future reference. In addition, key words that name the individual activity were recorded in a separate column for future reference.

A tally mark for each feature present was recorded in the appropriate column—one tally mark for each recording unit per essential feature per inquiry. The tally marks were totaled for each inquiry and recorded in the *inquiry total* column. The numbers in the inquiry total column could range from zero to five for each instance of inquiry analyzed. Based upon the inquiry total, the type of inquiry, full or partial, was recorded with a tally mark in the corresponding column. Thus an activity with an inquiry total of five was recorded as a full inquiry, indicating that the activity included all five essential features, with a tally mark in the full inquiry column. An activity with four or less essential features, indicating that the activity was missing at least one essential feature, was recorded as a partial inquiry with a tally mark in the partial inquiry column.

Phase IV: Reading and coding the data. After attending to the objectivity and systems of the study as described in the previous sections, I then read, interpreted, and coded instances of inquiry in the 2000 and 2010 teacher's editions of the Scott Foresman science texts. The analysis and interpretation of the data for this study required that I, the researcher, be the tool for interpreting the rules and coding procedures and deciding what counted as evidence of the five essential features of classroom inquiry. I carefully read all parts of each page and highlighted the inquiries specifically identified by the publisher. I then evaluated each activity to determine whether or not it addressed any of the five essential features of classroom inquiry and recorded

my analysis on the coding form, as previously explained. I did this for each of the identified inquiries in both of the text editions.

In order to ensure the trustworthiness of my data analysis during this phase, I had a teacher educator with a Ph.D. in science education also analyze a random sample of the identified inquiries using the same rules and procedures I had established for the study. We compared our findings and negotiated any differences in our assessments as needed to create common interpretations of the data and to be sure that my analysis was consistent and dependable.

Phase V: Determining frequency. After coding the inquiries identified in each textbook edition, I tabulated the number of occurrences for each essential feature and calculated their percentages relative to the total number of publisher-identified inquiries. I reported frequencies of total occurrences for each of the five essential features, along with the percent of *full inquiries* and *partial inquiries* in the textbooks. The inquiries with a total of five were labeled as *full inquiry* and those with a total of less than five were labeled as *partial inquiry*. Additionally, percentages for full and partial inquiries and for each of the five essential features of inquiry were calculated for purposes of comparison across publication years and branches of science. This analysis allowed me to know how many full and partial inquiries were included in the science texts.

Researcher Perspective

In order to better understand the lens through which I analyzed and interpreted the data, it is important to share my background information. I earned my bachelor's degree in elementary education and I am currently a master's degree candidate in Teacher Education, with an emphasis in literacy. I have completed my course work and am completing my thesis. For the

last six years I have been employed as a classroom teacher teaching second and third grade. As I have been working on my thesis, I have worked with a science teacher educator with a Ph.D. in Curriculum and Instruction to create and teach inquiry-based science curriculum.

Through my formal education, my experiences as an elementary grade teacher, and the mentoring I received from a science teacher educator, my teaching philosophy and commitment to the importance of science education in the school curriculum has been greatly influenced. Science has become a more important part of my classroom curriculum and I desire to provide a more substantial and meaningful science education to my students to help them gain a greater understanding and appreciation for the world around them.

Chapter 4

Findings

This content analysis was conducted to explore how two third grade science textbooks (Scott Foresman, 2000; 2010) attend to the five essential features of classroom inquiry (NRC, 2000). Comparisons were then made between publication years and among the three major branches of science (life, earth, and physical) common to both. The findings of this study are discussed in the following sections: emergent category of *non-inquiries labeled as inquiries*, inquiry in science textbooks, and inquiry by the major branches of science.

Emergent Category of Non-Inquiries Labeled as Inquiries

When analyzing the data, it became apparent that some of the activities the publisher had identified as inquiries lacked any of the essential features. Since I had previously determined to analyze all publisher-identified inquiries as part of my methodology, I analyzed these publisher-identified activities and created a new category, *non-inquiries labeled as inquiries*. These activities were found within the regular lesson activities in both texts as well as in those labeled *Inquiry: Additional Activity* in the 2000 edition, and in the *Take-Home Activity* segments in the 2010 edition. For example, after a lesson on electricity in the 2000 edition, the *Inquiry: Additional Activity* instructed the teacher to:

Have students use the [comb, wool cloth, paper towel torn into small bits] to observe charges in matter. The comb can be “charged” by rubbing it with a piece of wool cloth. After students read pages B74–B75, ask the following questions about this activity: What happens when you rub the comb with the wool cloth and then bring the comb near the pieces of paper? (The paper jumps to the comb.) Why does this occur? (The comb strongly attracts opposite charges in the paper.) (Scott Foresman, 2000, p. B74)

Even though there were questions included within this and other activities of this type, the questions were not inquiry questions (EF1) as identified in the Addendum (NRC, 2000). The NRC (2000) distinguishes inquiry questions as those that request students to construct explanations from the data they collect. In the example above, students could find answers to the questions by simply reading the text pages indicated in the activity (i.e. pages B74–B75). However, an example of an appropriate inquiry question for this activity could be “How much of a charge is created from rubbing a piece of cloth wool on a comb?” The response would be measured by the number of pieces of paper towel that stick to the comb. If students could not answer the questions by reading the text, the activity could also include prompting questions meant to encourage students to think more specifically about the activity.

