Bringing Back Books

Using text to support hands-on investigations for scientific inquiry

By Gina Cervetti and Jacqueline Barber

How can you connect, supplement, and extend students' firsthand investigations? Look toward your bookshelves for a clue. There is often more than one answer to any question asked in a science classroom, and similarly, there is more than one way to teach science. Until recently, inquiry-based science educators have actively avoided the use of text, relying on a generation of hands-on science programs that included little reading. In our minds, there's no question that hands-on investigations should be at the center of science instruction. It may then surprise you that we have spent the past several years grappling with the question of whether and how books—especially trade books—can be used to teach science. How can you use books to support and enrich students' inquiry experiences and create a more robust and authentic context for learning? For one, you can incorporate reading and writing—and literacy skills in general—into lesson plans as students learn about the work of other scientists and communicate their findings. Inquiry-based science educators have started to acknowledge that these are important tools in scientific

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inquiry and that scientists rely on and use literacy skills every day (Glynn and Muth 1994; Yore 2000; Yore et al. 2004).

In our curriculum-development work, we have focused on using books in support of students' firsthand experiences. Books and other textual materials can serve the following roles in support of scientific inquiry: providing context, modeling, supporting firsthand inquiry, supporting secondhand inquiry, and delivering content. As we describe each of these roles, we share examples that demonstrate how trade books can support students' (a) involvement in inquiry experiences, (b) grasp of science concepts, and (c) understanding of the nature of science. With the variety of excellent trade books available, you are certain to find books that serve similar roles in your own science units.

Role 1: Providing Context

Books and other textual materials can connect everyday experiences outside the classroom world with classroom investigations and invite students to think about these everyday experiences in a new way. In addition, students can be inspired by their reading to pose questions and engage in subsequent investigations.

Books can also introduce the natural contexts in which phenomena operate (e.g., habitats in which the organisms that we study live). For example, many teachers offer students the opportunity to observe the transformation of a caterpillar into a butterfly. Although observing this metamorphosis firsthand in the classroom provides a powerful experience, many students know little about the natural habitat of butterflies. Joanne Ryder's *Where Butterflies Grow* (1996) shows how caterpillars are camouflaged in the surroundings they choose and how and where caterpillars attach to vertical surfaces as they metamorphose into chrysalises. Reading this text can provide students with a rich understanding of the natural context in which butterflies live as they observe a fascinating part of the life cycle of butterflies.

Books provide context for inquiry-based investigations by connecting investigations to science and scientists (e.g., scientists who research related topics, how scientists use models). In our work as curriculum developers, we created a book that helps students relate their experience of cleaning up a small amount of oil in a dish tub model to the challenge of cleaning up thousands of gallons of oil in a moving ocean (Parizeau 2007). We also use a book to connect students' experiences designing new soda recipes to the work of food scientists (Cervetti 2007a). Having developed their own soda recipes, students read a book about how a food scientist creates new flavors of jelly beans. After reading, they reflect on how their design process is like the one used by the scientist.

Role 2: Modeling

Books can be rich sources of scientific models for students. For example, we can use books to model the inquiry process and specific inquiry skills, such as observing and making explanations. Books can also model the wondering and exploration that are the heart of science, as well as the missteps that are a necessary part of science. Books can tell the story of a particular scientist in which he or she describes a personal interest in science, demonstrates scientific habits of mind, and shares his or her own work. Irene Brady's *Wild Mouse* (1976) is an account of a writer who discovers that a pregnant mouse has nested in her desk drawer. She makes systematic observations and drawings of the mouse every day for a month. The text models careful observation, description, and illustration.

For a unit about design and invention, we wrote a book about one boy's attempt to design hair gel (Barber 2007b). Students use the text as a model of the design process to develop other useful mixtures. The text also models the processes of taking notes and analyzing data and the need to sometimes rethink a design in the face of failure.

In addition to modeling inquiry processes that students use in their investigations, books containing biographical sketches of scientists offer a window into their work and their passion for science.

Role 3: Firsthand Inquiry

We can use books to directly support students' involvement in firsthand investigations. Just as scientists rely on other scientists' work to provide information they need in their investigations, so too can field guides, handbooks, and other reference books provide information that supports investigations. Just-in-time information can help students make sense of their data and can inform their emerging conclusions. Leslie Dendy's *Tracks, Scats, and Signs* (1998) is a field guide that can be used to identify evidence of animals that students might see on a nature walk. Although students might not necessarily encounter the animals on a walk, the opportunity to identify evidence of animals' presence can inform and motivate careful observation.

