Capitalizing on Literacy Connections

A professional development institute shows meaningful integration is possible through the recognition of the critical connections between literacy and science.

By Karen Worth, Robin Moriarty, and Jeff Winokur

With the current intensity surrounding the No Child Left Behind Act, science has moved to the back burner at many schools. Educators everywhere are allotting less time for science. Many teachers have adapted by bringing reading and writing into the science program, but more often than not this has meant using science textbooks to teach the elements of reading or assigning science research papers to teach basic writing skills. Neither of these scenarios truly presents either subject—science or literacy—at its full potential.

We know literacy is a critical component of science inquiry, so why can't educators meaningfully incorporate literacy skills in school science programs? As science educators, teachers, and professional developers from the Education Development Center in Newton, Massachusetts, an international nonprofit research and development organization focused on education and human services, we say you can. In this article, we discuss our thoughts on the critical relationship between science and literacy and describe a framework we developed for a professional development institute to help elementary teachers effectively and meaningfully integrate these subjects.

Meaningful Connections

To make meaningful connections between science and literacy, it's important to first recognize the role of language in science. Reading, writing, and oral discourse—important literacy skills—are critical to science inquiry. Consider these obvious skill overlaps:

- Scientists read related literature before they embark on investigations of interesting phenomena. *What experiments have been done before? What do we already know? How do we know it? What were the scientists' questions?*
- Scientists write continuously. They document every step of their thinking and doing. Experiments are recorded in minute detail so others can try them. Results are interpreted and conclusions set on paper.
- And, when enough work has been done, scientists present their ideas, backed by evidence, for others to read and critique.

Connections between science and literacy are also apparent when reviewing the educational standards for both science and English/language arts. In science, both the *Benchmarks for Science Literacy* (AAAS 1993) and the *National Science Education Standards (NSES)* (NRC 1996) call for meaningful science education that demands more than acquisition of the scientific facts and skills. The *NSES* state: "Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately,. . . constructing a reasoned argument, and responding appropriately to critical comments" (p. 176).

At the same time, *Elementary School Practices* by the National Council of Teachers of English (NCTE 1993) offers strategies that suggest the value of pursuing literacy instruction in the science classroom. Specifically, the *Practices* encourages purposeful use of language and states: "Children learn best when they are working on meaningful projects and actively involved in experiments or explorations on a range of topics that interest them" (p. 3). The *Practices* also encourages interdisciplinary approaches to language arts instruction with arguments that echo the goals of the *NSES*. It states: "An interdisciplinary education which draws from the knowledge and processes of multiple disciplines should encourage students to become active learners equipped with the analytical, interpretive, and evaluative skills needed to solve real-life problems" (p. 2).

Through scientific inquiry, students have opportunities to use language in the context of solving meaningful problems and, as a result, engage in the kind of purposeful, communicative interactions that promote genuine language use (Truebal, Guthrie, and Au 1981). In addition to engaging in direct investigation of scientific phenomena, students make meaning by writing science, talking science, and reading science. At the root of deep understanding of science concepts and scientific processes is the ability to use language to form ideas, theorize, research, share and debate with others, and ultimately, communicate clearly to different audiences.

Moving from Theory to Practice

While much has been said and written in support of integration, the real question is *What does it take to help schools move toward more of this integration?* The answer? Professional development!

Because many preservice and inservice programs spend a great deal of time on reading and writing, most elementary teachers have a strong background and good experience teaching literacy. Far fewer teachers have a background and experience in teaching inquiry-based science, and still fewer have had opportunities to learn how to teach science through inquiry *with* a strong literacy component.

Teachers need professional development opportunities that provide the knowledge and skills necessary to engage students in meaningful science that involves rigorous data collection, research, and communication, all of which require the use of important literacy strategies.

This need was the impetus for the creation of our professional development institute. We developed the institute's framework around the premise that scientific and literacy processes develop simultaneously because science-process skills have literacy counterparts (Koballa and Bethe 1984).