Another example of a non-inquiry labeled as inquiry by the publisher is taken from another lesson on electricity, this time from the 2010 edition. In this activity, students are instructed to “Draw a machine that would grow cucumbers in space where there is little gravity. Label the parts that supply the plants with water, fertilizer, carbon dioxide, and light. Write a paragraph explaining how it would work” (Scott Foresman, 2010, p. 32). While this activity asks students to use their imagination and apply what they know about science to this scenario, it does not have an overarching question (EF1) or contain any of the other essential features of classroom inquiry. Thus, the activity was coded *non-inquiry labeled as inquiry* even though the publisher identified it as an inquiry.

Inquiry in Science Textbooks

Findings from the data analysis of the publisher-identified inquiries were focused into three main categories: (a) full inquiries, (b) partial inquiries, and (c) non-inquiries labeled as inquiries. In the following section, I report the results of the data analysis from each of the

textbook editions. The results for each of these sections are reported according to the categories of *full inquiries*, *partial inquiries*, and *non-inquiries labeled as inquiries*.

2000 science textbook. There were a total of 123 publisher-identified inquiries in the 2000 science textbook (Scott Foresman, 2000). These inquiries were identified by the publisher by a variety of headings, including *Inquiry*, *Inquiry: Additional Activity*, *Investigate Activity*, *Explore Activity*, *Extended Inquiry*, and *Experiment Activity*. In the following sections, the results of the data analysis are reported under the headings *full inquiries*, *partial inquiries*, and *non-inquiries labeled as inquiries*.

Full inquiries. After analyzing all 123 publisher-identified inquiries in the 2000 edition, there were only two full inquiries identified. These two full inquiries constituted only 1.6% of the total publisher-identified inquiries in this edition (see Table 2).

Table 2

Comparison of Inquiry Types Across Editions

Textbook Editions	2000		2010	
	Frequency	Percentage	Frequency	Percentage
Full Inquiries	2	1.6	5	6.5
Partial inquiries	76	61.8	38	49.4
Non-Inquiries	45	36.6	34	44.2
Publisher-Identified Inquiries	123	100.0	77	100.0

Partial inquiries. Of the 123 total publisher-identified inquiries in the 2000 edition, 76 (61.8%) inquiries were identified as partial inquiries, meaning that these activities exhibited at least one of the five essential features of classroom inquiry (see Table 2). The presence of each of the five essential features varied among and across each of the partial inquiries identified. Of these, 51 (67.1%) of them were driven by an overarching question (EF1). Thirty-four (44.7%) of the partial inquiries instructed students to collect and record data (EF2), and 33 (43.4%) of the

partial inquiries asked students to construct an explanation based upon the recorded data they collected (EF3). Five (6.6%) of the partial inquiries asked students to compare their explanations with other sources (EF4), and 11 (14.5%) partial inquiries expected students to communicate the results of their inquiry (EF5; see Table 3).

Table 3

Percentages of the Essential Features in Partial Inquiries for 2000 and 2010

Text- book Edition	Publisher Identified Inquiries	Partial Inquiries		Essential Features of Classroom Inquiry									
				EF1		EF2		EF3		EF4		EF5	
		#	%	#	%	#	%	#	%	#	%	#	%
2000	123	76	61.8	51	67.1	34	44.7	33	43.4	5	6.6	11	14.5
2010	77	38	49.4	38	100.0	22	57.9	23	60.5	0	0.0	8	21.1

Non-inquiries labeled as inquiries. Of the 123 publisher-identified inquiries in the 2000 edition, 45 (36.6%) of these were non-inquiries labeled as inquiries (see Table 2). In other words, none of these publisher-identified inquiries contained any of the five essential features of classroom inquiry.

2010 science textbook. In the 2010 science textbook, there were 77 publisher-identified inquiries (see Table 2). These activities were found under headings provided by the publisher such as *Directed Inquiry*, *Guided Inquiry*, *Full Inquiry*, and *Take-Home Activity* (Scott Foresman, 2010). In this edition, inquiries were easily identified by yellow triangles with the words *Lab Zone* written on them. As with the 2000 edition, each of these activities was analyzed for the presence of the five essential features of classroom inquiry and coded as either *full inquiries*, *partial inquiries*, or *non-inquiries labeled as inquiries*. Each of these categories is reported in the following sections.

Full inquiries. Of the total 77 publisher-identified inquiries in the 2010 edition, five (6.5%) were found to be full inquiries (see Table 2). Each of these five full inquiries contained all five of the essential features of classroom inquiry.