In our curriculum-development work, we invite students to use reference books to find information during investigations. For example, students use reference books that provide information about the properties of different substances—including flour, baking soda, and corn starch—to select ingredients to design their own useful mixtures, such as glue (Barber 2007a). The information students find supplements what they gather through hands-on experience and builds a richer collection of evidence than that which they can gather in a firsthand way alone.

Role 4: Secondhand Inquiry

Students need opportunities to collect data, but they have an even stronger need for repeated opportunities to practice the challenging skill of interpreting data. In secondhand investigations (Palincsar and Magnusson 2001), or investigations based on textual materials rather than firsthand experiences, readers interpret someone else's data presented in books or articles, and draw conclusions based on those data.

Secondhand data not only provides opportunities to interpret data that is difficult to collect in a classroom, it can also provide a common data set for a class of students, give students experience interpreting data presented in a variety of forms, and provide models of different ways of recording data. Additional experience reading and interpreting data provided in books can help students be successful in their own firsthand investigations. In addition, data presented in books is sometimes easier to interpret than the data that students collect themselves, increasing the likelihood that students will be able to draw reliable conclusions.

Data presented in books and other textual materials, such as magazine articles, can be pictorial (e.g., a collection of pictures or graphics), qualitative (e.g., words in tables), or quantitative (e.g., numbers in tables or graphs). There are a number of books that provide data tables that students can interpret, and there are wonderful pictorial books that provide opportunities for secondhand investigations for younger students. In Steve Jenkins and Robin Page's *What Do You Do With a Tail Like This?* (2003) students draw conclusions about the function of animal structures based on illustrations of those structures.

One book we wrote models recording and interpreting data by describing a series of investigations that a class of students conducts to help them create a habitat for snails (Cervetti 2007b). Readers are challenged to interpret some of the data tables in the text in preparation for their own investigations of the organisms in their desktop terrariums.

Role 5: Delivering Content

Last, books can of course present scientific concepts and facts. In combination with inquiry experiences, books can lend cohesion to series of hands-on investigations. Books can also expand and build on the ideas that students explore in their firsthand investigations. In addition, books can provide information about phenomena that would otherwise be unobservable in a classroom context—things that are too big or small, too dangerous or expensive, too distant, or occur over too long a period of time to observe firsthand in the classroom.

There are countless excellent trade books that deliver information about the natural world. For example, the book *Zipping, Zapping, Zooming Bats* (Earle 1995) provides information about bats and views of bats' internal and external structures, information not readily available for firsthand observation in most classrooms—even in a unit involving the study of bats.

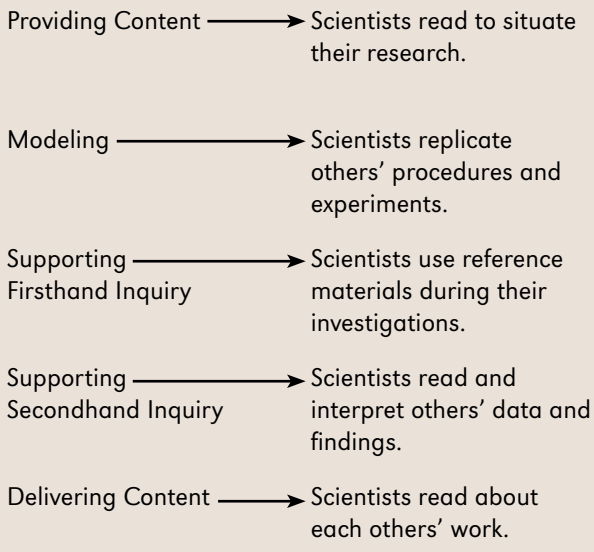
Countless books deliver information about unobservable phenomena (e.g., space, deep ocean, atomic structure). Examples we have written cover what happens to solids that dissolve in liquids and how, over time, natural forces shape the Earth (Beals 2007, Bergman and Barber 2007).

A Dynamic Tool

Many arguments against the use of books in inquiry science rest on the assumption that it is primarily a means of delivering content. In the past, books were often used to take the place of students' firsthand investigations, as evidenced by the extensive use of science textbooks in our nation's classrooms. The use of books, moreover, can cause students to refer to the authority of text even when they are capable of investigating and generating their own answers (Palincsar and Magnusson 1997). In part as a result of these concerns, many inquiry-based science educators shied away from the use of text or positioned reading only after hands-on investigations—inviting students to "do first and read and write later" (Yore 2000, p. 105). Books and other textual materials used in this role alone portray science largely as a set of facts, but text can instead play a set of dynamic roles in the inquiry process,

Figure 1.
Flow chart.

