READING ALOUD EXPOSITORY TEXT TO FIRST- AND SECOND-GRADERS A COMPARISON OF THE EFFECTS ON COMPREHENSION OF DURING- AND AFTER-READING QUESTIONING

by

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The purpose of this study was to compare the effects of questioning *during* a read-aloud and questioning *after* a read-aloud, using science-related informational tradebooks with first-and second-graders. Three thematically-related tradebooks were used, each portraying a scientist involved in authentic investigation. Students in two first/second grade classrooms were engaged in three read-aloud sessions. One group was engaged in discussion of text ideas during reading, while the other group engaged in discussion only at the conclusion of the read-alouds. After-story posttest results revealed minimal differences in scores between groups. However, students in the during-reading group demonstrated statistically significant differences in their pretest/posttest gain scores. This suggests that the cumulative effect of exposing students to multiple texts focusing on the work scientists do did affect students' building a robust representation of text ideas. Furthermore, these results suggest that pairing thematically-related texts with discussion during the read-aloud, cuing students to important ideas and encouraging text-to-text connections as they are encountered, was more beneficial than engaging students in similar discussion after reading.

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PREFACE

Many thanks go to my advisor, Linda Kucan, who introduced me to “crisp” scholarly writing. Your guidance and support from the development of my study through this written document have been invaluable. I am proud to have been your first doctoral candidate. I also appreciate the feedback from my committee members. Thank you to Isabel Beck for providing such a strong foundation of research on text-based discussion. Thank you, Jen Cartier for forcing me to consider the implications for science. Rebecca Hamilton, your encouragement kept me motivated. Thank you also to Louis Pingel for teaching me everything I know about statistics. I appreciate my graduate student researchers: Melissa Brydon, Tracy Busse, Ginny Hall, Michelle Rimbey, and Jill Vandermolen for volunteering to climb the hill for data collection. And finally, thank you to Marian Vollmer and Megan O’Brien and their wonderful students for participating in my study.

1.0 INTRODUCTION

Parents and caregivers have been reading aloud to children for generations, and teachers have traditionally included read-aloud sessions as a consistent feature of their classroom routines. Research supports these practices, demonstrating that read-aloud sessions have positive effects on reading achievement and promote independent readers (IRA/NAEYC, 1998; Snow, Burns, & Griffin, 1998).

Recently, there has been increased interest in enhancing the instructional potential of the read-aloud context (e.g., Fisher, Flood, Lapp, & Frey, 2004; Lane & Wright, 2007). This interest has focused on student participation, talk, and texts. Studies have shown the importance of students actively participating in the meaning-making process (Kletzien & Dreher, 2004; McGee & Schickedanz, 2007; Santoro, Chard, Howard, & Baker, 2008). Effective read-alouds include teacher modeling of higher-level thinking, questioning which promotes analytic talk, opportunity for recall, and addressing unfamiliar vocabulary within the read-aloud (McGhee & Schickedanz, 2007).

Talk surrounding read-alouds is an active area of interest and research (Smolkin & Donovan, 2001; Tower, 2002; Maloch, 2008). Traditional teacher-led discussions follow the Initiate-Respond-Evaluate (IRE) method (Mehan, 1979). In such discussions, teachers initiate a discussion by asking a question, call on a student for a response, and then evaluate the response as being correct or incorrect. This common method of eliciting talk about text is a way of

assessing comprehension rather than assisting in the process of *supporting* comprehension. Researchers question the effectiveness of this type of discussion, arguing that children will benefit more from responding to open-ended questions that engage them in explaining text ideas (Beck, McKeown, Hamilton, & Kucan, 1998; Beck & McKeown, 2001).

Two theoretical perspectives inform this view: research on self-explanation (Chi, et al., 1989; 1994) and Vygotsky's social-constructivist theory (1978). Chi and her colleagues found that students who engaged in explaining their developing understanding as they were reading were better able to respond to questions about what they had read than those who read the text twice without any explanation. Vygotsky's social constructivist theory suggests that in the social context of a discussion, students communicate their understanding as they construct meaning. During these conversations, students begin to internalize the idea of thinking about their own comprehension. These social contexts serve as a foundation for internalizing higher mental functioning.

Kletzien and Dreher (2004) suggested engaging students in discussion during read-alouds by allowing them to make interpretations, offer suggestions, and ask questions to support their active involvement in the meaning-making process. Recent studies are looking closely at the dialogue occurring during read-aloud sessions, taking note of authority and agency, or the role of both teacher and students in the discussion, how teachers pose questions, the types of questions asked, and student-to-student dynamics (Palincsar, Brown, & Campione, 1993; Pappas, Varelas, Barry, & Rife, 2003; Smolkin & Donovan, 2001, 2003). For instance, Palincsar, Brown, and Campione (1993) observed that one important factor in discourse with first-graders is finding ways for children to assume a voice in the dialogue.

Horowitz and Freeman (1995) investigated the influence of discussion on young children's preferences for science text. These researchers suggested two key elements in engaging young children in discussion about science texts: high-quality texts and effective questions. In exploring the second essential ingredient, Horowitz and Freeman investigated the types of questions posed in two kindergarten classrooms and two second grade classrooms. They found three types of questions used most often: first, preference questions, which ask students whether or not they like a particular science book; second, difficulty questions, which ask students to comment on the difficulty of a text; and third, authors' purpose questions, which address the author's intention for writing. Horowitz and Freeman designed pre- and post-reading questions around two dimensions: building vocabulary knowledge and clarifying misconceptions about the meaning of unfamiliar words and encouraging students to create images of science content. Additional post-reading questions were designed to encourage students to summarize and comment on what they had heard. Other post-reading questions prompted students to make intertextual connections. They used these types of questions with an informational science book and a narrative science book. Horowitz and Freeman found that the children preferred the informational science book over the narrative science book in the two classrooms engaged in discussion. The kindergarten students collectively preferred the informational science book and perceived it as easier than the narrative book. Although more than half of the kindergarten students said that the informational book had more unfamiliar words, it was regarded as easier to remember. Three-fourths of the second graders in the discussion group indicated that they would give the informational book to their best friend to read. In contrast, the non-discussion group of second graders (67%) preferred the narrative book. Similarly, 67% of the second graders in the non-discussion group rated the narrative text as easier than the expository text. Furthermore,

69% of the students in this group thought the expository book contained words they did not know.

In the kindergarten class, 61% of the children identified the informational book as one that is written to teach them something; and 67% of the children felt the author also wrote the text to entertain. On the other hand, half of the students in the second grade discussion group felt that the narrative book was written for entertainment and half felt the informational book was written for entertainment. However, 94% were able to identify the expository text as being written to teach them something.

Horowitz and Freeman found that in the second grade classroom not engaging in discussion, half (50%) of the students felt the expository book was written for the purpose of teaching and half (50%) felt the narrative book was written to teach them something.

These findings suggest that the discussion that surrounds science texts that are read aloud can have a powerful influence on student preference, sense of difficulty, and understanding of the author's purpose.

Beck and McKeown (2001) carefully considered the role of talking about texts and developed Text Talk, a discussion forum that makes use of open-ended questions during read-alouds with young children. Additionally, Beck and her colleagues promote the importance of discussion as a means of developing ideas *during* the read-aloud rather than *after* (e.g., Sandora, Beck, & McKeown, 1999). They argued that engaging students in discussion after smaller segments of text rather than after reading the entire text provides opportunities for students to carefully consider ideas, clarify misconceptions, and grasp subtleties implied in the text.

While several researchers have focused their attention on talk during read-aloud sessions, others have studied the nature of texts used. Historically, narrative text has been dominant in

primary classrooms. However, there has been a heightened interest in using informational text with young children (Pappas, 1993; Smolkin & Donovan, 2001; Kletzien, 2004). Duke's landmark study (2000) revealed alarming evidence of the lack of informational text available to young students. Informational text was extremely limited in the classrooms she observed. Opportunities to interact with the inadequate amount of expository text were also scarce. The most common occurrence involved teacher-led read-alouds.

Studies have revealed the educational potential of read-alouds as a vehicle for exposing children to informational text (Duke & Kays, 1998; Smolkin & Donovan, 2001). Teacher-led read-alouds can provide the necessary support as children encounter potentially difficult content, text features, and challenging vocabulary often found in informational tradebooks.

Based on the research described above, the present study was designed to investigate teacher-led interactive read-alouds as the context for using related informational tradebooks to support students in building an understanding of specific science content and concepts. The study compared the effects on comprehension of carefully planned questions posed during reading after small segments of text and questions asked only after the entire text had been read. Questions were designed for specific purposes, namely, to direct students' attention to the important ideas in texts; to support students in making text-to-text connections; and to clarify student understanding of content in each text. Additionally the content of the three texts selected for the read-alouds focused on three scientists who engaged in scientific inquiry through observation and investigation.

The review of research in the next section focuses on the following topics which provide a context for the present investigation: (a) use of informational text with primary students, (b)

intertextuality, (c) talk about informational text, and (d) integrating science and literacy instruction.

2.0 REVIEW OF RELEVANT RESEARCH

This review addresses four specific lines of research relevant to the present study: (a) the use of informational text with primary students, (b) intertextuality, (c) talk about informational text, and (d) integrating science and literacy instruction. First, some general information about informational tradebooks is presented.

2.1 INFORMATIONAL TRADEBOOKS

There has been a dramatic increase in the number and type of children's informational tradebooks (Smolkin & Donovan, 2001). Informational tradebooks differ from narrative tradebooks along several dimensions. While narrative texts offer a predictable pattern of plot with a beginning, middle, and end, informational tradebooks are less predictable. There are an increasing number of features characterizing informational text, such as diagrams, captions, sidebars, and juxtaposition of genres. These features complicate the text, particularly for young readers. Donovan and Smolkin (2001) analyzed the content of informational science texts. They examined lexical density (how tightly packed content nouns, content-related modifiers, and content-carrying verbs are in the grammatical structure); number of informational ideas; and the hierarchal relationships among ideas. They found that lexical density is far greater in scientific texts than in narrative storybooks. Additionally, implicit ideas tend to make the informational text more difficult to understand.

These differences can cause teacher reluctance in using informational text with young children. Recent research is attempting to clarify these features (e.g., Pappas, 2006), encourage increased use of informational text with young students (e.g., Duke & Kays, 1998) and suggest ways to support students in understanding the texts.

For instance, Smolkin and Donovan (2003) reported that exposing children to the complex ideas, syntax, dense text structures, and technical and abstract vocabulary of expository text early on helps prepare children for later experiences with content area informational text. They defined several key elements in orchestrating effective interactive information book read-alouds. First, children and their efforts to construct meaning become the center of the read-aloud process. Interaction during read-alouds supports co-construction of meaning and provides teachers with the opportunity to model strategies such as skilled meaning-making, reasoning, and comprehension processes. Another key element is teacher awareness of important informational text features. Smolkin and Donovan suggested that teachers should be familiar with the books in advance. This familiarity will allow teachers to anticipate places in the text that may be confusing or places appropriate for eliciting questions from the students. The final key element of successful interactive read-alouds is allowing adequate time for in-depth reading and discussion of informational books.

