The Science and Literacy Framework

A five-step model to help teachers design integrated science lessons using trade books—and develop both science and literacy processes.

By Charlotte Rappe Zales and Connie S. Unger

Almost every book has the potential to be a science book. For example, one would not think that there is science value in the fiction book *Hey, Little Ant* (Hoose and Hoose 1998). This story is about "the kid" who is about to squish "the ant." Both kid and ant give reasons why the ant should or should not be squished. The book ends by asking, should the kid squish the ant or set it free? What would you conclude? If you thought about why we need ants, you just turned a literacy book into a science lesson.

Reading captivating stories—both fiction and nonfiction—provides enjoyment for students, through both the text and illustrations. Carefully selected trade books can introduce science concepts, develop background knowledge, reinforce hands-on lessons, support science-process skills, and at the same time enhance related literacy-process skills. They can also provide inspiration and structure for integrated science and literacy lessons.

Based on these ideas, we developed the Science and Literacy Framework, which enables teachers to plan integrated lessons that capitalize on the similarities between science processes and literacy processes. The Science and Literacy Framework provides a template for integrated lesson planning, allowing the teacher to analyze a book in detail for its science and literacy attributes. Figure 1, p. 44, shows The Science and Literacy Framework with additional prompts for teachers. Here we describe three experiences from several hundred teachers who used the framework to build successful integrated lessons in their K–6 classrooms.

The Framework's Five Steps

Step One: Determine the Science Content

The first step in the Framework asks the teacher to review the book through a science lens. For example, when Chris, a third-grade teacher, read *The Perfect Pet* (Palatini 2003), he discovered a science lesson about classifying animals because he was thinking about science as he read. The story is about a girl trying to select a pet that would meet her mother and father's approval. As she promotes each choice, her parents describe characteristics they do not like. Chris realized that if he sorted the animals by their attributes, he was ready to teach classification.

Steps Two and Three: Identify Relevant Science and Literacy Processes

Steps 2 and 3 turn the teacher's attention to literacy and science processes. Some teachers questioned the difference between science content and science processes. *Science content* is the actual subject matter or topics. *Science processes* are strategies that scientists use in all their endeavors, such as predicting, observing, experimenting, measuring, inferring, classifying, modeling, and communicating. Students need to be alert to the processes by name and to what scientists are doing when they use a particular process. The Framework ensures that the teacher identifies the relevant processes and can refer to them by name as the lesson is taught.

Literacy processes are skills that readers use to develop meaning as they read. Students anticipate what will happen (predicting), and they develop a picture of the content in their mind (visualizing). They want to know more (questioning), they tell the story in their own words (summarizing), and they draw conclusions (inferring). Students think about cause and effect (analyzing), consider the value of the content (determining importance), and relate the content to previous knowledge (connecting).

Teachers immediately noticed that science and literacy have processes that are similar. Predicting and inferring are common to both, visualizing blends with observing, questioning and experimenting complement each other, as do analyzing and classifying. These similarities enable integrating instruction about the processes for both science and literacy simultaneously.

Step Four: Select Teaching Strategies

After determining the science content and selecting the relevant processes, the teacher is ready to plan the lesson (Step 4). The teacher prepares to activate prior knowledge and ready the students before reading the selected book. A variety of teaching strategies (e.g., a K-W-L chart) connect to students' lives, expand vocabulary, predict content, and arouse curiosity. During the read-aloud or other reading method (e.g., buddy reading, individualized reading), the teacher plans to focus the lesson on the science content and the science/literacy processes. Stopping to ask questions about the text or illustrations will help develop understanding of the content. As the science and literacy processes occur in the book, the teacher should point them out, and then allow the students to define and discuss them. Emphasis on the science and literacy processes will clarify for students how scientists and readers work. After reading, the teacher extends the book through discussion, projects, or connections to other content areas.

Step Five: Present the Science Lesson

Now the students are ready for the science lesson that emerges from the Framework (Step 5). After Barbara read *Lost in the Woods* (Sams II and Stoick 2004), her first-grade students began their science lesson. *Lost in the Woods* is a photographic portrayal that narrates the first days in a fawn's life. Left alone and waiting for its mother, the fawn meets many forest creatures. The students constructed trifold displays as models to assess their understanding of forest animals' habitat. Then, using their prior knowledge about the rain forest, they compared those animals to their new learning about animals in the temperate zone. In this way, the Framework facilitated developing a science lesson from a literacy book.

The Framework in the Classroom

Integrated Curriculum

For her first-grade students, Carol selected *Atlantic* (Karas 2002) to read as a springboard for her district's unit on oceans. The Framework raised Carol's understanding about the potential of *Atlantic*. As a result, she designed integrated lessons that emerged from the book. The whole day wrapped around *Atlantic*.