Partial inquiries. Thirty-eight (49.4%) of the 77 publisher-identified inquiries in the 2010 edition were identified as partial inquiries containing at least one, but not all, of the essential features (see Table 2). As with the 2000 edition, these partial inquiries were analyzed according to the presence of the five essential features (see Table 3). Of the 38 partial inquiries identified, all were driven by an overarching question (EF1). Over half, 22 (57.9%), of the partial inquiries instructed students to collect and record data (EF2), and 23 (60.5%) of the partial inquiries asked students to construct an explanation based upon the data they collected and recorded (EF3). None of the partial inquiries prompted students to compare their results with another source (EF4). Of the partial inquiries, eight (21.1%) instructed students to either write or orally communicate their results (EF5).

Non-inquiries labeled as inquiries. Of the 77 total publisher-identified inquiries in the 2010 textbook edition, 34 (44.2%) did not have any of the five essential elements of classroom inquiry. Thus, these were clearly non-inquiries labeled as inquiries (see Table 2).

Inquiry by the Major Branches of Science

After the data were analyzed by publication year, the data were examined based on each major branch of science (life, earth, and physical) within both the 2000 and 2010 editions for the five essential features. As with the findings for the textbook editions, the results for each of these branches are reported as *full inquiries*, *partial inquiries*, and *non-inquiries labeled as inquiries*.

Life science. There was a difference in the number of publisher-identified inquiries between the 2000 and 2010 editions for the life science unit (see Table 4). The total number of

publisher-identified inquiries within the life science section of the 2000 edition was 40, while in the 2010 life science section there were 22 inquiries identified by the publisher. Both text editions had one full inquiry, which comprised 2.5% and 4.5% for the 2000 and 2010 editions respectively.

Table 4

Inquiry Types Across Major Branches of Science and Editions

Types of Inquiry	Life Sciences				Earth Sciences				Physical Sciences			
	2000		2010		2000		2010		2000		2010	
	#	%	#	%	#	%	#	%	#	%	#	%
Publisher-Identified Inquiries	40	100.0	22	100.0	38	100.0	27	100.0	45	100.0	28	100.0
Full Inquiries	1	2.5	1	4.5	1	2.6	1	3.7	0	0.0	3	10.7
Partial Inquiries	24	60.0	11	50.0	20	52.6	13	48.1	32	71.1	14	50.0
Non-Inquiries Labeled as Inquiries	15	37.5	10	45.5	17	44.7	13	48.1	13	28.9	11	39.3

In the 2000 edition, there were 24 (60.0%) partial inquiries; there were 11 (50.0%) in the 2010 edition. As with the partial inquiries in each of the texts as a whole, there were differences in the representation and distribution of the essential features between the two editions (see Table 5). There were 17 (70.8%) partial inquiries that were guided by an overarching question (EF1) in the 2000 edition, while there were 11 (100.0%) of the partial inquiries in the 2010 edition that had overarching questions. There were 11 (45.8%) partial inquiries in the 2000 edition and 7 (63.6%) of them in the 2010 edition that instructed students collect and record data (EF2). There were 10 (41.7%) partial inquiries in the 2000 edition and seven (63.6%) partial inquiries in the 2010 edition that asked students to construct an explanation based upon the data they collected and recorded (EF3). Partial inquiries that prompted students to compare their results with another

source (EF4) in either edition of the text were the lowest of the essential features, with just three (12.5%) in the 2000 edition and none (0%) in the 2010 edition. Lastly, the 2000 edition contained three (12.5%) partial inquiries for the 2000 edition and three (27.3%) partial inquiries in the 2010 edition that instructed students to either write or orally communicate their results (EF5).

Table 5

Essential Features in Partial Inquiries Across Branches and Editions

Textbook Edition	Publisher Identified Inquiries	Partial Inquiries		Essential Features of Classroom Inquiry									
				EF1		EF2		EF3		EF4		EF5	
				#	%	#	%	#	%	#	%	#	%
Life Sciences													
2000	40	24	60.0	17	70.8	11	45.8	10	41.7	3	12.5	3	12.5
2010	22	11	50.0	11	100.0	7	63.6	7	63.6	0	0.0	3	27.3
Earth Sciences													
2000	38	20	52.6	14	70.0	9	45.0	9	45.0	2	10.0	3	15.0
2010	27	13	48.1	13	100.0	7	53.8	8	61.5	0	0.0	2	15.4
Physical Science													
2000	45	32	71.1	20	62.5	14	43.8	14	43.8	0	0.0	5	15.6
2010	28	14	50.0	14	100.0	8	57.1	8	57.1	0	0.0	3	21.4

Earth science. Within the earth science sections, results varied between the 2000 and 2010 editions (see Table 4). There were 38 publisher-identified inquiries within the earth science section of the 2000 edition, while there were 27 in the 2010 edition. There was only one full inquiry in each edition, representing 2.6% of the total inquiries in the 2000 edition and 3.7% of the inquiries in the 2010 edition.