2.2 USE OF INFORMATIONAL TEXT WITH YOUNG CHILDREN

Heightened interest in availability of informational tradebooks for young children influenced Duke's (2000) seminal work, which investigated the nature and degree of experience first-grade

students had with informational text. Duke's observations in twenty first-grade classrooms focused on environmental print, the classroom library, and classroom activities engaging the students in print. Duke defined informational as any text or context having any of the following features: "(a) a function to communicate information about the natural or social world, typically from one presumably more knowledgeable on the subject to one presumed to be less so; (b) an expectation of durable factual content; (c) timeless verb constructions; (d) generic noun constructions; (e) technical vocabulary; (f) classificatory and definitional material; (g) comparative/contrastive, problem/solution, cause/effect, or like text structures; (h) frequent repetition of the topical theme; and (i) graphical elements such as diagrams, indices, page numbers, and maps." (p.205). She found that informational print was scarce in first grade classrooms, noting that no more than 10 percent of the print displayed on classroom walls and other surfaces was informational. She also found that informational texts were scarce among the books available in classroom libraries. Most importantly, Duke reported that the extent to which informational texts were used in classroom activities was extremely limited. During 79 days of observation, Duke reported a total of 282 minutes spent with informational text during whole-class written language activities, or an average of 3.6 minutes per day.

Duke described activities, although rarely occurring, observed with informational texts. The most commonly observed activity was teacher read-aloud. Some read-alouds were rather brief; for example, the teacher reading a short passage from an article. Other episodes were lengthier, such as the teacher reading aloud an entire book. Frequently the read-aloud was associated with a thematic unit being studied in the classroom.

Duke concluded that narrative text continues to be the primary kind of text used in early literacy instruction; content-area instruction does not provide adequate exposure to informational

text in first-grade classrooms; there is reason to hypothesize that students perform poorly with informational text because of their limited experience with it, as opposed to the notion that low achievement is related to attributes of the genre.

In contrast to the classrooms Duke studied, other studies reveal the potential of using informational tradebooks with young children. Recently, Maloch (2008) found that informational texts served as an avenue for inquiry when used in a second-grade classroom. Here, the teacher provided opportunities for engagement and the necessary scaffolding with informational text. Rather than direct instruction, the classroom teacher used interactive discussion to facilitate learning by involving students in meaningful conversations about informational text features. These discussions allowed students to draw on their own experiences to questions and respond to teacher-posed questions as they worked together to make sense of ideas in the text.

2.3 INTERTEXTUALITY

Intertextuality refers to connections readers make between and among texts. Because a single text can rarely cover the complexities of a topic, particularly in science, using complementary texts provides multiple opportunities for students to explore the nature of the ideas presented (Hartman & Hartman, 1993). Students' understanding of one text can support their understanding of subsequent texts if they are encouraged to make intertextual connections (Hartman, 1995).

Two recent studies looked closely at the features of talk surrounding the text during read-alouds and the function of intertextual connections made by young students. First, Smolkin and

Donovan (2001) found examples of the development of intertextuality among first-grade students during read-alouds of informational tradebooks when specific supports were provided. Examples of such supports included teachers providing scaffolds, such as reminders that needed ideas could be found in the text, to support students in connecting words within a sentence or between two separate sentences; between ideas in the text; and between ideas and the text's structure. Also, the teacher modeled to support students in creating mental imagery and made analogies. For instance, while reading about dinosaurs she used her hands to physically represent the size of the dinosaur rather than relying on a verbal explanation. Additionally, the teacher clarified when students' comments reflected inaccurate prior knowledge based on previous experiences with narrative texts, cartoons, or movies. As the transcripts revealed, children listened during teacher-led read-alouds, they seemed to be actively integrating new ideas with their existing knowledge of the content.

Additionally, Pappas, Varelas, Barry, and Rife (2003) provided a detailed exploration of the form and function of intertextual connections made in two urban classrooms, one first-grade and one second-grade, while students and teacher were engaged in information book read-alouds with six science-related books. They used Bloome and Egan-Robertson's (1993) criteria for identifying instances of four categories of intertextuality: (a) connections to written text, texts which are shared orally, other media, and prior discourse that occurred in the classroom; (b) associations with hands-on explorations; (c) relations made to recounting events; and (d) links to implicit, generalized events.

Pappas, Varelas, Barry, and Rife concluded that both student and teacher voices were heard in the collaborative, dialogically-oriented read-alouds observed in their study. Student comments, questions, ideas, and interpretations were heard. Instances of intertextuality promoted

engagement as participants imagined, clarified, related, encouraged, validated, made sense, and reflected on their own and others' experiences.

2.4 TALK ABOUT TEXT

The previous section described the effects of talk that support students in making intertextual connections among related texts. In this section, general features of talk that support students in actively constructing meaning are considered.

Sandora, Beck, and McKeown (1999) made a comparison of two discussion techniques, Questioning the Author (Beck, McKeown, Kucan, & Hamilton, 1997) and Great Books (Dennis & Moldof, 1983). Questioning the Author is a during-reading discussion technique that engages students in responding to teacher-posed questions that engage students in making sense of text ideas as they are encountered. During the read aloud, the teacher stops after predetermined segments of text posing questions which encourage students to think about the author's intent. In contrast, Great Books is a post-reading discussion technique which encourages students to think about and interpret the author's purpose. Here, the text is not segmented; discussion occurs at the conclusion of the reading. Sandora and her colleagues argued the importance of discussion during-reading rather than after-reading. Waiting until the conclusion of the text to discuss ideas assumes that readers were successful in constructing meaning as they encountered the text. This type of discussion does not consider the possibility that students may be confused by complex ideas or difficult vocabulary as they read, thus interfering with a deeper conceptual understanding of the text. Talking about these text ideas as they are encountered becomes the

focus of collaborative discussion, which according to social-constructivist theory, promotes learning.

Planning for a Questioning the Author discussion involves a teacher in reading a text and segmenting it into smaller more manageable segments. This allows the reader to construct meaning as they encounter new ideas and allows the discussion leader to clarify misconceptions, provide explicit vocabulary instruction, and monitor students as they develop an understanding of important ideas presented in the text.

The Text Talk approach (Beck & McKeown, 2001) was developed on the same premise as Questioning the Author and makes use of the same procedures. By discussing segments of texts during a read-aloud, teachers can scaffold children to focus on important ideas. Text Talk uses open questions and discussion to help keep key ideas in focus, while allowing the teacher to monitor children's responses, and support them as they construct meaning.

2.5 INTEGRATING SCIENCE AND LITERACY INSTRUCTION

Researchers are beginning to acknowledge the power and usefulness of integrating science and literacy instruction (Guthrie & Ozgungor, 2002; Palincsar and Magnusson, 2001). Recently, Barber, Nagy-Catz, and Arya (2006) found that second- and third-graders engaged in a science/literacy integrated approach, outperformed those students involved in a science-only or literacy-only approach on post-test measures. They used a combined science/literacy approach for assessing young children's science content knowledge through a pretest, read-aloud, and

posttest. Their findings supported a combined science/literacy approach as a means of improving students' conceptual understanding in science, specifically related to shoreline ecosystems.

The National Science Standards (National Research Council, 1996) emphasize the importance of introducing science concepts early on and providing opportunities for students to build on these ideas in deeper ways across the grades. The goal of the National Science Standards was that by mastering a set of content standards, students would achieve scientific literacy. Historically, there have been many definitions about what it means to be scientifically literate. Researchers, such as DeBoer (2000) define scientific literacy in broad terms and argue that an open-ended approach allows teachers and students more freedom to choose and develop an understanding of a wide variety of science content and methodologies. However, other researchers, both internationally (Appleton, 1999; 2003 and Harlen, 2001) and in the United States (Metz, 1995) find that teachers don't hold that view and do in fact rely on the standards to identify topics to address.

The current study acknowledges the power of the standards approach but attempts a more thoughtful manner of instruction by using the read-aloud context as a vehicle for engaging students with important science ideas through informational tradebooks. This study focuses on standards related to science as inquiry and science as a human endeavor. Specifically, this study focuses young children's attention on scientists at work: *what* they do, *how* they do it, *why* they do it, and the tools they use. Appendix A presents the standards related to this study and the content in the books that relate to those standards.

The focus of the present study builds on the ideas presented in this review: using informational tradebooks with young readers, encouraging them to make intertextual connections

across three related science tradebooks, and supporting them through teacher-led discussion as they encounter new ideas and important vocabulary.

3.0 METHODOLOGY

The purpose of this study was to compare the effects on comprehension of during- and after-reading questioning using expository text during read-alouds with first and second graders. Specifically, this study addressed three research questions:

1. Do students who engage in teacher-led discussion ***during*** read-alouds build a more robust representation of text ideas than students who engage in teacher-led discussion ***after*** read-aloud sessions?

2. What is the cumulative effect of a thoughtful arrangement of books used during read-aloud sessions on students' understanding, specifically their understanding of what scientists do?

3. How do student interactions with text ideas during discussion differ between groups?

In the sections that follow, I discuss the study participants, materials, measures, and procedures.

3.1 PARTICIPANTS

The participants for this study were first- and second-grade students from two intact multi-age classrooms in a university lab school. Only those students with parental permission participated

in the study. Furthermore, students who were absent during any part of the data-collection sessions or excused for small-group reading instruction were not included as participants. The initial number of possible participants was 17 in each group. The number was diminished because some students did not have parent permission on time and others left during the read-aloud sessions for other intense reading instruction.

One first/second grade class was randomly assigned to be the during-reading group and the other second grade class was selected to be the after-reading group. The during-reading group included nine students, four first-graders and five second-graders and the after-reading group included seven students, three first-graders and four second-graders. Both groups included more girls than boys. The during-reading group included three boys and six girls, while the after-reading group included two boys and five girls.

3.2 TEXTS

Because this study was designed to investigate students' ability to build a robust representation of a specific concept- scientists at work, texts were selected that provided rich descriptions of scientists conducting investigations in a variety of contexts. Other text-selection criteria included accessibility to first- and second-graders in terms of concepts and presentation of information. In order to create texts of comparable length for 20-minute read-aloud sessions, texts were edited. The editing was such that it did not disrupt the narrative presentations.

Three texts were chosen. All are illustrated tradebooks written for children. Each tradebook portrays a real scientist engaged in authentic investigations (Ford, 2006). Specifically,

each person has a question and goes about discovering possible answers to that question through observation, study, and investigation.

The three texts selected were: *Snowflake Bentley* (Martin, 1998) recognized as an Outstanding Science Tradebook for Children in 1999 by the National Science Teachers' Association; *Rare Treasure* (Brown, 1999) recipient of the Giverny Book Award as the 2002 Best Children's Science Picture Book; and *The Boy Who Drew Birds* (Davies, 2004) honored as a 2005 Outstanding Science Tradebook for Students K-12 by the National Science Teachers' Association.

Each text provides biographical information about a real person presented in a narrative style. In addition, one includes special features which are described below. Most importantly, each text reveals the thinking and work of a scientist engaged in an authentic investigation. Specifically, *Snowflake Bentley* (Martin, 1998) tells the story of Wilson Bentley whose interest in snowflakes led him to take thousands of photographs using special techniques that he developed over time. The main biographical story is told in a narrative style. Additional factual information is included in annotations, or sidebars, on selected pages. For example, one sidebar includes this information: "He learned that most crystals had six branches (though a few had three). For each snowflake the six branches were alike" (p. 8). This juxtaposition of genres (narrative biography and informational) is described by Pappas (2006) as a hybrid text.

Rare Treasure (Brown, 1999) describes young Mary Anning's discovery of a remarkable skeleton and other fossils. Because of her work, scientists were able to better understand extinct creatures from long ago. Brown's text provides a simple biography that spans the lifetime of Mary Anning told in chronological order.

The Boy Who Drew Birds (Davies, 2004) describes the findings of John James Audubon in his pursuit to understand the disappearance of birds in winter and their return in spring. Audubon reads about birds and conducts experiments which he carefully documents in order to support his theory that the birds that leave their nests in the winter return in the spring. The sections of the tradebook selected for the read-aloud provide narrative biographical information like the book about Mary Anning, but the time span presented focuses on Audubon's childhood.