Examples of Authentic Uses of Text in Science



supporting and extending students' investigations. Each of the roles we have described is authentically connected to the activities of practicing scientists and to ways of learning and communicating science. Figure 1 maps these text roles onto the work of scientists.

Several programs of research have demonstrated how inquiry-based science experiences combined with science text can support students' scientific understanding (e.g., Guthrie and Ozgungor 2002; Romance and Vitale 1992). Palincsar and Magnusson (2001) have demonstrated how reading can be used to deepen conceptual understanding by helping students extend, sharpen, and clarify the concepts investigated through hands-on experiences. Our own research has demonstrated that students who experience science through a balance of text and hands-on experiences exhibit greater growth in science knowledge than do students who participate in curriculum involving mainly hands-on inquiry experiences or mainly reading science books (Cervetti et al. 2006). A considered use of text in combination with experience can result in a curriculum that is richer, more coherent, and more authentic than hands-on-dominated or text-dominated approaches to science. The field is ready for a next generation of science curricula that take advantage of both experience and text to create powerful learning opportunities. ■

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Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Teaching Standards

Standard B: Teachers of science guide and facilitate learning.

Content Standards

Grades K–4

Standard A: Science as Inquiry

- Understanding about scientific inquiry

Standard G: History and Nature of Science

- Science as a human endeavor

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.

References

Barber, J. 2007a. *Handbook of interesting ingredients*. Nashua, NH: Delta Education.

Barber, J. 2007b. *Jess makes hair gel.* Nashua, NH: Delta Education.

Beals, K. 2007. *Solving dissolving*. Nashua, NH: Delta Education.

Bergman, L., and J. Barber. 2007. *What's stronger? The forces that cause erosion.* Nashua, NH: Delta Education.

Brady, I. 1976. *Wild mouse*. New York: Scribner.

Cervetti, G. 2007a. *Jelly bean scientist.* Nashua, NH: Delta Education.

Cervetti, G. 2007b. *Snail investigations.* Nashua, NH: Delta Education.

Cervetti, G., P.D. Pearson, M.A. Bravo, and J. Barber. 2006. Reading and writing in the service of inquiry-based science. In *Linking science and literacy in the K–8 classroom,* eds., R. Douglas, M. Klentschy, and K. Worth, 221–244. Arlington, VA: The National Science Teachers Association.

Dendy, L. 1998. *Tracks, scats, and signs*. Minocqua, WI: Northwood Press.

Earle, A. 1995. *Zipping, zapping, zooming bats*. New York: Harper Collins.

Glynn, S.M., and K.D. Muth. 1994. Reading and writing to learn science: Achieving scientific literacy. *Journal of Research in Science Teaching* 31: 1057–1073.

Guthrie, J.T., and S. Ozgungor. 2002. Instructional contexts for reading engagement. In C. Collins Block and M. Pressley, eds., *Comprehension instruction: Research based best practices*, 275–288. New York: Guilford.

Jenkins, S., and R. Page. 2003. *What do you do with a tail like this?* New York: Houghton Mifflin.

Palincsar, A.S., and S.J. Magnusson. 1997. *The interaction of first and second hand investigations in guided inquiry science teaching*. Paper presented at the annual conference of the National Reading Conference, Austin.

Palincsar, A.S., and S.J. Magnusson. 2001. The interplay of first-hand and text-based investigations to model and support the development of scientific knowledge and reasoning. In S. Carver and D. Klahr, eds., *Cognition and instruction: Twenty five years of progress*, 151–194. Mahwah, NJ: Erlbaum.

Parizeau, N. 2007. *The black tide.* Nashua, NH: Delta Education.

Romance, N.R., and M.R. Vitale. 1992. A curriculum strategy that expands time for in-depth elementary science instruction by using science-based reading strategies: Effects of a year-long study in grade four. *Journal of Research in Science Teaching* 29 (6): 545–554.

Ryder, J. 1996. *Where butterflies grow*. New York: Puffin.

Yore, L.D. 2000. Enhancing science literacy for all students with embedded reading instruction and writing-to-learn activities. *Journal of Deaf Studies and Deaf Education* 5 (1): 105–122.

Yore, L.D., B. Hand, S.R. Goldman, G.M. Hildebrand, J.F. Osborne, D.F. Treagust, and C.S. Wallace. 2004. New directions in language and science education research. *Reading Research Quarterly* 39 (3): 347–352.