Partial inquiries in the 2000 edition totaled 20 (52.6%), while there were 13 (48.1%) in the 2010 edition. In the 2000 edition, there were 17 (44.7%) non-inquiries labeled as inquiries, and there were 13 (48.1%) in the 2010 edition. These partial inquiries were analyzed according to the frequency and percentages of each of the essential features (see Table 6). There were 14 (70.0%) partial inquiries that were guided by an overarching question (EF1) in the 2000 edition, while all 13 (100.0%) of the partial inquiries in the 2010 edition had an overarching question. Nine (45.0%) partial inquiries in the 2000 edition compared to seven (53.8%) in the 2010 edition asked students to collect and record data (EF2). There were nine (45.0%) partial inquiries in the 2000 edition and eight (61.5%) in the 2010 that asked students to construct an explanation based upon the data they collected and recorded (EF3). As in the life science sections of the text, there were not many partial inquiries that prompted students to compare their results with another source (EF4) for either edition, with two (10.0%) in the 2000 edition and none (0%) in the 2010 edition. Lastly, three (15.0%) partial inquiries in the 2000 edition compared to two (15.4%) partial inquiries in the 2010 edition instructed students to either write or orally communicate their results (EF5).

Within the earth science sections of the two textbook editions, there were also non-inquiries labeled as inquiries by the publisher. In the 2000 edition, 17 (44.7%) of the 38 publisher-identified inquiries in that section were non-inquiries labeled as inquiries, while the 2010 edition had 13 (48.1%) out of 27 publisher-identified inquiries that were actually non-inquiries labeled as inquiries.

Physical science. The last branch of science analyzed was physical science (see Table 4). There were 45 publisher-identified inquiries within the physical science section of the 2000 text, while there were 28 in the 2010 edition. Out of the 45 publisher-identified inquiries, there were

no (0%) full inquiries found in the 2000 edition, which increased to three (10.7%) in the 2010 edition.

In the 2000 edition, 32 (71.1%) partial inquiries were identified, and 14 (50.0%) partial inquiries were found in the 2010 edition. Essential features identified in each of the partial inquiries for the physical science sections of each edition were calculated (see Table 5). Of the partial inquiries for the 2000 edition, there were 20 (62.5%) that contained an overarching question (EF1), while all 14 (100.0%) partial inquiries in the 2010 edition were guided by an overarching question. There were 14 (43.8%) of the partial inquiries in the 2000 edition and eight (57.1%) in the 2010 edition that instructed students to collect and record data (EF2). There were 14 (43.8%) partial inquiries that asked students to construct an explanation based upon the data they collected and recorded (EF3) in the 2000 edition and eight (57.1%) partial inquiries that contained this essential feature in the 2010 text edition. In the physical science sections in both the 2000 and 2010 editions, none (0%) of the partial inquiries prompted students to compare their results with another source (EF4). Of the partial inquiries, five (15.6%) of them in the 2000 edition and three (21.4%) of them in the 2010 edition instructed students to either write or orally communicate their results (EF5).

As in the previously reported branches of science, non-inquiries labeled as inquiries were also found in the physical science section. There were 13 (28.9%) non-inquiries labeled as inquiries in the 2000 edition and 11 (39.3%) of them in the 2010 edition.

Comparison of science texts. In comparing the findings of the content analysis of the 2000 edition to that of the 2010 edition, there were differences found in both the total number of publisher-identified inquiries—123 in the 2000 edition compared to 77 in the 2010 edition—and

the total percentages of full inquiries, partial inquiries, and non-inquiries labeled as inquiries (see Table 2).

In the 2000 edition 1.6% of the total publisher-identified inquiries were full inquiries, compared to 6.5% in the 2010 edition. There were more partial inquiries found in the 2000 edition, 61.8%, compared to 49.4% found in the 2010 edition. However, the partial inquiries that were guided by an overarching question (EF1) increased from 67.1% in the 2000 edition to 100% in the 2010 edition. Partial inquiries that instructed students to collect and record data (EF2) also increased from 44.7% in the 2000 edition to 57.9% in the 2010 edition. Another increase was noted in the percentage of partial inquiries that asked students to construct an explanation based upon the data they collected and recorded (EF3), from 43.4% in the 2000 edition to 60.5% in the 2010 edition. There was only one essential feature that did not show an increase from the 2000 edition to the 2010 edition: the one prompting students to compare their results with another source (EF4) decreased from 6.6% in the 2000 edition to 0% in the 2010 edition. The final essential feature, which instructed students to either write or orally communicate their results (EF5), was present in 14.5% of the partial inquiries in the 2000 edition and increased to 21.1% in the 2010 edition.

A large number of publisher-identified inquiries were found to be non-inquiries labeled as inquiries in both textbook editions. The 2000 edition contained 36.6% non-inquiries labeled as inquiries, and the 2010 edition contained 44.2% non-inquiries labeled as inquiries. In comparison, there were fewer non-inquiries labeled as inquiries in the 2000 edition than in the 2010 edition.

Findings of the three major branches of science represented in common sections in both texts revealed similarities and differences between the 2000 and 2010 editions (see Table 4). Of

the publisher-identified inquiries in the life science section in the 2000 edition, 2.5% represented full inquiries, while in the 2010 edition full inquiries increased to 4.5%. Partial inquiries in the life science section decreased from 60.0% in the 2000 textbook to 50.0% in the 2010 edition, yet the percentage of non-inquiries labeled as inquiries increased from 37.5% in the 2000 edition to 45.5% in the 2010 edition.