3.3 ARRANGEMENT OF TEXTS

There were two important aspects to consider in thoughtfully arranging the texts. First, which texts would be included and in what order they would be read. As noted above, the three texts were selected because the ideas presented are accessible to first- and second-graders. These ideas were about facts regarding snowflakes, fossils, and bird migration and about scientific inquiry. The second consideration related to sequence of presentation. All three texts reveal scientists involved in three different kinds of inquiry. *Snowflake Bentley* includes explicit descriptions about Wilson's desire to study snowflakes and the experiments he conducted to develop the technology to learn more about them. This text was selected to be read first because of this clean portrait of inquiry. Unlike *Snowflake Bentley*, the investigations of Mary Anning in *Rare Treasure* were not experimental, or trial-and-error. Rather, Anning engaged in historical inquiry. The placement of *Rare* Treasure after *Snowflake* Bentley was deliberate. Students were encouraged to compare her activities to those of Willie Bentley, but they were also shown that inquiry could involve investigating the past. The third book, *The Boy who Drew Birds* includes a

descriptive portrayal of John James Audubon as a scientist. The questions John is trying to answer about where birds go in the winter and whether they return to the same nest in the spring are described, as well as the steps in his investigation.

These three books reveal the breadth and depth of scientific inquiry. Exposing students to all three texts provides multiple opportunities to relate to scientists with different types of questions using a variety of methods to answer those questions.

3.4 DURING-READING TEXT DISCUSSION SCRIPTS

To prepare for the during-reading discussion of the three texts, I used procedures based on Questioning the Author (Beck et al., 1997) and Text Talk (Beck & McKeown, 2001). Specifically, I divided each text into manageable segments, that is, chunks of text with enough information for students to think and talk about, but not so much information that students would be overwhelmed.

For each segment, I developed questions designed for particular purposes. First, questions were designed to foreground a scientist at work. For instance, during the reading of *Snowflake Bentley,* one question encouraging students to recognize that Willie studied, kept record, and conducted experiments was: “Remember we’re thinking about scientists and what they do. What does Willie do that shows he is acting like a scientist?”

Another question type was designed to address content-specific information in each text. For example, while reading *Rare Treasure,* one question was: “So, what have we learned about fossils?” Followed by, “What are they? Where are they found? How are they found?”

A third kind of question was developed to assist students in making connections to previously read texts. For example, while reading the third text, which is about John James Audubon, a question was: “Does John’s idea of turning to books remind you of anyone else that we have read about?”

Finally, another kind of question was developed to support students’ understanding of important science-related vocabulary—words that would help them build a representation of what a scientist does. Questions such as “What does it mean to study something?” and “What does it mean that he kept a record?” are examples.

The questions about scientists and the specific contexts of their work were designed to encourage students to develop their ideas about what scientists do and how scientists approach their questions or interests. These questions offered consistent cues to the main theme of the texts, a practice described by Goldenberg and Patthey-Chavez (1995) as supportive and beneficial.

The questions that encouraged students to make intertextual connections (Pappas, Varelas, Barry, & Rife, 2003) promoted students’ developing representation of scientists at work by prompting them to explicitly compare, contrast, and connect information across the three texts.

Questions that focused on vocabulary drew students’ attention to words such as *study*, *experiment*, and *discover*. The words are found in all three texts and relate directly to scientists at work.

The questions described above were used with the during-reading group of students. After each text segment was read, a question was posed. (See Appendix B.)

3.5 AFTER-READING TEXT DISCUSSION SCRIPTS

The after-reading group questions were posed only after the entire text was read. Like the questions used with the during-reading group, these questions focused on scientists at work, content-specific information, intertextual connections, and vocabulary. For example, after reading *The Boy Who Drew Birds* (Davies, 2004), questions focusing on a scientist at work included: "How did John try to find answers to the questions he had? How did he try to learn about bird migration?"

A sample question designed to address content-specific information for *The Boy Who Drew Birds* (Davies, 2004) was: "After reading this book, what have you learned about bird migration?"

Example questions designed to encourage students to make intertextual connections were: "Did John do anything that reminded you of Willie or Mary? How does John fit into your idea of a scientist? Would you call him a scientist? What makes you say that?" (See Appendix C for a full description.)

3.6 MEASURES

Measures were developed to provide data related to each research question. Identical measures and procedures were used with students in both the during-reading and the after-reading groups. For all measures, individual students were assessed orally and responses were tape-recorded.

The first research question was: *Do students who engage in a teacher-led discussion during read-alouds build a more robust representation of text ideas than students who engage in discussion after read-aloud sessions?*

The data to answer this question came from an analysis of student responses to questions on the after-story tests. These questions were posed after each book was read. The questions focused on the scientist described in the book, and general ideas about scientists. (See Appendix D for a complete set of questions and ideal responses.)

The second research question was: *What is the cumulative effect of a thoughtful arrangement of books used during read-aloud sessions on students' understanding of what scientists do?*

Data from the pretests/posttests provided information related to this question. The first part involved questions about the scientist in each story and the focus of their inquiry. Specifically, those questions included: "What do you know about Willie Bentley? What do you know about snowflakes?" Students earned one point for each response that related to ideas learned from the text. The second part included the prompts to capture students' understanding of a scientist at work: "Tell me what you know about scientists. How would you describe a scientist? What do they do? What tools do they use?" Students earned one point for each comment that accurately reflected scientists and their work.

Another part of the pretest/posttest was a picture task measuring students' knowledge of tools a scientist might use. Students were presented with eight pictures. Each picture represented a tool that a scientist might use, such as a microscope, camera, or a notebook and pen. Students were prompted to indicate whether or not a scientist might use the pictured tool. They explained the reasoning for their selections. Furthermore, students were asked to describe how a scientist would use the given tool. Finally, students were prompted to name additional tools a scientist might use that were not included in the set of pictures. (See Appendix E for a complete set of pretest/posttest questions and ideal responses.)

The third research question was: *How do student interactions with text ideas during discussion differ between groups?* To answer this question, transcripts from all during-reading and after-reading discussions were tape-recorded and transcribed. The transcripts of these discussions were analyzed to identify specific instances of students' cued interactions with text ideas.

3.7 SCORING

Student responses on the after-story tests were compared to the ideal responses found in Appendix D and student responses on the pretest/posttest were compared to the ideal responses indicated in Appendix E. Students earned one point for each response given that matched an ideal response. In some instances students earned one-half points for partial ideas. Interrater reliability was achieved by having the author and one other coder each score approximately 28% of the student responses with 91% agreement. Initially, 20% of the students' responses were blind-coded by each coder. Discrepancies were discussed and additional responses were blind-coded until a stronger level of agreement was reached.

3.8 PROCEDURES

The discussion that follows lays out the procedures that were used on each day of the study. The author was the discussion leader during all read-aloud sessions. A team of three graduate student

researchers assisted in administering the pretest/posttest and after-read-aloud questions to individual students in order to reduce the amount of time students were taken from other instructional activities.

The study was conducted over five days. On days one and five, students met individually with me or one of the graduate student researchers to complete the pretest/posttest.

On days two, three, and four, I read-aloud one of the three texts using the appropriate discussion method with the during- and after-reading groups. At the conclusion of the read-aloud, students met individually with me or one of the graduate student researchers to respond to the after-reading questions.

3.9 THEORETICAL PERSPECTIVES FOR HYPOTHESES

Based on the review of research and informed by the theoretical perspectives of self-explanation and social-constructivism, my hypotheses were that students in the during-reading discussion group would (a) build a more robust representation of text ideas as demonstrated on their after-story test scores and (b) show greater learning gains on the pretest/posttest measures than students in the after-reading discussion group. Segmenting the texts into more manageable chunks and directing students' attention to the important ideas throughout the read-aloud should have provided more support for the during-reading group in constructing meaning. Also, students in the during-reading group had more opportunities to talk about important text ideas. This talk should have helped them to make sense of these ideas more than students in the after-reading group who had fewer of such opportunities.

4.0 RESULTS

The purpose of this study was to investigate the possible effects on student comprehension of concepts presented in science texts that were read aloud to students assigned to one of two groups. One group engaged in discussing the text *during* the read aloud, while the other group engaged in discussion about the text only *after* the read-aloud.

Three tradebooks about real scientists carrying out authentic investigations were the books read aloud to both groups. These books focused on Wilson Bentley, who investigated snowflakes; Mary Anning, who discovered fossils; and John James Audubon, who studied bird migration. The scientist in each book had a question and conducted an inquiry to discover possible answers to that question through observation, study, and investigation. The books contained two kinds of information: (a) factual content about snowflakes, fossils, and bird migration and (b) conceptual information about the process of conducting scientific inquiry with attention to observation, questioning, recordkeeping, consulting reference sources, and documenting and sharing findings.

The research questions and data sources for this study are presented in Table 1.

Table 1
Research Questions and Data Sources

Research Question	**Data Source**
Do students who engage in teacher-led discussion *during* read-alouds build a more robust representation of text ideas than students who engage in teacher-led discussion *after* read-aloud sessions?	After-story tests
What is the cumulative effect of a thoughtful arrangement of books used during read-aloud sessions on students' understanding, specifically their understanding of what scientists do?	Pretests/Posttests
How do student interactions with text ideas during discussion differ between groups?	Discussion Transcripts

Table 2 provides an overview of the specific questions for the pretest/posttest and after-story tests.

Table 2

Pretest-Posttest and After Story Test Items

PRETEST **CONTENT QUESTIONS**	**AFTER-STORY TESTS**	**POSTTEST** **CONTENT QUESTIONS**
What do you know about		**What do you know about**
Snowflake Bentley Snowflakes	Why do you think Willie picked snowflakes to study? What did you learn about Willie?	Snowflake Bentley Snowflakes
Mary Anning Fossils	Why do you think Mary picked fossils to study? What did you learn about Mary?	Mary Anning Fossils
John James Audubon Bird migration	Why do you think John James picked birds to study? What did you learn about John James?	John James Audubon Bird migration

Table 2 continued

PRETEST SCIENTIST QUESTIONS	AFTER-STORY SCIENTIST QUESTIONS	POSTTEST SCIENTIST QUESTIONS
Tell me what you know about scientists. How would you describe a scientist? What do they do? What tools do they use?	Was Willie a scientist? What evidence from the story would support your answer?	Tell me what you know about scientists. How would you describe a scientist? What do they do? What tools do they use?
PRETEST PICTURE TASK Would a scientist use…? How or why?	Was Mary a scientist? What evidence from the story would support your answer?	POSTTEST PICTURE TASK Would a scientist use…? How or why?
• Microscope • Magnifying glass • Telescope • Test tubes and beakers • Notebooks • Camera • Books • Shovel	Was John James a scientist? What evidence from the story would support your answer?	• Microscope • Magnifying glass • Telescope • Test tubes and beakers • Notebooks • Camera • Books • Shovel

4.1 AFTER-STORY TESTS

Analysis of student responses to the after-story test items was used to address the first research question: *Do students who engage in teacher-led discussion during read-alouds build a more robust representation of text ideas than students who engage in teacher-led discussion after read-aloud sessions?*

Student scores for the after-story tests were calculated by comparing student responses to the ideal responses developed for each item**.** (See Appendix D.) Each after-story test included two content-specific questions: one about the person's interest (worth 1 possible point) and one about the person (4 possible points). The after-story test also included two questions asking students to consider how the person in each story related to what they were learning about scientists (worth 5 possible points). Students could earn a total of ten points on each after-story test.

In general, the scores were low for both groups. Only responses which matched anticipated responses to the questions were awarded points. For instance, on the after-story test following the story about Mary Anning a response indicating that she "found fossils" was counted but not merely that she "liked fossils."