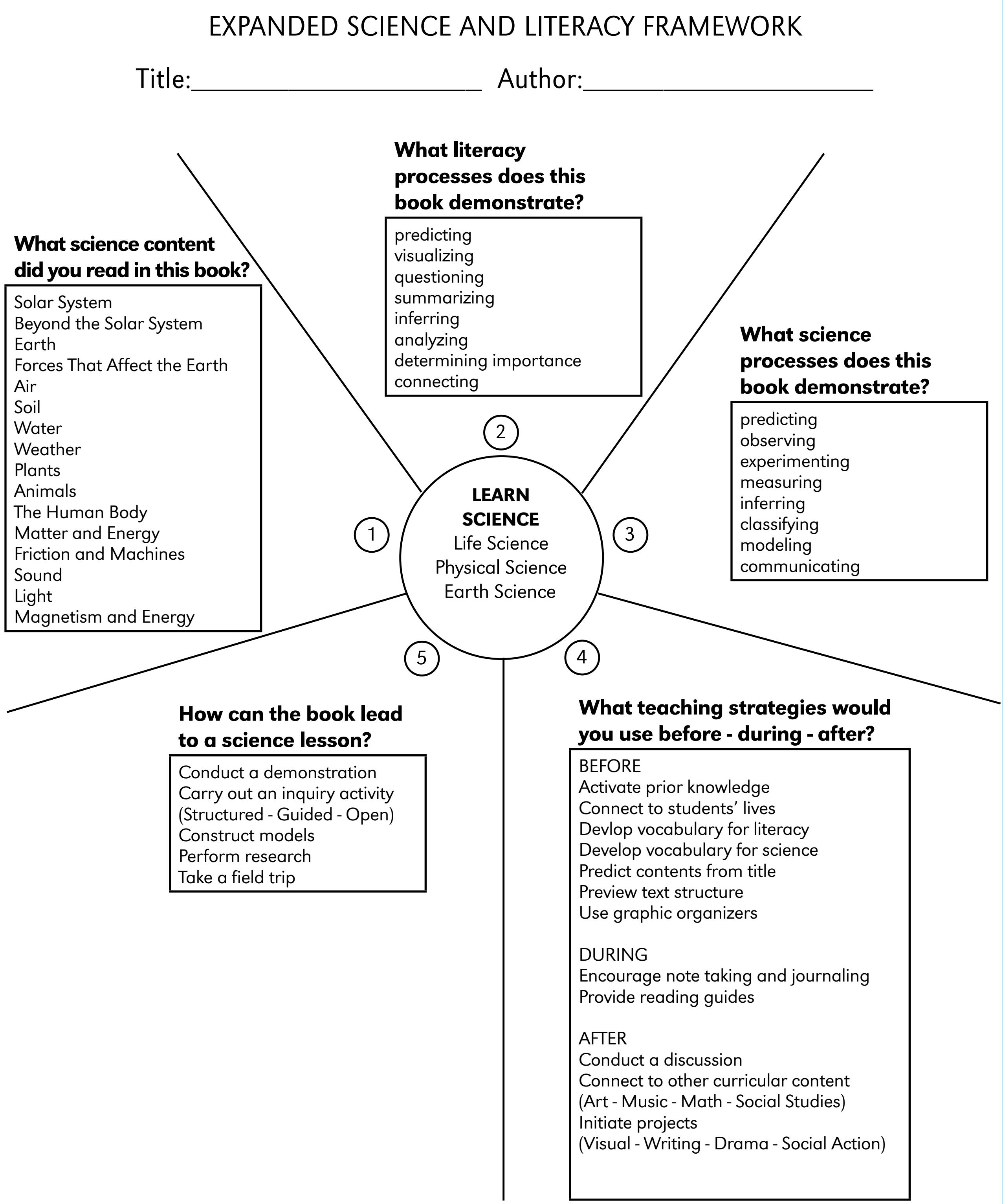
In Step 1 of the Framework, Carol outlined the science content: characteristics of the ocean, water cycle, life in the ocean, relation of the ocean to Earth, and ecology. From the content, she identified relevant literacy and science processes. For Step 2, literacy processes, Carol chose connecting to students' personal experiences, predicting to anticipate the book's content, questioning related to the illustrations of the beach and the water cycle, and determining importance about environmental issues that the book raised. For Step 3, science processes, Carol planned to include observing images of fish in the ocean, classifying fish by their size, and experimenting with types of water.

Right before Carol read the book, she used an anticipation guide to connect students to their prior knowledge and to introduce unfamiliar vocabulary. The anticipation guide presents statements with which students agree or disagree. In addition to activating their prior knowledge, it identifies mis-

Figure 1.

Science and Literacy Framework.