Similar trends in data distributions were found in the earth science sections of the textbooks. In the 2000 edition, 2.6% of the total publisher-identified inquiries were found to be full inquiries, while in the 2010 edition full inquiries increased to 3.7%. Partial inquiries in the earth science section decreased slightly from 52.6% in the 2000 textbook to 48.1% in the 2010 edition. However, the percent of non-inquiries labeled as inquiries increased slightly from 44.7% in the 2000 edition to 48.1% in the 2010 edition.

While similar distribution trends were also found in the physical science sections of the textbooks, there seemed to be greater changes in the data between the two editions. The greatest change noted was from no full inquiries (0%) among the publisher-identified inquiries in the physical science section in the 2000 edition to 10.7% in the 2010 edition. As with the life and earth science sections, the partial inquiries also decreased in the physical science section from 71.1% in the 2000 edition to 50.0% in the 2010 edition. This decrease in partial inquiries in the 2010 edition was more dramatic than the ones noted in either the life or earth science sections. Non-inquiries labeled as inquiries increased from 28.9% in the 2000 textbook to 39.3% in the 2010 edition.

Chapter 5

Discussion

Over the last few decades, science education in the United States has been restructured in an effort to reflect alignment with the national science standards that provide a framework for developing scientific literacy in students (NRC, 1996). The Standards identify inquiry as a key element for developing scientific literacy. Indeed, inquiry has been deemed as an imperative to not only learning science in the classroom but also for understanding the way in which science is done (Bybee, 1997; NRC, 1996; 2000). Along with the Standards, the Committee on the Development of an Addendum to the *National Science Education Standards* has identified five essential features of classroom inquiry as elements that, when applied to school science programs, will increase the potential success of developing scientific literacy in students (NRC, 2000).

Since many teachers use science textbooks as either their total science curriculum or to guide their science instruction in their classrooms, it is important to know if inquiry, as defined by the presence of the five essential features (NRC, 2000), is represented within these resources. Therefore, the purpose of this study was to investigate how these five essential features were represented within third grade science textbooks published in 2000 and 2010 by Scott Foresman. This chapter presents reflections on the findings, implications, and recommendations based on this study.

Reflections on Inquiry in Science Texts

In this study, I found little evidence of explicit inclusion of the five essential features of classroom inquiry in the 2000 and 2010 third grade science textbooks published by Scott

Foresman. In this section, I discuss the *full inquiries*, *partial inquiries*, *non-inquiries labeled as inquiries*, and inquiries in the branches of science common within both editions.

Full inquiries. In both the 2000 and 2010 editions of the Scott Foresman third grade science textbooks, there were limited instances where all five of the essential features of classroom inquiry were represented in the publisher-identified inquiries. In fact, in the 2000 edition, the percent of full inquiries represented less than 2% of the total publisher identified inquiries and in the 2010 edition, less than 7%. The percent of full inquiries in each edition is low and, unfortunately, gives the indication that there was not a high level of commitment by the publisher to include the five essential features in the inquiry activities in either publication.

Partial inquiries. Approximately half of the publisher-identified inquiries in each of the two editions of the science textbooks analyzed in this study were partial inquiries. Within these partial inquiries the five essential features were not equally represented. The most consistently represented features were those where students engaged in scientifically oriented questions (EF1), gave priority to evidence in responding to questions (EF2), and formulated explanations from evidence they collected (EF3). Of these, the scientifically oriented questions were found in most of the partial inquiries. Upon further investigation, I found that the extension activities identified as *partial inquiries* all contained an inquiry question to guide the activity. These guiding questions provided a good start to these inquiry-type activities, but without all the essential features being explicitly included these were not inquiries in the fullest sense.

While I found that the first three essential features (i.e. question, evidence, and explanation) were included within most of the partial inquiries, the last two features (i.e. compare and communicate) were rarely found in the partial inquiries in either edition. Least common was having students compare and connect their explanations to scientific knowledge. In

fact, of the total partial inquiries found within the 2000 edition, only a small percentage contained this feature, while in the 2010 edition there were none. The last essential feature, having students communicate and justify their explanations (EF5), was represented in less than a quarter of the inquiries in both the 2000 and 2010 editions.

Each of the five essential features is important and needs to be included within every inquiry to best increase students' science literacy. The large number of partial inquiries within these textbooks and implies that teachers must fill in the gaps and supplement these activities with the features necessary to create full inquiries. This assumes that all teachers using the textbooks are familiar with the essential features of classroom inquiry and that they are prepared and willing to assume the responsibility to do this.

Non-inquiries labeled as inquiries. Perhaps the most interesting finding of this study was one that I had not considered at the outset of my data collection. In the analysis of the publisher-identified inquiries, I found that many were not inquiries at all, thus a new category emerged. These inquiries comprised a little over a third of the total publisher-identified inquiries in the 2000 edition and nearly half in the 2010 edition. Even though these activities asked students to do a variety of exercises related to a lesson or regarding some aspect of science being studied, not even one of the essential features was explicitly included in them. This could be misleading to many teachers to see activities in the science textbooks labeled as inquiries by the publisher, but not actually be inquiries as defined by the Addendum (NRC, 2000).