In response to the question "Why do you think Snowflake Bentley was so interested in snowflakes?" Typical responses included sparse ideas such as "He liked snow" or "He thought they were neat." However, on the after-story test for *The Boy who Drew Birds,* one student indicated that John "drew pictures of birds and he studied books and looked at books to see if he found any evidence." Another student explained that John "wanted to find out interesting facts about birds like if they come back after their journey to the south."

An independent samples t-test assuming equal variances revealed no statistically significant differences between the scores of the during- and after-reading groups on the after-story tests for all three stories, as shown in Table 3.

Table 3
After-Story Test Scores

Group	*Snowflake Bentley*		*Rare Treasure*		*The Boy Who Drew Birds*	
	M	SD	M	SD	M	SD
During-reading	2.5	.71	2.39	.82	2.67	1.46
After-reading	2.07	1.06	2.79	1.47	1.71	.91

However, a closer look at student responses to the after-story question, "If someone asked you if Snowflake Bentley/Mary Anning/John James Audubon was a scientist, what would you say?" and the follow-up question, "What evidence from the story supports your answer?" revealed noteworthy differences. Although students in both groups indicated that they would consider each person portrayed in the texts to be a scientist, more students in the during-reading group were able to provide evidence to support their answer than students in the after-reading group. See Table 4.

The most obvious differences in student responses were found in the after-story test for the book about John James Audubon. Not only did more of the students in the during-reading group provide evidence than the after-reading group, the responses were richer. That is, responses included more relevant information revealing a deeper understanding of text ideas. For instance, one student in the during-reading group said, "He did experiments with birds…he tied a string to a bird and then to see if it came back which is my idea of an experiment what

scientists does to find out new things." Another said, "He looks really closely at things and he drew them." Typical responses from the after-reading group were brief: "He studied"; "He made pictures of birds"; "He looked in books."

Table 4
Number of Students Providing at Least One Example as Evidence

	Texts		
	Snowflake Bentley	*Rare Treasure*	*The Boy who Drew Birds*
During-reading group	6/9	5/9	8/9
After-reading group	4/7	4/7	3/7

4.2 PRETESTS/POSTTESTS

Results from the pretests/posttests were used to answer the second research question: *What is the cumulative effect of a thoughtful arrangement of books used during read-aloud sessions on students' understanding of the scientists in the three stories and generally what scientists do?* The pretests/posttests included questions about each of the three persons featured in the texts, what each person studied, and a set of questions regarding a scientist at work. As for the after-story tests, student scores for the pretests/posttests were calculated by comparing student responses to the ideal responses developed for each item. (See Appendix D.)

The first pretest/posttest question was, "What do you know about Snowflake Bentley/Mary Anning/John James Audubon? What can you tell me about him/her?" Responses such as "He studied snowflakes" or "He took pictures of snowflakes" were awarded one point. Vague or general responses such as, "He liked snowflakes" were not awarded any points. Rich responses were awarded multiple points. For example, this student response was awarded three

points: “He made the world realize snowflakes aren’t like dirt, they had all different shapes and sizes, not one snowflake is alike (1) and he was very interested in snow and he liked studying it (2) and taking pictures of it (3).”

The second pretest/posttest question asked students what they knew about the specific subject studied by each scientist: snowflakes, fossils, and bird migration. Students’ earned points for responses that represented rich details shared in the text. For instance, one student earned two points for this response about snowflakes: “They are bits of snow that have frozen and crystallized (1) and the beginning of snowflakes is very little and then branches stick out (2).”

The final set of pretest/posttest questions consisted of four probes regarding a scientist at work. Students were asked what they know about scientists, to describe a scientist, discuss what scientists do and the tools they use. Points were given to responses demonstrating an understanding that scientists wonder about answers to unsolved problems, ask questions, observe, study things, conduct experiments, consult books, and discover. Although students mentioned several tools that are in fact used by scientists, such as microscopes, magnifying glasses, and computers, only the following responses regarding tools found in the texts read were counted for the purpose of this study: books, notebooks, pens/pencils, cameras, and tools to dig.

Points earned from responses to each question were combined for one composite pretest and posttest score per student.

As anticipated there were no significant differences on the pretest scores between groups. Furthermore, there were not significant differences on the posttest scores between groups. See Table 5.

Table 5
Pretest/Posttest Scores

Group	Pretest		Posttest	
	M	SD	M	SD
During-reading	4.28	3.29	9.17	3.7
After-reading	5.5	4.01	7.71	3.44

Significant differences were found for gain scores as a result of an independent samples *t*-test assuming equal variances. Specifically, the gain scores of the during-reading group were greater compared to those of the after-reading group ($p = .038$). See Table 6.

Table 6
Pretest/Posttest Gain Scores

Group	Average Gain Score	SD
During-Reading	4.89	2.06
After Reading	2.21	3.49

A closer look at individual gain scores shows that all students' scores in the during-reading group (students 1-9) improved. However, one student in the after-reading group (students 10-16) scored higher on the pretest than on the posttest, resulting in a negative gain score. See Table 7.

Table 7
Individual student scores

Student	Pretest	Posttest	Gain Score
1	9	14.5	+5.5
2	0	4	+4
3	6	9	+3
4	1	4.5	+3.5
5	3	12.5	+9.5
6	4	10	+6
7	9	13	+9
8	1.5	7	+5.5
9	5	8	+3
10	0	5	+5
11	8.5	9.5	+1
12	4	12	+8
13	3	4	+1
14	3	4	+1
15	9	11.5	+2
16	11	8	-3

4.3 PRETEST/POSTTEST PICTURE TASK

Students were also asked to complete a picture task as part of the pretest/posttest assessments. Students were shown eight pictures and were asked to indicate whether a scientist would use them. The tools that were pictured included examples of four common scientific tools-- a microscope, magnifying glass, telescope, and test tubes-- and four less common tools used by the scientists in the three stories—notebooks, shovel, books, and a camera. Students were asked if each object would be considered a tool for a scientist and then they were asked to describe its purpose. Points were awarded for each item identified as a scientific tool. Additional points were awarded if the student provided a scientific purpose for the tool. For instance, half points were given for a purpose statement such as, “A scientist would write in a notebook.” A full point was awarded for responses such as, “A scientist would write about their discoveries in a notebook.”

An important finding is that the during-reading group showed greater gains in their scores from picture task pretest to picture task posttest as shown in Table 8. This difference approaches significance using an independent sample *t*-test assuming equal variances ($p = 0.08$).

Table 8
Pretest/Posttest Picture Task Gain Scores

Group	Average Gain Score	SD
During-Reading	2.56	2.51
After Reading	0.79	2.18

4.4 DISCUSSION TRANSCRIPTS

Discussion transcripts with the during-reading and after-reading groups were analyzed to answer the third research question: *How do student interactions with text ideas during discussion differ between groups?* Students' cued interactions with text ideas were compared between groups. Students in the during-reading group had the opportunity to interact with ideas throughout the reading of the text while students in the after-reading group were only cued at the conclusion of the read-aloud.

Students were cued for two purposes. Specifically, students were encouraged to consider text ideas related to scientific inquiry: the process of a scientist at work, what scientists do, and how the three scientists portrayed in these texts were similar. Students were also encouraged to talk about the focus of inquiry for these three scientists: snowflakes, fossils, and bird migration.

Table 9 presents transcript excerpts from the during-reading and after-reading group discussions about the first and last texts. The students provided responses to the prompts from the discussion leader.

Table 9 *Cued Interactions with Text*

TEXT	DURING-READING GROUP	AFTER-READING GROUP
	Talk About Scientific Inquiry Process	
Snowflake Bentley	**What does it mean to study something?** Student: To try to find out more about it. **What does it mean that he kept record?** Student: He keeps score. Student: Like if you write down every day if you saw something then you could put it in a book and keep track. **What is he thinking? What does he want to do? What's his plan?** Student: He could take pictures of snowflakes so he could have memories.	**So what did we learn about scientists?** Student: That they could study snowflakes. **What tools did Willie use?** Student: Microscope, black tray and a turkey feather. Student: a camera **What are some of the things Willie does that allow me to call him a scientist?** Student: Studies stuff. Student: He's interested in something and he doesn't want to stop learning about it.

	How will the camera help Willie with his plan? Student: It will magnify the snowflakes. **How is Willie sharing his discoveries with others?** Student: He's going around and giving speeches and showing different people the different slides and showing them pictures. Student: He's writing it down in the news. **How would you explain to someone what a scientist is or what a scientist does?** Student: Scientists learn about stuff. Student: They study things.	

	Student: They use tools that make things look bigger. Student: They study things that they're interested in. Student: They use special tools like a magnifying glass, which isn't really special but a special camera.	
	Talk About Focus or Content of Scientific Inquiry	
Snowflake Bentley	**How does Willie feel about snow? What from the story tells you that?** Student: He thought that it was really beautiful. Student: It said that he really liked it. **Tell us what Willie has learned about snowflakes.** Student: It starts off with cold air and then	**What did you learn from this book about snowflakes?** Student: Snowflakes aren't just all nice and the same. They are different and you can see them under a microscope. Student: They look like specks. Student: They normally have six branches.

	water traps the air. Student: A tiny speck.	**What are some of the ways Willie learned about snowflakes?** Student: He used an awesome camera. Student: He put them on a black tray and looked at them under a microscope.
	Talk About Scientific Inquiry Process	
The Boy who Drew Birds	**What is John wondering about?** Student: He's wondering about those birds. Student: He wondered if they are the same birds that he had met last year. **Did anyone else look in books to find the answers to their problems?** Student: Mary Anning. Student: That other guy.	**What did John do that reminded you of Willie or Mary?** Student: He studied. Student: They all loved something when they were little and then when they grew up… Student: They never gave up.

	Student: Snowflake Bentley. **Why doesn't John James believe what he read? He didn't believe because he didn't have** Student: Proof. **What do you think John James might do if he is studying the birds?** Student: By looking at what they eat and what they do.	**Would you call John a scientist?** Student: He studied and is reading books. Student: He helped the world know about it. Student: He does the same thing scientists do today, he just did it in a different way.
	Talk About Focus or Content of Scientific Inquiry	
The Boy who Drew Birds	**John knew the birds would leave soon. How did he know this?** Student: Winter is coming Student: It is getting cold and winter is coming.	**Who can tell us what we learned about birds in winter?** Student: People didn't know and believed that little birds flew south and then came back.

	Student: Last year there weren't any birds in the cave. Student: He had to wait last year so he'll have to wait again. Student: They left last year so he thinks they will leave again. **Why do you think John James is tying string to the bird's leg?** Student: Maybe he wanted to see if it was the *same* bird and would come back. **What's the main thing John learned?** Student: The same birds did come back.	

The transcript excerpts provide evidence of the opportunities for student talk focused on important text ideas: the process and content of scientific inquiry. All student responses were coded as either (INQ) for ideas related to scientific inquiry or (SF, F, or BM) for ideas related to the focus of scientific inquiry. Those responses considered scientific inquiry included ideas such as: studied, read books, experiments, never gave up, kept record, or any tools a scientist might use (camera, books, etc.). Responses coded as related to the focus of scientific inquiry included comments specific to snowflakes, fossils, or bird migration. Table 10 summarizes the number of interactions for the during- and after-reading groups.

