Literacy in the Learning Cycle

Incorporating trade books helps plan inquiry-learning experiences

By Susan Everett and Richard Moyer

Some things never change, and one of those things is the focus on literacy in the elementary years. As long-time proponents of inquiry, we would like to share ways to effectively use trade books within the 5E learning cycle inquiry teaching/learning model. The *National Science Education Standards* (NRC 1996) note that science is more than doing activities—scientific literacy includes communication, reading, conversation, and using evidence to evaluate arguments. This considerable overlap in the process skills of both reading comprehension and scientific inquiry creates an ideal opportunity for integration.

Trade books can be used in all phases of the learning cycle to support effective teaching and learning. Romance and Vitale (1992) found that texts and other nonfiction science books can be effective tools for teaching reading, as the science activities give learners a purpose for their reading. In this article, we provide examples of trade books appropriate for each phase and identify ways to incorporate their use.

The Five Es

The learning cycle originally developed by Atkin and Karplus (1962) included three stages—exploration, concept introduction, and concept application. Eventually, the model added an assessment step and evolved into a five-step cycle—engage, explore, explain, extend, and evaluate (BSCS 1992; Bybee 1997 [Figure 1]).

Trade Books for the Engage Phase

The engage phase begins with tapping students' prior knowledge and experiences and serves to set up a question for the students. Books that help to generate questions are most appropriate for the engage phase. Such books may:

- suggest a problem to be fixed (as in the environmental example below);
- allow students to make predictions;
- pose an activity; or
- pique curiosity, which can be used to develop student questions.

Lynne Cherry's *A River Ran Wild* (1992) tells the story of the Nashua River in Massachusetts and New Hampshire. The narrative follows the settlement and development of the area, as the river became polluted and then was restored. This book can be used to set up a water filtration activity for grades 4–6 by creating a model of the river. As the story is read, the teacher adds "pollutants" that represent what is happening to the river in the story.

Engage: Use an aquarium as a model of the river before the land around it was developed for agriculture and the paper mill industry. Read *A River Ran Wild* up to the point in which the river has become polluted and Marion has a dream to clean it up. Add the following materials to the water: clean stones for a "pebbled bottom," small twigs to represent lumber, soil for the farm runoff, shredded paper for pulp from the mills, small pieces of plastic to represent plastic waste, a small amount of cocoa to represent chemical pollutants, vinegar for foul smells, and a drop or two of food coloring for paper dyes. At this point, discuss what has happened to the water in the aquarium and elicit students' suggestions for answering the question: How can the polluted water be restored?

Explore: Have students filter the water through different materials—gravel, sand, and silt. Students may suggest variables to test at this point in the lesson as well.

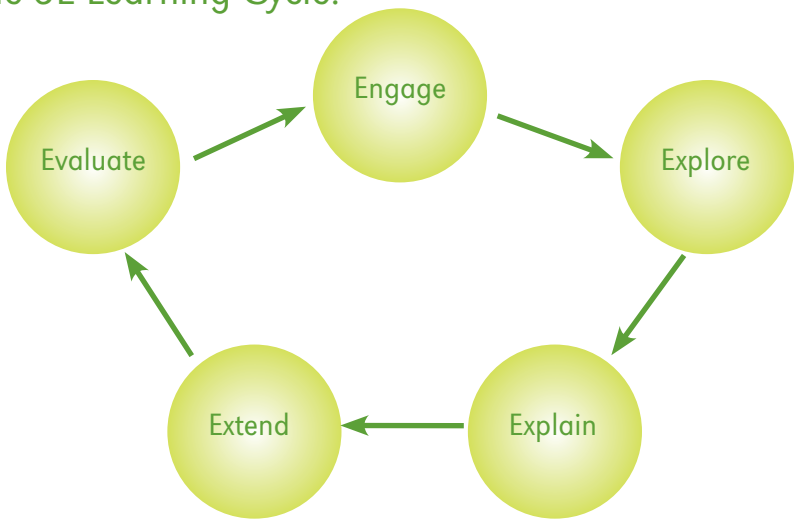
Explain: The water should become clear, although some dye may remain, as will the vinegar. Use results to develop understanding of concepts of porosity and permeability. Finish reading the book.

Extend: The exploration leads to discussion of both natural and engineered filtration, such as wells and waste-water treatment plants.

Evaluate: Set up several different filters with varying amounts of gravel, sand, and silt, and have students predict how fast (and perhaps how much) water will flow through each.

Figure 1.

The 5E Learning Cycle.



When choosing books to support inquiry science teaching, keep in mind the purpose of each phase of the learning cycle. *Engage* sets up some explorable question, *explore* is the students' attempt to answer that question, *explain* provides some rationale for what happened, *extend* seeks to take the lesson further and apply it to the real world, and *evaluate* is meant to provide information for the teacher regarding students' understanding of the concept.

Trade Books for the Explore Phase

The explore phase focuses on an activity (usually hands-on) that seeks to answer a question. Younger children, or those that are new to inquiry, need to practice answering and developing questions before participating in full inquiry to answer their own questions. With this goal in mind, we have identified a category of books that pose readily testable questions. These types of books are often designed to be read and then put aside for investigation. Simon and Fauteux have a series, including *Let's Try It Out in the Air* (2001), which contains many simple questions and suggestions for exploration. In a physical science lesson, a K–3 class might use the following learning cycle:

Engage: Have children drop balls of different masses to determine that they fall at the same rate.

Explore: Read the pages in *Let's Try It Out in the Air* that deal with children dropping objects. The book poses the following question, "Do they [a ball and a piece of paper] fall straight down or . . . float on their way to the floor?" Using a variety of objects, have children investigate to find things that are affected by the air as they fall.

Explain: Discuss results and read

appropriate pages that provide explanation.