The boxes contain examples but not an exhaustive list.



conceptions. Students revisit the anticipation guide later in the lesson to reinforce correct information.

When Carol asked students to predict what the book was about, she connected to other books they had read, including *Mister Seahorse* (Carle 2004) and *Crab Moon* (Horowitz 2000), and to their prior experience with beach and weather. The children talked about the types of fish that live in each habitat and then illustrated sea horses and turtles in an ocean environment.

Children wrote poems to the ocean in their Writer's Workshop. The science content enabled the students to write with voice, namely, showing passion about the topic, using figurative language, and presenting a point of view. Graphing types of fish by size involved the process of classifying. Observing illustrations of the oceans flowing between continents prepared students for mapping skills.

By focusing Carol's thinking, the Framework enabled her to plan a lesson that integrated science, literacy, art, math, and social studies. Understanding is easier and at a higher level when content areas are connected.

Hidden Science Content

At first glance, *The Raft* (LaMarche 2000) does not appear to lend itself to a science lesson. This book tells the story of a young boy who visits his grandmother in the Wisconsin woods for the summer. However, when third-grade teacher Stacy analyzed *The Raft* using the Framework, she realized that she could use it to teach weather and animals after reading the boy's complaints about the weather and his adventures into the woods and along the river.

Using connecting, she built a bridge between students' prior knowledge and the book by having a discussion about summer vacations. As she read, students were busy predicting what adventures the boy would have and inferring the boy's moods as the days progressed. They observed the weather concepts as the story described in detail the hot, sticky days. They asked questions about the animals that appeared in the story, then identified and classified them.

As part of their science lesson, students chose a woodland animal, researched it, and then prepared a poster with a labeled picture and a description of its habitat. The Framework brought science into a story that one would not think of as a science lesson, and it sensitized the reader to see more details in the book.

The Science Lens

We encourage teachers to try the Framework. We welcome feedback so that we can continue to extend its usefulness. The Science and Literacy Framework facilitates analyzing the content of a book and increases understanding of the potential of a book. It brings awareness of science to the conscious level and redefines the teacher's thinking. When reading a book, teacher and children make more observations using a science lens. Integrated lessons make learning more authentic, save time, and enable learning at a higher level. The Science and Literacy Framework makes the reading purposeful and gives a clear focus for the teacher. Most importantly, the Framework encourages teachers and children to think as scientists about every book they read. ■

Connecting to the Standards

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

Teaching Standards

Standard D:

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science.

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

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Resources

Carle, E. 2004. *Mister seahorse*. New York: Philomel.

Hoose, P., and H. Hoose. 1998. *Hey, little ant*. Berkeley, CA: Tricycle Press.

Horowitz, R. 2000. *Crab moon*. Cambridge, MA: Candlewick Press.

Karas, G. 2002. *Atlantic*. Cambridge, MA: Candlewick Press.

LaMarche, J. 2000. *The raft*. New York: HarperCollins Publishers.

Palatini, M., and B. Whatley. 2003. *The perfect pet*. New York: HarperCollins.

Sams II, C. and J. Stoick. 2004. *Lost in the woods*. Milford, MI: Carl R. Sams II Photography, Inc.

The Science Literacy Framework supports science understanding by strategically incorporating literacy techniques in science lessons. Although â€œliteracyâ€ is in the name, this is not an attempt to hijack precious science instruction time for English and language arts; it is instead a way to make science teaching deeper, more engaging, and student-centered.Â As a bonus, this framework also addresses the science and technical subjects in the Common Core State Standards (CCSS) and the science and engineering practices in the Next Generation Science Standards (NGSS). The framework involves skills such as asking questions, analyzing and interpreting data, constructing explanations, engaging in argument from evidence, and evaluating and communicating information. Visual literacy was initially defined as a personâ€™s ability to â€œdiscriminate and interpret the visible actions, objects, and symbols natural or man-made, that he encounters in his environmentâ€ (9). In 1978, it was defined â€œas a group of skills which enable an individual to understand and use visuals for intentionally communicating with othersâ€ (10).Â Analogous to the PISA mathematics and literacy frameworks (1, 8), we present here a DVL-FW that covers a typology of core concepts and terminology together with a process model for constructing and interpreting data visualizations.Â In psychology and cognitive science, research has aimed to identify the cognitive processes required for reading visualizations and confounding variables. This framework for Atmospheric Science Literacy provides guidance to educators and the public on these big ideas. We have chosen to structure the framework with Essential Principles (EPs) at the highest level, on which more detailed information depends. Subordinate and more specific Fundamental Concepts (FCs) offer foundational knowledge which is needed to fully understand the Essential Principles. The Atmospheric Science Literacy Framework is a component of a larger effort to develop a comprehensive literacy framework for the entire Earth System. Several other related frameworks have already