Table 10
Number of Cued Interactions

	During Reading	After Reading
Interactions related to scientific inquiry	34	25
Interactions related to the focus of scientific inquiry	20	8
Total interactions	54	33

As Table 10 shows, students in the during-reading group talked about important text ideas with greater frequency than students in the after-reading group. These verbal interactions provided opportunities for reiterating information described in the text as well as making inferences about that information. For example, following a segment of text about Willie's idea to purchase a camera, the discussion leader asks "What is he thinking? What does he want to do?" One student replies that "he could take pictures of snowflakes so he could have memories." The discussion leader further prompts, "How will the camera help Willie with his plan?" Another student responds, "It will magnify the snowflakes."

As the transcripts show, most of the talk that transpired during the 20 minute discussion sessions was very focused on the content of the texts. As seen in Table 8, the number of cued interactions was greater with the during-reading group across all three texts. In other words these students had more opportunity to talk about text ideas. A closer look at the type of interactions shows that those related to scientific inquiry were more common than those related to the focus of each scientist's inquiry: snowflakes, fossils, and bird migration. Thus the discussion focused on building students' general idea of a scientist at work across stories rather than the individual scientists portrayed.

The next section includes a discussion of my original hypotheses and interpretation of the results outlined above.

5.0 DISCUSSION

There is little research available to document the interactions of young students with expository texts. The present study was an attempt to address that gap. The children in this study were first- and second-graders who listened as three informational tradebooks were read aloud to them and who participated in talking about those texts.

5.1 LIMITATIONS

The most obvious limitation of this study is the small number of participants: 9 students in the during-reading group and 7 students in the after-reading group. A larger sample size may have revealed greater differences between groups.

Additionally, the entire study occurred over five school days. This brief time period may have influenced the amount of growth students' demonstrated in their understandings. Also, because we were guests in the classrooms, the procedures described in this study were isolated events in relation to the rest of the school day. Connections were not made with other activities, discussions, or literacy events.

Despite these limitations, however, this study suggests that first- and second-graders can be engaged in thoughtfully considering important text ideas in a read-aloud context and that the careful selection of texts can support their developing understanding of themes that emerge in compelling ways when more than one text is used.

5.2 IMPLICATIONS

The texts in this study were chosen to provide a rich context for considering the work of scientists. Across the three texts, students learned about Wilson Bentley who studied snowflakes by figuring out how to photograph them, Mary Anning who discovered fossils and studied them to learn about creatures that lived long ago, and John James Audubon whose careful observations of birds documented that baby birds too return to their nests each spring.

The discussion about these texts prompted students to think about the content of the scientists' investigations—snowflakes, fossils, and bird migration. But the questions also prompted students to consider larger themes across the texts; namely, how scientists go about their work, observing, formulating questions, developing ways to answer those questions, keeping records of their findings, and sharing their discoveries with others. This study provides some evidence to suggest that first- and second-graders are able to apprehend and articulate these larger themes as demonstrated in their pretest/posttest performances.

Students in both groups scored generally low on the after-story tests. One explanation for this could be the measures themselves. First, only one measure was used to check understanding. Perhaps multiple measures would have provided more opportunities for the students to talk about their understandings. Second, the after-story test questions were vague. Students were only prompted with general comments such as "anything else? or "are there any other ideas you want to share?" If the measures had included probes such as "think about some of the things we just read about. Can you remember anything about what Willie was doing?" students may have offered more information to demonstrate their understanding.

Although after-story test scores did not indicate statistically significant differences between the scores of the during-reading and after-reading discussion groups; such differences were demonstrated in the pretest/posttest gain scores.

One way to think about the after-story test scores and the gain scores is to consider that they represent measures of two different kinds of understanding: understanding of an individual text and understanding of multiple texts over time. Research supports the notion of the impact interacting with thematically-related texts on student understanding. Hartman (1995) found that high-school students made intertextual connections across five related texts. Their understandings from one text provided support as they encountered new ideas in subsequent texts. Multiple exposures to a related concept across stories afforded students more time to build a mental representation of important ideas.

The gain scores suggest that interactions with a thoughtful arrangement of related texts can influence the learning of young children. Although the scores on the individual after-story tests were low, the gain scores on the pretest/posttest show the cumulative effect of multiple exposures to the important ideas through related tradebooks. This evidence supports the practice of moving beyond a single text as a source of building students' understanding.

Another way to think about the greater gain scores for the during-reading group over the after-reading group is to focus on the opportunities for interacting with text ideas. Students in the during-reading group were cued after small segments of text to consider content and vocabulary in the text. The questions kept them focused on the text ideas. Their attention was directed more than students in the after-reading group to think about the process each scientist was using in devising and carrying out a plan to answer his/her scientific question.

Students in the during-reading group were cued throughout the read-aloud sessions to consider the actions of Willie, Mary, and John James as scientific in nature. The after-story test scores show that the students in the during-reading group were better able to provide text-based evidence to support their responses.

Recent research supports the integration of science and literacy instruction with young students (Barber, Nagy-Catz, and Arya, 2006), and suggests using tradebooks as a part of an inquiry-based science curriculum, where students are engaged in activities to develop their understanding of science and scientific practices (Ford, 2006). Tradebooks, such as those included in this study, can support students in learning more about how scientists think.

The read-aloud context is a powerful one—young students have the opportunity to engage with ideas in texts above their reading level. They can be exposed to important ideas and themes of consequence. Attending to larger themes and constructs, such as scientific inquiry, can influence student understanding of subsequent texts, and their way of thinking about them. As such, the results of this study are encouraging and generative, providing a basis for further investigation.

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APPENDIX A

A.1 NATIONAL SCIENCE EDUCATION STANDARDS

National Science Education Standards: Science as Inquiry, Content Standard A: As a result of activities in grades K-4, all students should develop understanding about scientific inquiry, specifically:

1. Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.

2. Scientists use different kinds of investigations depending on the questions they are trying to answer.

3. Types of investigations include describing objects, events, and organisms; classifying them; and doing a fair test (experimenting).

4. Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists may obtain using only their senses.

5. Scientists develop good explanations, using observations (evidence) and what they already know about the world (scientific knowledge).

6. Good explanations are based on evidence from investigations.

7. Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.

8. Scientists review and ask questions about the results of other scientists'' work. (National Academy Press, 123).

The second standard is: History and Nature of Science, Content Standard G: As a result of activities in grades K-4, all students should develop understanding of science as a human endeavor, specifically:

1. Science and technology have been practiced by people for a long time.
2. Men and women have made a variety of contributions throughout the history of science and technology.
3. Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood.
4. Science will never be finished. Many people choose science as a career and devote their entire life to studying it.
5. Many people derive great pleasure from doing science

. (National Academy Press, 141).

Content Standard	Text Excerpts		
	Snowflake Bentley	*Rare Treasure*	*The Boy who Drew Birds*
A.1. Scientific Investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.		"One day, Joseph found a fantastic fossil skull…Was it a crocodile? A dragon? A monster? What did the rest of the creature look like? A year passed before Mary discovered the answer." (8) The discovery excited the scientists. Like Mary's earlier find, the ichthyosaur fossil, it was a rare clue to solving the puzzle of life long ago. What creature had become this jumble of bones trapped in rock?	"*Are these the same pewees who built the nest last year?* he wondered. *Where did they spend the winter? Will they return next spring?"* (5) "*But where were last year's babies, now grown? Had they returned too?* He began to search the woods and orchard nearby, listening for their call." (21)

		How did it move? What did it eat? How was it like modern creatures? Answering these questions helped reveal the ancient world in which the plesiosaur had lived." (18)	
A. 2. Scientists use different kinds of investigations depending on the questions they are trying to answer.	"Even so, his first pictures were failures—no better than shadows. Yet he would not quit, mistake by mistake, snowflake by snowflake, Willie worked through every storm." (14)	"she freed her latest discoveries from dirt, sand, and rock. Mary worked carefully, sometimes for days, to avoid damaging the fossils…she drew pictures of them." (15)	"He studies birds in nature, to learn their habits and behaviors." (12) "*I will bring my books to the cave.* John James decided. *And my pencils and paper. I will even bring my flute. I will study my cave birds every day. I will draw them just as they are."* (12)

A.3. Types of investigations include describing objects, events, and organisms; classifying them; and doing a fair test (experimenting).	"From his boyhood on, he studied all forms of moisture. He kept record of the weather and did many experiments with raindrops." (7) "Willie decided he must find a way to save snowflakes so others could see their wonderful designs. For three winters he tried drawing snow crystals. They always melted before he could finish" (8) "Willie studied snowstorms. He stood at the shed door and held out a black tray to catch the flakes…He waited hours for just the right crystal…the snow would melt…He had to work	"In 1811, Mary found a fossilized skeleton." (10) "Day after day, Mary searched in the shadows of the treacherous cliffs, sometimes waling ten miles in one day. Her sharp eyes spotted fossils where others saw nothing." (21)	"The walls were covered with pencil and crayon drawings of birds…He hoped someday he would make drawings worth keeping." (9)

A.4. Simple instruments such as magnifiers, thermometers, and rulers, provide more information than scientists may obtain using only their senses.	"When his mother gave him an old microscope he used it to look at flowers, raindrops, and blades of grass. Best of all, he used it to look at snow." (6) "Willie read of a camera with its own microscope. 'If I had that camera I would photograph snowflakes' he told his mother." (10) "The camera made images on large glass negatives. Its microscope could magnify a tiny crystal from sixty-four to 3,000 times its actual size" (12)		

A.5. Scientists develop good explanations, using observations (evidence) and what they already know about the world (scientific knowledge).		"Mary tried to make sense of her discoveries." (26)	"In bed that night he formed a plan…. He had read of medieval kings who tied bands on the legs of their prize falcons so that a lost falcon could be returned. Why not band a wild bird to find out where it goes? It had never been done, but John James could try. He pulled a string from his pocket and tied it loosely around the baby bird's leg. The bird pecked it off. The next day, he tied another string to the bird's leg. Again the bird pecked it off. Finally, John James walked five miles to the nearest village and

			bought some thread woven of fine strands of silver. This thread was soft and strong. He tied a piece of it loosely to one leg of each baby bird. A week later, the birds were gone." (14-16)
A.6. Good explanations are based on evidence from investigations.	"Their intricate patterns were even more beautiful than he imagined. He expected to find whole flakes that were the same. But he never did." (8)		"One morning, John James heard a bird call, *Fee-bee! Fee-bee!* He ran to the cave. He ducked his read and stepped inside. The female bird did *not* fly out of the cave like an arrow shot from a bow. The male bird did *not* beat his wings above John James's head

			and snap his beak. Instead, they ignored John James as if he were an old stump. Watching the birds fly in and out of the cave, John James knew that his friends had returned." (21) "Up the creek, under a bridge, he found two more nesting birds. And one wore a silver thread around its leg." (23)

A.7. Scientists make the results of their investigations public, they describe the investigations in ways that enable others to repeat the investigation.	"He gave copies away or sold them for a few cents. He made special pictures as gifts for birthdays. He held slide shows on the lawns of his friends." (22) "He wrote about snow and published pictures in magazines. He gave speeches about snow to faraway scholars and neighborhood sky watchers." (24) "Other scientists raised money so Willie could gather his best photographs in a book." (24)	Mary's pterodactyl was displayed at the British Natural History Museum and is still there today." (26) "Mary shared her ideas with the finest scientists." (26)	

A.8. Scientists review and ask questions about the results of other scientists' work.		"Mrs. Stock gave her a geology book. From it Mary learned about rocks and mountains of the earth. She read other books and taught herself about animals, fish, and fossils." (11) "She studied her science books." (15) "She read her science books and studied her collection." (27)	"James went to his bookcase and took down the natural history books…The scientists who wrote these books did not agree and gave different answers." (10)

G.1 Science and technology have been practiced by people for a long time.	"In the days when the farmers worked with ox and sled and cut the dark with lantern light, there lived a boy who loved snow more then anything in the world." (1)		"he thought of the two-thousand year old question. *Where do small birds go, and do they return to the same nest in the spring?"* (19)
G.2. Men and women have made a variety of contributions throughout the history of science and technology.		"Mary Anning lived from 1799 to 1847, but her spirit dwelled in a time millions of years ago, when the monsters and dragons we now call dinosaurs roamed…Mary Anning pried fossils from the ground but it was knowledge that she unearthed." (29)	
G.3. Although men and women using scientific		"Fossils were strange and mysterious. Although they had been	

inquiry have learned much about the objects, events, and phenomenon in nature, much more remains to be understood.		found before, scientists were just beginning to understand that they were the remains of animals or plants that no longer existed…" (6)	
G.4. Science will never be finished. Many people choose science as a career and devote their entire life to studying it.		"She made it her life's work." (11)	
G.5. Many people derive great pleasure from doing science.	"Willie so loved the beauty of nature, he took pictures in all seasons…But snow crystal pictures were always his favorite." (20)		"But what he liked to do best, from sunup to sundown was watch birds." (1)

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APPENDIX B

B.1 DURING-READING DISCUSSION SCRIPTS

Introduction: "We are going to read a story today. I want you to think about how the character in this story, whose name is Willie fits into your idea of a scientist. Think about how scientists think and what they do. Let's see how our ideas about scientists connect to Snowflake Bentley." Show cover, read title, author, and illustrator.