Inquiries in branches of science. In this study, it was interesting that the percentages of *full inquiries*, *partial inquiries*, and *non-inquiries labeled as inquiries* across the three major branches of science were proportionately the same for each edition and followed the overall distribution found in the texts as a whole. The percentage of *full inquiries* was greatest in the

2010 edition with the highest being almost 11% in the physical science section. Earth science and physical science branches were just below and just over 4% which were increase from the 2000 edition. Otherwise, approximately half of all publisher-identified inquiries in each branch were apt to be *partial inquiries* and the remainder was *non-inquiries labeled as inquiries*.

Implications for the Education Community

Implications of this study focus on textbook publishers, inservice teachers, teacher preparation programs and preservice teachers, and students. These implications are discussed in the following sections.

Textbook publishers. An interesting finding that emerged from the data analysis was that in the 2000 edition of the textbook, a little over half of the partial inquiries were opportunities for students to extend their learning based on a previously conducted inquiry lesson activity in the text. The publisher included these activities under the title *Inquire Further*, which suggested that students participate on their own in further investigation of the topic. Each *Inquire Further* was prompted by an inquiry question; however, no other essential features were explicitly included. In one activity, for example, after being asked to explore habitats by observing a jade plant and an elodea plant, students were invited to “Inquire Further: What would happen if you changed the amount of light in a plant’s habitat? Develop a plan to answer this or other questions you may have” (Scott Foresman, 2000, p. A84). This was a *partial inquiry* because it contained at least one of the essential features. These types of activities suggest two possibilities. First, that the publisher may be providing an inquiry question, of sorts, to encourage teachers to move toward more open or student-directed inquiries, as opposed to the more traditional guided or teacher-directed inquiries. It also suggests that the publisher may be providing the inquiry question assuming that teacher will then supply the additional four

elements of classroom inquiry to create full inquiries. However, I find that the likelihood that the publisher is thinking this far ahead is not probable.

In this study, the publisher, Scott Foresman, labeled activities in the science textbooks as inquiries, but in actuality, the large majority of those activities were not inquiries. The publisher may have assumed that teachers using these textbooks are aware of and can insert the essential features that were not explicitly included. However, if this is the case, the publisher needs to be aware that many teachers using these textbook materials are inexperienced and unfamiliar with the use of and need for the essential features in teaching science. Also, textbook publishers claim that their textbook materials are complete curriculum packages ready for teacher and classroom use; however, the findings of this study question the completeness of the activities and the lack of full inquiries according to the Standards (NRC, 1996) and the Addendum (NRC, 2000).

The Standards (NRC, 1996) and the Addendum (NRC, 2000) have provided a framework and explanations for inquiry in science, yet the publisher of the texts used in this study have not fully moved to including inquiry activities that obviously align with these standards and frameworks. As publishers move closer to the intentions of the Standards and explicitly include full inquiries throughout their texts, they will be much more helpful in moving toward the goal of a more scientifically literate citizenry.

Inservice teachers. There are implications based on this study for elementary teachers who use these science textbooks. A teacher using these texts as they are, who is not aware of the five essential features of classroom inquiry or the Standards, might assume that the inquiries identified by the publisher are quality inquiries. However, as the findings of this study highlight, only a small percentage of the activities in the two editions of the third grade textbook were full inquiries. Therefore, practicing teachers must be made aware of the possible deficiencies in the

activities publishers identify as inquiries in science textbooks. Ultimately, they would then be supported, perhaps through professional development opportunities, in making appropriate instructional changes to increase the quantity and quality of inquiries provided in the science textbooks.

Teacher preparation programs. Teacher preparation programs, particularly early childhood and elementary education, need to prepare their preservice teachers to be critical consumers of teaching materials based on content-area standards. For pre-service teachers, it is particularly prudent that they are well prepared in their teacher education programs to analyze and evaluate textbooks, and learn to modify instruction so that the five essential features are addressed in every inquiry presented in the science textbooks.

Students. Perhaps the greatest implication of this study is in regard to the students who are taught using these science textbook materials. Considering that the textbooks analyzed in this study contained so few full inquiries, there is cause for concern regarding the students who may use them. Students who are taught and learn science primarily through these textbooks may not receive the necessary exposure to inquiry skills necessary to develop the scientific literacy they will need as future citizens. These students are missing out on experiences and processes that teach them to be critical thinkers and problem solvers. They do not develop the appropriate literacy skills in science to access science knowledge and interpret science texts, thus short changing their science understandings and abilities. These students, individually and as a nation, then risk being able to perform on the same levels in science as their counterparts internationally, consequently disadvantaging themselves and our advancements as a country. Overall, the lack of exposure to full inquiries across students' educational experiences may impact their content

knowledge, their future access to knowledge, and ultimately, their citizenship participation across their lifetime.