Extend: Relate to real-world examples such as falling leaves, suspended dust particles, and parachutes.

Evaluate: As a performance assessment, have students find the lightest object (or one with greatest surface area) that falls at the same rate as a ball.

Trade Books for the Explain Phase

Books are commonly used during the explain phase of the learning cycle, as this is when students make sense of the activity and develop an understanding of the concept (and develop reading to learn strategies). Look for books that address the lesson objective; however, it is not necessary to use the entire book in an explain phase of a lesson. Select books on the science concept at several different reading levels that are appropriate for your class.

Another promising use of trade books in this phase is to incorporate the history and nature of science. By using biographies, you can help students feel connected to scientists from the past or from other cultures.

Our example of a learning cycle lesson on water for grades 4–6 uses *A Drop of Water* (Wick 1997), which contains exquisite photographs of evaporation, condensation, surface tension, and other water-related concepts accompanied by simple, easy-to-read explanations. For an expanded version of this and other learning-cycle lessons, see Moyer, Hackett, and Everett (2007).

Engage: Use a sealed plastic bag of colored water as a model representing all the water on Earth. Ask students to predict what will happen to the water in the bag if it is taped to a sunny window.

Explore: Have students measure the mass and volume of the water. Will these values change? Make daily observations for at least a week.

Explain: Have students measure again to determine if the mass or volume of water in the bag has changed. Read and discuss the photographs beginning on page 22 of *A Drop of Water*.

Extend: Look at a diagram of the water cycle and identify where water exists in different states. Students could consider where water might remain in the same state for a relatively long or short time.

Evaluate: Have students imagine that they are a drop of water. They should describe how they would move as they change state in the water cycle.

Trade Books for the Extend Phase

When selecting books for the extend phase, look for trade books that apply the science concept to the real world or make connections to other familiar concepts. *Arctic Lights Arctic Nights* (Miller 2003) provides a description of the "Land of the Midnight Sun" in a simple but powerful way. It presents data for sunrise and sunset times, number of hours of daylight, and the average temperatures, for one day each month for an entire year. Therefore, this book is useful for helping students in grades 4–6 connect to what they have learned about how temperature changes as the number of hours of daylight vary as compared to Fairbanks, Alaska.

Engage: Have students observe sunrise and sunset times for a week to determine that they are changing. Students should speculate how this information might relate to their average daily temperature. Focus students on how they could experimentally determine the effect of hours of daylight on temperature.

Explore: Students should place a thermometer in a container of soil and illuminate it with a lamp. Monitor as the temperature rises, recording periodically. When the temperature no longer rises, turn off the lamp and monitor until the soil reaches room temperature. Have students graph the temperature versus time.

Explain: The students will notice that the longer the soil is exposed to the light (up to a point) the warmer it becomes. In the model, the steady state nearly represents the temperature in tropical areas where there is little variation in temperature and daylight hours.

Extend: Read *Artic Lights Artic Nights* and discuss the number of daylight hours and average temperature in Fairbanks. Compare this information to your local daylight hours and temperature. Relate to the Engage phase by noting whether the days are getting longer or shorter and the temperature getting warmer or colder. This might be a good op-

portunity to note that there is a lag time after the summer and winter solstices before the temperature starts to reverse direction.

Evaluate: Present students with average daily temperature for a tropical city. Ask them to use what they learned to explain why these temperatures have little variation throughout the year.

Trade Books for the Evaluate Phase

The evaluate phase may seem like the least obvious place to incorporate a trade book, but many assessment ideas can be found in trade books that pose a question or a problem (these books would also be useful in the engage or explore phases). Make sure that the problem posed in the book assesses the same lesson objective so that students can be assessed on their understanding of the lesson concept based on their written responses to the question(s) posed in the books. Pamela Allen's *Who Sank the Boat?* (1982) poses a question in its title that can be used to assess K–3 students' understanding of buoyancy. In this book, several animals get into a boat one at a time for a trip. Each illustration shows how the boat sits lower in the lake. When the smallest animal, a mouse, gets into the boat, it is swamped with water.

Engage: Demonstrate that a lump of modeling clay readily sinks. Challenge students to alter the clay so that it will float.

Explore: Have students experiment with the clay to make small boats or other shapes that will float.

Explain: The clay boat floats because you have increased the volume of the clay/air system, which increases its buoyancy.

Extend: Challenge students to experiment to design a boat that will hold the greatest amount of cargo (pennies or paper clips).

Evaluate: Read *Who Sank the Boat?* and have students write a few sentences to explain why the mouse caused the boat to sink.

Choosing Trade Books

There are countless trade books to use in inquiry science lessons; however, some include misconceptions and content errors. For this reason, you may wish to select from books that have been reviewed by a reputable source. The NSTA/Children's Book Council publishes a list of Outstanding Science Trade Books for Students K–12 each March in *Science and Children* (archived lists are available online). NSTA Recommends lists more than 3,000 books vetted by science educators (see NSTA Connection). The American Association for the Advancement of Science (AAAS) Science Books and Films list is another valuable resource (see Internet Resource). It requires a subscription, so check with your library. A list of additional books to use in all of the 5E phases is available online (see NSTA Connection).

As you can see, there are many possibilities for incorporating children's trade books into science lessons. This integration of language arts with science can help promote literacy in both content areas as well as provide engaging ideas and rich extensions for inquiry-based science lessons. ■

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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–8

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry

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

NSTA Connection

Download a list of additional trade books for each learning cycle phase at *www.nsta.org/SC0910*. Visit NSTA Recommends (*www.nsta.org/recommends*) and the Outstanding Science Trade Books for Students K–12 (*www.nsta.org/publications/ostb*) websites for vetted lists of science trade books.

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Internet Resource

Science Books and Films Online
www.sbfonline.com