Book #1 *Snowflake Bentley*	
Text	Questions
In the days when the farmers worked with ox and sled and cut the dark with lantern light, there lived a boy who loved snow more than anything in the world.	"How do we know that this is a boy that lived long ago?" (because farmers today don't use ox and sleds, and most would not use a lantern, they would use a flashlight)
Willie Bentley's happiest days were	

snowstorm days. He watched snowflakes fall on his mittens, on the dried grass of Vermont farm fields. On the dark metal handle of the barn door, He said snow was as beautiful as butterflies, or apple blossoms.	"How does Willie feel about snow? What from the story tells you that?" (he is fascinated by it, he looks at it closely and compares it to beautiful things)
He could net butterflies and show them to his older brother, Charlie. He could pick apple blossoms and take them to his mother. But he could not share snowflakes because he could not save them.	"Why couldn't he save snowflakes?" (because they melt) "There's some more interesting information about Willie."

When his mother gave him an old microscope, [a microscope is an instrument for viewing objects that are too small to be seen by just using your eyes] he used it to look at flowers, raindrops, and blades of grass. Best of all, he used it to look at snow. While other children built forts and pelted snowballs at roosting crows, Willie was catching single snowflakes. Day after stormy day he studied the icy crystals.	"What does it mean to study something?" (to try to learn more about something)
From his boyhood on, he studied all forms of moisture. He kept record of the weather and did many experiments with raindrops. [doing an experiment means trying out a new idea or a new way of doing things to find out what will happen]	"What does it mean that he 'kept record?" (wrote notes about and tracked what the weather was like each day) "Remember we're thinking about scientists and what they do. What does Willie do that shows he is acting like a scientist?" (study, kept records, conducted experiments)

Their intricate patterns were even more beautiful than he imagined. [Intricate means that something is very detailed or complex.] He expected to find whole flakes that were the same, that were copies of each other. But he never did. Willie decided he must find a way to save snowflakes so others could see their wonderful designs. For three winters he tried drawing snow crystals. They always melted before he could finish.	intricate: very detailed and complex "It says that Willie wanted to find a way to save snowflakes. How did he try first?" (he tried to draw snow crystals)
Note: same page—He learned that most crystals had six branches (though a few had three). For each snowflake the six branches were alike. "I found that snowflakes were masterpieces of design," he said. "NO one design was ever repeated. When a snowflake melted…just that much beauty was gone, without leaving any record behind."	Here is some more information. The author includes Willie Bentley's actual words.

Starting at age fifteen he drew a hundred snow crystals each winter for three winters. When he was sixteen, Willie read of a camera with its own microscope. “If I had that camera I would photograph snowflakes,” he told his mother. Willie’s mother knew he would not be happy until he could share what he had seen. “Fussing with snow is just foolishness,” his father said. Still he loved his son. When Willie was seventeen his parents spent their savings and bought the camera.	“What is he thinking? What does he want to do? What’s his plan?”
The camera made images on large glass negatives. Its microscope could magnify a tiny crystal from sixty-four to 3,600 times its actual size.	“How will the camera help Willie with his plan?” (By making them bigger so he will be able to see their details)
It was taller than a newborn calf and cost as much as his father’s herd of ten cows. Willie was sure it was the best of all cameras. Even so his first pictures were failures—no better than shadows. Yet he would not quit.	“Wow, this camera seems very large, much larger than cameras we use today.”

Mistake by mistake, snowflake by snowflake, Willie worked through every storm.	"Let's think about this. The author is telling us something important about Willie. What is he telling us?" (that he was not a quitter, he thought this was important so he stuck to it even if it was hard)
But in those days no one cared. Neighbors laughed at the idea of photographing snow. "Snow in Vermont is as common as dirt," they said. "We don't need pictures." Willie said the photographs would be his gift to the world. While other farmers sat by the fire or road to town with horse and sleigh, Willie studied snowstorms. He stood at the shed door and held out a black tray to catch the flakes.	
Note: opposite page—He learned that each snowflake begins as a speck, much too tiny to be seen. Little bits—molecules—of water attach to the speck to form its branches. As the crystal grows, the branches come together and trap small quantities of air. Many things affect the	

way these crystal branches grow. A little more cold, a bit less wind, or a bit more moisture will mean different shaped branches. Willie said that was why, in all his pictures, he never found two snowflakes alike.	"Tell us what Willie has learned about how snowflakes are formed. How does the process begin? Then what?" (he learned that snowflakes start out as crystals too small to be seen with your eyes, but as the crystal grows it forms branches, between the branches are little pockets of air and that the crystals grow differently depending on how cold it is or how windy or how much moisture is in the air) "How did he learn this? (He learned this by watching and making careful observations) Do you think scientists learn this way?
When he found only jumbled broken crystals, he brushed the tray clean with a turkey feather and held it out again. He waited hours for just the right crystal and didn't notice the cold. If the shed were warm the snow would melt. If he breathed on the black tray the snow would melt. If he twitched a muscle	

as he held the snow crystal on the long wooden pick the snowflake would break. He had to work fast of the snowflake would evaporate before he could slide it into place and take its picture. [to evaporate means when a liquid changes into gas because the temperature increased] Some winters he was able to make only a few dozen good pictures. Some winters he made hundreds.	
Willie so loved the beauty of nature he took pictures in all seasons, In the summer his nieces and nephews rubbed coat hangers with sticky pitch from spruce trees. Then Willie could use them to pick up spider webs jeweled with water drops and take their pictures. On fall nights he would gently tie a grasshopper to a flower so he could find it in the morning and photograph the dew-covered insect.	"We know Willie is really interested in snowflakes. But here we read that he is also taking pictures of other things in nature. How would you describe a person who would *gently tie a grasshopper to a flower, so he could find it in the morning?"* (patient, careful, clarify this part) "Are these words we could use to describe scientists?"
But his snow crystal pictures were always his favorites. He gave copies away or sold them for a few cents. He made special	

pictures as gifts for birthdays. He held evening slide shows on the lawns of his friends. Children and adults sat on the grass and watched while Willie projected his slides onto a sheet hung over a clothesline.	

He wrote about snow and published his pictures in magazines. He gave speeches about snow to faraway scholars and neighborhood sky watchers. “You are doing a great work,” said a professor from Wisconsin. The little farmer came to be known as the world’s expert on snow, “the Snowflake Man.” But he never grew rich. He spent every penny on his pictures. Willie said there were treasures in snow. “I can’t afford to miss a single snowstorm,” he told a friend. “I never know when I will find some wonderful prize.” Other scientists raised money so Willie could gather his best photographs in a book. When he was sixty-six years old Willie’s book—his gift to the world—was published. Still he was not ready to quit.	“How is Willie sharing his discoveries with others? (putting his pictures in magazines and going to other places and telling people—audiences—about them)
Less than a month after turning the first page on his book, Willie walked six miles home in a blizzard to make more pictures. He became ill with pneumonia after that	

walk and died two weeks later.	
A monument [which is a large structure usually built of stone, to remind people of a famous person or an event in history] was built for Willie in the center of town. The girls and boys who had been his neighbors grew up and told their sons and daughters the story of the man who loved snow. Forty years after Wilson Bentley's death, children in his village worked to set up a museum in honor of the farmer-scientist. And his book has taken the delicate snow crystals that once blew across Vermont, past mountains, over the earth. Neighbors and strangers have come to know of the icy wonders that land on their own mittens—thanks to Snowflake Bentley.	monument: a large structure usually built of stone, to remind people of a famous person or an event in history. "Here they are calling Willie a scientist. Now that we have read this story, how would you explain to someone what a scientist is or what a scientist does? (a scientist is a person who tries to solve a problem or find the solution to a question by studying, watching, reading about, experimenting, discovering etc.)"
	CODA
	"Would you study snowflakes?" "What part of the story did you like best?"

Introduction: "We are going to read another story today. I want you to think about how the character in this story, whose name is Mary is similar to Willie whom we read about last time. Also, think about how Mary fits into your idea of a scientist. Listen to some of the things Mary does and see if you can make any connections to the things Willie did and what things a scientist might do."

Book #2 *Rare Treasure* Mary Anning and her Remarkable Discoveries	
Text	Questions
Mary and her older brother, Joseph, were just a few years old when they began visiting the nearby rocky beaches with their father. Richard Anning taught them how to hunt for fossils.	"Listen carefully as the author tells us about fossils."

Fossils were strange and mysterious. Although they had been found before, scientists were just beginning to understand that they were the remains of animals or plants that no longer existed, living things that had died many, many years ago. Usually the remains of plants and animals decompose or are eaten, but sometimes they are covered by dirt or sink in the mud. Of these, a rare few lie undisturbed for millions of years. While they are buried, the soft parts, such as flesh, decay, leaving bones, shell, or flat impressions in the earth. Minerals seep into these remains and become stone. These fossils survive hidden in the ground until they are revealed by a shovel or pick, are driven to the surface by an earthquake or volcano, or are uncovered when wind or water wears away the earth.	"So, what have we learned about fossils?"(they are the remains of animals or plants that no longer existed, living things that had died many, many years ago) What are they? (the remains of plants and animals) Where are they found? (covered by dirt or sink in the mud, a rare few lie undisturbed for millions of years) "How are they found?" (The soft parts decay leaving bones, shell or flat impressions in the earth. Minerals seep into these remains and become stone. They are revealed by a shovel or pick, or they are driven to the surface by an earthquake or volcano, or may be uncovered when wind or water wears away the earth.)