Recommendations

Recommendations are provided based upon the findings of this study. To extend this study, it would be beneficial to conduct several more pertinent studies. First, another content analysis could be conducted using multiple science texts across grade levels, publication years, and publishers to identify the presence of the five essential features of classroom inquiry. A content analysis of these texts would allow greater awareness and understanding of the quantity and quality of inquiry learning activities offered in textbooks. Also, it would be particularly interesting to compare the results from textbooks published prior to the discussions leading to the development of the Standards (NRC, 1996) to those published more recently to give insights into possible trends regarding the inclusion of the five essential features over a 20-year span. Another study could be conducted that goes beyond partial and full inquiry identification. This study would analyze the variance of each of the essential features on the continuum (NRC, 2000) between open inquiries (student-directed) and directed or structured inquiries (teacher-directed). Having made the point that teachers rely heavily on textbooks for their science curriculum, it would also be interesting to study how elementary classroom teachers use science textbooks and the inquiry activities within these textbooks. This would provide insight into science instruction, how useful teachers actually think the science textbooks are, and how the textbooks contribute to advancing students' science literacy.

Another recommendation addresses the need for teacher preparation programs to address the essential features of classroom inquiry in their elementary science methods courses. Teacher preparation programs need to prepare teachers to be able to identify inquiry in science teaching

materials and then know what to do to supplement the absence of the essential features of inquiry. Similarly, on the school district level, professional development needs to be provided for inservice teachers regarding the five essential features along with expectations that teachers employ these in their science teaching in order to strengthen science literacy in their students.

The last recommendation is that science textbook publishers align their textbooks and teaching materials with the Standards (NRC, 1996) and the Addendum (NRC, 2000) and make the five essential features explicit in their textbooks. The realities of teaching in today's educational milieu is one of limited time for teachers' daily preparation and teachers need science materials that contain quality activities focused on moving students toward the goal of scientific literacy.

Conclusion

Since the adoption of the Standards in 1996, there has been a renewed commitment to preparing a scientifically literate citizenry, starting with students in the elementary grades. In order to do this, classroom teachers are encouraged to include a strong inquiry component in the methods they use to teach their science curriculum. In today's educational climate where the focus in the elementary grades is on literacy and mathematics instruction, teachers depend on science textbooks to provide the basis for what they teach in science and how they teach it. Often, due to time and resource limitations, they depend on these resources to provide all that they need in one easy-to-access resource to meet the Standards and expectations to set their students on their way to being scientifically literate.

While inquiry activities may be identified by publishers in textbooks, it does not mean that those activities align with the elements of inquiry as outlined by the Addendum (NRC, 2000), referred to as the five essential features of classroom inquiry. Based on this study, full

inquiries are limited in the textbooks analyzed; however, partial inquiries and non-inquiries labeled as inquires are more common. Thus, in order to use these resources successfully, teachers must be well-prepared to recognize and analyze activities for the presence of the essential features and supplement what is lacking in order to create full inquiries from possibly incomplete investigation activities. Unless publishers and teachers make efforts to include the five essential features of classroom inquiry in their teaching and teaching resources, there is a risk that students taught using these resources will not acquire the knowledge and skills to be scientifically literate.

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Appendix A

Content Analysis Coding and Rules

In conducting a content analysis, the researcher is responsible to insure the objectivity and trustworthiness of the data analysis by creating codes, coding rules and procedures, and defining recording units (Holsti, 1969; Krippendorff, 2004). The rules for coding for this study are described in the following sections.

Rules for Coding

The five essential features of classroom inquiry (EF; NRC, 2000, p. 29) will be used as a priori codes for data analysis. Each of these features and the rules for coding are described below.

EF1: Question. The first feature states, “Learners are engaged in scientifically oriented questions” (NRC, 2000, p. 29). With this feature, the recording unit is a question, which must be identified as an overarching scientifically oriented question; it drives the inquiry.

First, the question may be either an existence of causal/functional question. This means that the question must be a “why” or “how” question. These types of questions may use other question words like “where,” “can,” “what,” and “in which/which.” Examples include the following:

- a. “How are these rocks similar to or different from rocks in your area?”
- b. “Which foods contain solids, liquids, and gases?”
- c. “What can you learn from an imprint?”

Second, the question must be overarching. This means that it guides the inquiry, whether the teacher, textbook, or the student poses it. It is the focus of the inquiry. Any question that is prompting or leading in nature will not be considered. These prompting questions typically

happen throughout the inquiry and generally lead back to the overarching question. These types of questions usually clarify. The following are examples of prompting or leading questions.

- a. “How does the shape of the air space change?”
- b. “What happens to the air?”
- c. “Why should people use fresh water wisely?”

EF2: Evidence. This feature states, “Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions” (NRC, 2000, p. 29). Evidence (or data) is the part of any inquiry activity wherein students record observations of a natural phenomenon using the five senses (sight, hearing, touch, smell, taste). There are two types of observation: qualitative observations, which describe the “quality” of phenomena, and quantitative observations, which describe “quantities” and require the learner to measure something. Either will be considered if the evidence is recorded. For this feature, the recording unit may be words, phrases, or sentences that allude to the collection and recording of data. The recording unit may also be a graphic organizer (e.g., table, graph, diagram) that suggests that the students should record data. This feature of classroom inquiry is present if any of the following three rules is met.

First, this feature is present if words, phrases, and sentences are used that explicitly instruct learners to **observe, inspect, or view** a phenomenon and then **record, describe, or write down** data to answer the question of the inquiry. Examples include:

- a. “Observe the inside and outside of the shell with the hand lens. Record your observations.”
- b. “Inspect the condition of the pill bugs for 5 minutes every day for a week. Describe what they look like in your science journal.”

Second, this feature is present if words, phrases, or sentences are used that explicitly ask learners to **measure** and **record** data, such as in the following examples:

- a. “Measure and record the wind speed for 1 week.”
- b. “After measuring the growth of the two plants, record their heights and determine the difference in the two.”

Third, this feature is present if some sort of graphic organizer on which students would be expected to record data. Some examples include:

- a. Students are asked to observe and record observations on a matrix.
- b. Students are to record data on a table.

EF3: Explanation: The explanation feature of classroom inquiry is present when “Learners formulate explanations from the evidence to address scientifically oriented questions” (NRC, 2000, p. 29). In other words, this means that students generate an answer using the data they have collected that addresses the original scientifically oriented question. This feature is present if the inquiry prompts students to create an explanation. Students may be asked to **explain** or **interpret** the data to answer the overarching question as in the following examples:

- a. “Interpret your data.”
- b. “Explain your results.”
- c. “Interpret this data: When you breathed out, you added carbon dioxide to the BTB.
Can a small amount of carbon dioxide show a different effect than a larger amount?
Explain.”

This feature is also present if the inquiry prompts student to **define** or **write a definition** for something based on the evidence. This should direct students to make an inference based on

the data collected or provided. In these cases, words, phrases, and sentences may also use the words **infer** or **inference**. For example:

- a. “Write an operational definition of an electric circuit.”
- b. “Make an inference about the relationship between fruits and seeds.”
- c. “Infer: Why should people use fresh water wisely?”

EF4: Compare. This feature states that, “Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding” (NRC, 2000, p. 29). The student needs to compare his or her explanation to other explanations posed by classmates, a science expert, or those published in the textbook or other science trade books. The recording units for this feature will consist of words, phrases, and sentences that ask learners to evaluate and compare their explanations with others. Thus, this feature is present if words, phrases, or sentences include the words **connect** or **connection** as students connect their explanation to those of others. For example:

- a. “How does your explanation connect to those of your peers?”
- b. “Look for a connection between your explanation and what the textbook states.”

This feature may also be present if words, phrases, or sentences include the words **compare your results**, **compare your explanation**, or **how** is your explanation similar or different than another. For example:

- a. “Compare your result to those of the other students in the class.”
- b. “How is your explanation similar or different than the one your teacher gave?”

EF5: Communication. This feature states, “Learners communicate...their proposed explanations” (NRC, 2000, p. 29). The recording units for this feature include words, phrases, or sentences that specifically instruct students to communicate their explanations to others. This

feature is present if words, phrases, or sentences include words such as **communicate**, **share results**, or **discuss**, as in the following examples:

- a. “Communicate your conclusion with your group.”
- b. “After determining the results, share them with the class in the form of a poster.”
- c. “Discuss your ideas with the class.”

Extended inquiry. After identifying the five essential features of classroom inquiry, the researcher should continue to examine the data for further inquiries included within the inquiries identified by the publisher. These extended inquiries provide opportunities for students to apply the data from the earlier inquiry to a new question, explore new inquiry questions and collect new data, or develop an entirely new inquiry.

To code this item, the researcher will check “yes” if there is an extended inquiry or will check “no” if no extended inquiry is included. If there is an extended inquiry, the researcher will determine whether the inquiry is *open* or *guided*. An inquiry is open if it is entirely learner self-directed (the learner generates the inquiry question, decides what to use as data, formulates an explanation based on the evidence collected, independently compares the explanation to other resources, and communicates the explanation logically and reasonably. The inquiry is guided if the teacher provides any direction or structure for the learner (e.g., if the teacher provides the question).

Inquiries labeled as inquiries. If an activity does not have an overarching question that leads it and is hands-on in nature, a mark will be placed in this column. When this happens none of the essential features will be marks. This type of activity is not an extension of an inquiry either. Therefore, a mark will not be placed in the extended inquiry column. The only mark will be placed in the Hands-on column. Examples of this type of activity is one that has no

scientifically oriented question to lead the investigation or the activity is one that is hands-on in nature.

Appendix B

Textbook Analysis Coding Form

Inquiry I.D. Number	Key Word	Five Essential Features of Classroom Inquiry						Inquiry Total	Full Inquiries	Partial Inquiries	Non-Inquiries
		EF1 Question	EF2 Evidence	EF3 Explanation	EF4 Compare	EF5 Communicate					
						Written	Oral				
Percentage											