The Annings displayed the puzzling yet delightful fossils that they found on a table near Richard's shop on Bridge Street. Wealthy tourists visiting the popular Lyme Regis shore bought them. Mary and Joseph still collected and sold fossils they found on the rugged ribbon of shore that separated the sea and the cliffs.	"Remember, we heard that the Anning's father taught them how to hunt for fossils, now we learn what they did with the fossils. What was that?"
One day Joseph found a fantastic fossil skull. It was nearly the length of a man's arm and had a snout that held many sharp teeth. Was it a crocodile? A dragon? A monster? What did the *rest* of the creature look like? A year passed before Mary discovered the answer.	"Why are Mary and Joseph wondering what the rest of the creature looks like? I think that the fossil they found must be a small part of the creature but not the entire thing." "What does it mean to discover something?" (to find out new information or a solution to a problem or to figure out something that you did not know or understand before)

In 1811, Mary found a fossilized skeleton beneath a cliff called Black Ven, where Joseph had found the skull. It looked like a porpoise and was about seven feet long. Men helped her free the skeleton from the earth. She sold it to a rich neighbor, who showed it to scientists. They were thrilled by the rare treasure, a fossil of a reptile that had once lived in the sea. The scientists called the creature ichthyosaur, which means lizard fish. Only a few ichthyosaur fossils had ever been found and none were as nearly perfect as this one.	"A fossilized skeleton is a skeleton, or the bones of some creature that have hardened and stayed in the same shape." "Mary found a treasure. A treasure is something valuable or precious and that reminds me of when Willie said that there are treasures in the snow. How can fossils be a treasure? How can there be treasures in the snow?" (because they are great discoveries and they are rewards for all of their hard work)
Almost everyone forgot that it had been found by a twelve-year-old Mary Anning and her teenage brother. Mary still collected fossils and also earned money from small jobs she did for her neighbors. One of them, Mrs. Stock, gave her a geology book. From it Mary learned about rocks and mountains of the earth. She read other books and taught herself about animals, fish and fossils.	

Years passed. Joseph became an upholsterer and Mary collected fossils alone. She made it her life's work.	"This is a big idea. Here we learn that this is not just something Mary does for fun. This is something she decided was important and chose to do it as her job."
It must have been Mary's great delight because she pursued it despite the dangers on the rocky shore. Boulders fell from the cliffs, torrents of thick black mud slid from the heights, high seas pummeled the shore, and waves could sweep a careless visitor away. But the beach was rich in fossils. As the cliffs crumbled, new fossils were revealed. Many were smaller than your thumb. Others were yards long and embedded in thick, heavy rock. Workers were needed to dig them from the earth, and then horses carted them away.	"Why would fossils be revealed when the cliffs crumbled?" (because fossils are usually buried so as a cliff would crumble apart you would be able to see the fossils that had been buried)
Mary sold her treasures from a small, cluttered shop on Broad Street. There she freed her latest discoveries from dirt, sand, and rock. Mary worked carefully, sometimes for days, to avoid damaging the fossils. Sometimes she cemented a fossil to a frame to help support it. She drew pictures of them. She studied her science	"Why do you think she is drawing pictures of her fossils?" (just like Willie did, to keep a record of her findings) Here we read that she studied her science books. We learned that word earlier this week. Remind us what it means to study

books.	something?
In 1823, Mary discovered the first complete fossil of a plesiosaur, another reptile that had lived in the sea. It was an astonishing nine-foot-long creature with a long, serpentlike neck, a lizard's head, a crocodile's teeth, a chameleon's ribs, and the paddles of a whale.	.
The discovery excited the scientists. Like Mary's earlier find, the ichthyosaur fossil, it was a rare clue to solving the puzzle of life long ago. What creature had become this jumble of bones trapped in rock? How did it move? What did it eat? How was it like modern creatures? Answering these questions helped reveal the ancient world in which the plesiosaur had lived.	"How might looking at a fossil tell scientists about how a creature moved or what it ate? (by looking at a complete fossil you will be able to consider the shape of its teeth to determine if it was a meat eater or a plant eater, by observing its limbs you may be able to detect how it moved, you may also be able to locate characteristics unique to the creature that may have served as protection or used to hunt)

William Buckland, a famous geologist, brought his family to Lyme Regis to meet Mary and to search for fossils. She escorted Buckland and his children on fossil hunts. Richard Owens, the scientist who invented the word *dinosaur*, also combed the beach with Mary.	"What does it mean to say they combed the beach?"(searched very carefully, trying not to miss anything)
Day after day, Mary searched in the shadows of the treacherous cliffs, sometimes walking ten miles in one day. Her sharp eyes spotted fossils where others saw nothing. Mary's dog trotted faithfully beside her. People said the dog guarded her discoveries while she fetched her tools or got help.	
In 1828, Mary discovered a very rare fossil of a pterodactyl, a flying reptile that had the body of a lizard and the snout of a crocodile. Mary's pterodactyl was displayed at the British Natural History Museum and is still there today.	
Mary tried to make *sense* of her discoveries.	"How could Mary make sense of her

Mary Anning lived from 1799 to 1847, but her spirit dwelled in a time millions of years ago, when the monsters and dragons we now call dinosaurs roamed. She had little money, but she was rich in spirit. She was unschooled, but the professors heeded her words. She rarely strayed from her home. But her name became known everywhere. Mary Anning pried fossils from the ground, but it was knowledge that she unearthed.	"Mary Anning pried fossils from the ground, but it was knowledge that she unearthed. Unearthed means to dig up something from the earth like she did with the fossils but it can also mean make information known to people. So what does it mean that Mary Anning unearthed knowledge?" (by digging up fossils and studying them, Mary learned a lot about dinosaurs that lived long ago and when she shared her findings she gave others that knowledge)
	CODA
	"Would you like to study fossils?" "What part of the story did you like best?"

Introduction: "We are going to read another story today. I want you to think about how the character in this story, whose name is John James is similar to Willie and Willie whom we read about before. Also, think about how John James fits into your idea of a scientist. Listen to some of the things John James does and see if you can make any connections to the things Willie or Mary did and what things a scientist might do."

Book #3 *The Boy Who Drew Birds*	
Text	Questions
It was true that John James could skate, hunt, and ride better than most boys But what he liked to do best, from sunup to sundown, was watch birds. John James happiest memories were of woodland walks with his father near their home in France. On these walks, Papa Audubon would talk of birds. Their beautiful colors, their graceful flight, and—most wonderful of all—the mysterious disappearance each fall, followed by their faithful return in the spring.	"So what do we know about James? What excites him?" (he loved to watch birds and he wondered about them) "So, do you think that scientists get really excited about things like that?" "Remember Willie and Mary. What did they get excited about?" (snowflakes and fossils)
But now John James was eighteen years old and he walked through the	"Remember, he lived in France with his father."

Pennsylvania woods alone, his father four thousand miles away. Only six months before, his father had put him on a ship. The ship carried John James to America, where he was to live in a farmhouse on the banks of a creek.	
It was April in Pennsylvania, and slashes of snow still lay in deep hollows. John James splashed across the icy creek. He scrambled up the bank and approached the limestone cave, wondering what he would find today. Just the empty nest of a pewee bird, as he had found the last five days—Or would there be—	"We know he traveled by ship to America, but now we learn that he is in our state Pennsylvania."
Ffh, Ffh, Ffh! A flurry of wings greeted John James. The pewee fly-catchers had returned!	"So, what did John find?" (that the birds had returned to the empty nest)
The female bird flew out of the cave like an arrow shot from a bow. The male bird, larger, and darker, beat his	

wings above John James's head and snapped his beak. *Clack, clack, clack!*	
John James ran out of the cave and crouched next to the creek. He watched as the birds dipped and soared, snapping up mayflies in flight. *Are these the same pewees who built the nest last year?* he wondered. *Where did they spend the winter? Will they return next spring?*	"It says John 'wondered' and then there are questions—*Are these the same pewees who built the nest last year? Where did they spend the winter? Will they return next spring?* Who is asking these questions?" (John is asking himself) "What is John wondering about?" (there have not been birds around lately, now birds have arrived, he is wondering if they are the same birds that he saw last year, or if new birds have come) "Do you think this is something scientists might do?"
John James ran home through the woods. "*Madame Thomas! Madame Thomas!"* he shouted, bursting into the farmhouse kitchen. Íl y a des oiseaux!" In his excitement, his words tumbled out in French.	(ill-ya-day-wa-zō)

Mrs. Thomas was the housekeeper Papa Audubon had hired to take care of Mill Grove, his American farmhouse. She pointed her long wooden spoon at John James' muddy shoes. He quickly took them off and placed them by the fire to dry. "Birds," he said. "I see birds. Two. In cave. Beautiful!" Mrs. Thomas frowned. She was fond of this energetic French boy. And yet she had to admit he was something of a cracked pot. Birds! Always birds! From the moment he woke up in the morning to the moment he closed his eyes at night, he thought only of birds. It was strange for a boy his age. "Master Audubon," She scolded, "thou wouldst do well to do God's work by tending the farm more and chasing birds less."	a cracked pot: she thinks he is a little crazy, odd like a pot with a crack in it "Tell us what this is all about. Why is John so excited?" (because he has been waiting a long time to watch the birds and now they have come back. He thinks he may be able to find out if the birds return to their nest) "Why does the housekeeper seem upset?" (she thinks he spends too much time wondering about birds and thinks he should do his jobs to help on the farm.)

John climbed straight to his attic room—his *muse*, he called it. Every shelf, every tabletop. Every square inch of the floor was covered with nests and eggs and tree branches and pebbles and lichen and feathers and stuffed birds: redwings and grackles, kingfishers and woodpeckers. The walls were covered with pencil and crayon drawings of birds all signed "JJA."	
Every year on his birthday, John James took down these drawings—a year's worth of work—and burned them in the fireplace. He hoped some day he would make drawings worth keeping.	"Why doesn't John keep his drawings?" (he knew that he had not yet solved his questions, he knew that his drawings did not provide answers)
John James went to his bookcase and took down the natural history books, gifts from his father. *Where do small birds go in the winter? Do the same birds come back to the same nests each spring?*	"These questions have appeared before. John wants to know the answers." "Does John's idea of turning to books remind you of anyone else that we have read about?" (Yes, Willie and Mary)
The scientists who wrote these books did not agree; each gave a different answer. Two thousand years before, the	Migrate: to fly south in the winter and return to north in the spring

Greek philosopher Aristotle had given his answers to these questions. Aristotle said that *every fall great flocks of* cranes flew south and returned in the spring. But he believed that small birds did not migrate. Small birds, wrote Aristotle, hibernated under water or in hollow logs all winter.	"So, Aristotle wrote this book. What did it say about birds? What was the difference between what Aristotle said about small birds and big birds?" (every fall, large birds like cranes flew south and returned home in the spring, but small birds did not fly south, instead they hibernated under water or in hollow logs)
Many scientists of the day agreed with Aristotle. Small birds, they said, gathered themselves in a great ball, clinging beak to beak, wing to wing, and foot to foot, and lay under water all winter, frozen-like. Fishermen even told stories of catching such tangles of birds in their nets. John James had never, *ever* found a tangled ball of birds under water. And he did not believe everything scientists said. Why, some of them believed that birds transformed from one kind into another each winter! And one scientist claimed that birds traveled to the moon each fall and returned in the spring. He said the trip took	"John read some more about unusual ideas about where small birds go in the fall and winter. What are some of those ideas?" (that small birds clung to each other in a big ball under water all winter, or that birds transformed into another kind of bird during the winter, or birds traveled to the moon during the winter and it took 60 days to make the trip) "Why doesn't John believe what he read?" (in his experience he had never seen a tangled ball of birds under water.)

sixty days!	
He considered himself a naturalist. He studies birds in nature to learn their habits and behaviors.	"So, the books didn't give John the answers he wants. How's he going to 'study birds in nature to learn their habits and behaviors?' What does that mean?" (he's going to observe birds in nature where birds live, he will watch them to see how they act and what they do, he will look for to see if different birds do the same things over and over again)
I will bring my books to the cave. John James decided. *And my pencils and paper. I will even bring my flute. I will study my cave birds every day. I will draw them just as they are.* And because he was a boy who loved the out-of-doors more than the in, that is just what he did.	"Who remembers what it means to study something? What do you think James might do if he is studying the birds?" (watch them closely, see what they do, how they act) "It says that John would draw the birds just as they are. I think that means that he would draw them where they live in their own environment."

In a week, the birds were used to him. They ignored him as if he were an old stump. They carried bits of moist mud as he drew with his pencils. They brought in tufts of green moss as he read his French fables. They gathered stray goose feathers from the banks or the creek as he played songs on his flute.	John James knew the birds would leave soon. "How did he know this?" (He had watched the birds each year and he knew they would fly away for the winter)
Soon the dried brown nest had become a soft green bed. And John James had learned to imitate the throaty call of the birds: *Fee-bee! Fee-bee!*	But would they come back? He had to know! This question is really important. As we read the rest of the story we are going to find out how James went about answering this question.
Spring slipped into summer. Summer sighed and became fall. John James watched as two broods of nestlings hatched. He watched as the young birds flew for the first time. He began to feel a part of this small family.	
When the days grew shorter and the autumn air began to bite. John James knew the birds would leave soon, But would they come back? He had to know!	
In bed that night, he formed a plan.	

The next day, when the mother and father birds were away from the nest, John James picked up one of the baby birds. He had read of medieval kings who tied bands on the legs of their prize falcons so that a lost falcon could be returned. Why not band a wild bird to find out where it goes? It had never been done, but John James could try. He pulled a string from his pocket and tied it loosely around the baby bird's leg. The bird pecked it off. The next day, he tied another string to the bird's leg. Again the bird pecked it off. Finally, John James walked five miles to the nearest village and bought some thread woven of fine strands of silver. This thread was soft and strong. He tied a piece of it loosely to one leg of each baby bird. A week later, the birds were gone.	"Okay, let's stop here. Why was James tying a string on the bird's leg? What did he think was going to happen? (if he saw the bird later with the string on its leg, he would know it was the same bird that he had tied before it flew away)
All winter, John James worked in his *muse*, painting the pencil sketches he had made in the cave. He hoped that on his next birthday he would have one or two	

pictures worth saving from the fire.	
The creek was frozen now, and each time John James skated past the empty cave, he thought of the two-thousand-year-old question. *Where do small birds go, and do they return to the same nest in the spring?*	
The days grew longer. The ice on the creek had cracked and melted.	"What is happening?" (spring is coming)

One morning, John James heard a bird call, *Fee-bee! Fee-bee!* He ran to the cave. He ducked his head and stepped inside. The female bird did *not* fly out of the cave like an arrow shot from a bow. The male bird did *not* beat his wings above John James's head and snap his beak. Instead, they ignored John James as if he were an old stump. Watching the birds fly in and out of the cave, John James knew that his friends had returned.	"Why does he run to the cave?" (since he heard a bird call he ran to the cave to see if the birds had come back) "How does he know that it is the same birds?" (since they are not reacting to him he thinks they must remember him from before)
But where were last year's babies, now grown? Had they returned too? He began to search the woods and orchard nearby, listening for their call. Out in the meadow, inside a hay shed, he found two birds building a nest. One wore a silver thread around its leg. Up the creek, under a bridge, he found two more nesting birds. And one wore a silver thread around its leg.	"What does this mean? Why do these birds have silver thread tied around their legs?" (because they are the same baby birds that he tied the thread to their legs, they have returned home)

John James wanted to shout, "Yes! The same birds return to the same nest! And their children nest nearby." But who would have heard him? *I will write to my father,* he decided. *I will tell him what I have learned in America*	"So John answered his questions! What were those questions?" (Where do small birds go in the winter? Do the same birds come back to the same nests each spring?) "What's the main thing John James learned in America?" (that birds leave their nests in the winter and return home in the spring)
	CODA
	"Would you like to be a scientist?" "What was your favorite part of this story?"

APPENDIX C

C.1 AFTER-READING DISCUSSION SCRIPTS

Questions after each story for after-reading group only—whole group discussion:

Snowflake Bentley

We learned a lot from this book. I learned lots of new ideas about snowflakes. Let's talk about some of those ideas. Who can tell me something they learned from this book about snowflakes?

What are some of the ways that Willie learns more about snowflakes?

What are some of the things he did?

What tools does he use?

What did he do to figure things out?

What are some of the things that Willie does that would allow us to call him a scientist? What have we learned about scientists?

Rare Treasure

Wow! We learned so much in this book. We heard a lot about fossils. Let's talk about some things we learned. Who wants to go first?

What are some of the ways that Mary learned more about fossils?

Really think about what did she *do*?

What tools does she use?

How does she find out more?

What are some of the things that Mary does that are similar to the things that Willie did? Can we also call Mary a scientist? Why do you think that?

The Boy Who Loved Birds

Now we just read a book about John James Audubon, This book told us about an idea about birds in the winter. Who can tell me what they learned about that idea?

How did John try to find answers to the questions he had?

What was his big question?

How did he try to solve that problem?

Did John do anything that reminded you of Willie or Mary? How does John fit into your idea of a scientist? Would you call him a scientist? What makes you say that?

APPENDIX D

AFTER-STORY TESTS

After-story test for *Snowflake Bentley*

Why do you think Willie picked snowflakes to study? (one point was earned for a correct response)

He lived in a place where there was a lot of snow (1/2) and he thought that snowflakes were beautiful. (1/2)

What did you learn about Snowflake Bentley? (one point was awarded for each accurate response—a total of four points may be earned)

He studied snowflakes.

He took photographs of snowflakes with a special camera so he could look closely at them.

He was a scientist.

He discovered that snowflakes have six sides, each snowflake is different, and snowflakes have intricate designs. (any part of this response counts for one point)

If someone asked you if Snowflake Bentley was a scientist what would you say? (one point was awarded for a correct response)

Yes

What evidence (you know, things) from the story would support your answer? (one point was awarded for each accurate piece of evidence—a total of six points may be earned)

He wondered about snowflakes.

He had questions about snowflakes.

He tried to solve the question by studying snowflakes.

He watched them closely.

He read about snowflakes.

He conducted experiments using a special camera.

After-story test for *Rare Treasure*

Why do you think Mary picked fossils to study? (one point was earned for a correct response)

She was curious about fossils because when she was a young girl her father taught her to hunt for fossils on the beach near her home.

What did you learn about Mary Anning? (one point was awarded for each accurate response—a total of four points may be earned)

She was a scientist.

She dug for fossils.

She discovered fossils that had never been found before.

Her discoveries taught people about creatures that lived long ago.

If someone asked you if Mary Anning was a scientist what would you say? (one point was earned for a correct response)

Yes

What evidence (you know, ideas) from the story would support your answer? (one point was awarded for each accurate response—a total of four points may be earned)

She wondered about fossils.

She dug for fossils or she studied them.

She drew pictures of the fossils she found.

She tried to make sense of her discoveries.

After-story test for *The Boy Who Drew Birds*

Why do you think John James picked birds to study? (one point was earned for a correct response)

John James' father took him when he was a young boy for walks in the woods and talked to him about birds. He told John James about their beautiful colors, the way they fly gracefully and their mysterious disappearance each fall and their return in the spring,

What did you learn about John James Audubon? (one point was awarded for each accurate response—a total of three points may be earned)

He studied birds in nature.

He watched birds closely.

He wondered if the birds he met were the same birds he had seen the year before.

If someone asked you if John James Audubon was a scientist what would you say? (one point was earned for a correct response)

Yes

What evidence (remember evidence, means ideas) from the story would support your answer? (one point was awarded for each accurate response—a total of five points may be earned)

He wondered about birds.
He studied birds in nature.
He kept drawings of the birds he was watching.
He read about birds.
He experimented by tying a string to the bird's leg and waiting to see if the bird returned.

APPENDIX E

E.1 PRETESTS/POSTTESTS

PRETEST/POSTTEST
CONTENT QUESTIONS

Students' responses were scored using the table below. Students earned one point if they provided any of the responses.

Assessment Question	Student Response
Pre- Have you ever heard of Snowflake Bentley? What can you tell me about him? Post- What have you learned about Snowflake Bentley? What can you tell me about him?	Student indicates s/he has heard of Snowflake Bentley and… This person is someone who studied snowflakes. He took pictures so he could look closely at them. He tried to draw them so he could study them, but they melted before he could finish. He took close-up pictures of snowflakes. Because of his work, today we know a great deal about snowflakes
Tell me some things you know about snowflakes.	They have six sides, or are hexagonal shape. No two are alike. They are ice crystals. They are intricate/complex/complicated/detailed
Pre- Have you ever	Student indicates s/he has heard of Mary Anning and…

heard of Mary Anning? What can you tell me about her? Post- What have you learned about Mary Anning? What can you tell me about her?	That this is someone who studied fossils. Mary discovered fossils by digging for them.(If student responds that Mary was someone who found dinosaur bones, assessor will probe further) Because of her work, today we know about fossils but also about the creatures that lived long ago.
Tell me some things you know about fossils.	They are the remains of animals or plants that no longer exist. They are living things that had died many, many years ago. They are the remains of plants and animals. They are covered by dirt or sink in the mud, a rare few lie undisturbed for millions of years. T the soft parts decay leaving bones, shell or flat impressions in the earth. Minerals seep into these remains and become stone. They are revealed by a shovel or pick, or they are driven to the surface by an earthquake or volcano, or may be uncovered when wind or water wears away the earth.

Pre- Have you ever heard of John James Audubon? What can you tell me about him? Post- What have you learned about John James Audubon? What can you tell me about him?	Student indicates that s/he has heard of John James Audubon and… He was a person who studied birds. He solved the mystery of bird migration. He spent a lot of time with birds, learning about them and wondering where they went during the winter. Because of his work, today we know that birds fly away during the winter but return to their nests in the spring.
Tell me some things you know about birds.	Student indicates that birds leave their nests when cold weather comes and return when winter turns to spring.

PRETEST/POSTTEST

CONCEPT OF A SCIENTIST

Students' responses were scored using the table below. Students earned one point if they provided any of the responses.

Assessment Question	Student Response
Pre- Tell me what you know about scientists. Post- What did you learn about scientists?	Scientists study ideas. Scientists conduct experiments. Scientists wonder about answers to unsolved questions. Scientists try to solve questions or problems. Scientists read to learn more about an idea. Scientists discover.
What do they do?	wonder, study, experiment, discover
What tools do they use?	books, notebooks (paper) and pens/pencils, cameras, tools to dig.
What are they like as people?	A scientist is someone who studies something. They want to know more about a topic, or they have a question about that topic and they try to discover the answer or solution.
Is there anything else you want to say about scientists?	

E.2 **PICTURE TASK PRETEST/POSTTEST**

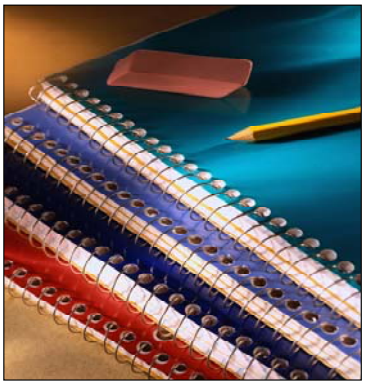
Show students a series of 8 pictures one at a time and say:

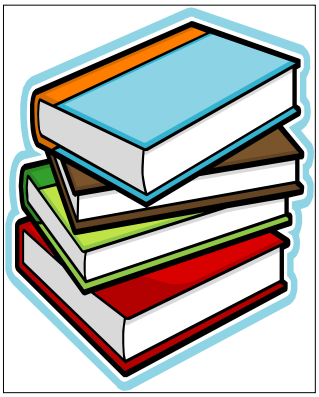
Do you think this is something a scientist might use?

How would a scientist use this?

Maybe we don’t have pictures of everything a scientist might use. Can you think of other tools that a scientist might use?

PICTURES FOR PICTURE TASK





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