For example, inquiry skills, including questioning; drawing from prior knowledge; designing investigations; collecting and recording data; analyzing and interpreting data; drawing conclusions from evidence; and communicating findings (NRC 1996) are very similar to literacy skills used when students make meaning from text and write themselves.

As students read and write, they determine importance, create mental images, synthesize, identify prior knowledge, ask questions, and infer. To read deeply, students must learn to spot key ideas as they read, distinguish the important from the interesting, and link new information to what they already know. To write

well students must know the purpose of their writing; choose an audience; organize ideas; choose a genre; choose words and style to match the intended genre; determine structure, format, organization, and text features; and publish (Pearson et al. 1992).

We wanted teachers to recognize these similarities and to see for themselves the inherent links in science and literacy skills. What we came up with was a five-session professional development institute that first engages inservice teachers in inquiry science and then reiterates, in additional in-depth sessions, four literacy components that are inherent in science inquiry—Science Talks/Discussions; Science Notebooks; Formal Scientific Reports; and Reading Expository Text.

This article describes the design of the institute using the example of a study of circuits, but it could easily be adapted to other science content areas.

Session One:

Engagement in Inquiry

The first session of the institute focuses on engaging the participating teachers with the science, the inquiry process, and the use of language. In this session, teachers worked directly with batteries and bulbs and wires and motors to explore electric circuits.

The institute's facilitator began by engaging teachers in a discussion about what they already knew (or thought they knew) about electric circuits, modeling questions for probing learners about their thinking, such as *What are all the ways we use electricity in our daily lives? Where do you think electricity comes from? Has anyone ever wired a lamp or other electrical appliance? What do we know about how batteries provide electricity?* and *How do you think a light bulb works?* The facilitator also asked teachers to make drawings to help represent their thinking.

As they moved to the guided exploration with circuits, the teachers kept science notebooks in which to record observations, drawings, and descriptions of the various pathways that either complete a circuit or not.

Toward the end of the session, the teachers reported their findings and discussed their ideas as a group, using their notebook entries for evidence to support their conclusions about circuits. The facilitators videotaped this discussion for use in the institute's later sessions.

The session closed with a careful summary of all of the ways in which language was used in guided inquiry into electric circuits, including discussion before, during, and after experiences; keeping notes in notebooks; reading back from notebooks; presenting ideas; and listening to the ideas of others.

Teachers were given a homework assignment to write a brief but formal report of their inquiry using the data from their notebooks as well as what they learned from the discussion.

With personal experiences with the materials as a foundation, the institute next moved to deeper consideration of four specific uses of literacy to support student understanding of key concepts about circuits. A literacy specialist joined the group to ensure the integrity of both science and literacy—and authentic connections between the two—were maintained. Samples of children's work were collected from the classrooms of teachers engaged in a study of circuits to use in sessions three and four.

Session Two:
Science Talks/Discussions

One critical component of inquiry-based science is the discussion that supports students in developing meaning from their direct experiences. Oral language is also a critical foundation for literacy. As students discuss their ideas they are learning to listen to others; interpret the meaning of their words; and use detailed, meaningful, and clear language to express their own ideas.

In many classrooms, discussions are either left out for lack of time or are a simple sharing of ideas with no significant dialogue among students and little development of individual and collective knowledge. In this session, we introduced an alternative way to discuss ideas known as *accountable talk*. "Accountable talk is not empty chatter; it seriously responds to and further develops what others in the group say. Students introduce and ask for knowledge that is accurate and relevant to the text under discussion. They use evidence from the text in ways that are appropriate and follow established norms of good reasoning" (New Standards Primary Literacy Committee, 1999, p. 24).

To begin, teachers viewed the videotape of their classroom discussion about electric circuits. They discussed both the role of the teacher in guiding the discussion and the nature of the dialogue.

In this discussion, the institute facilitators emphasized the importance of large-group discussions for student meaning-making and the use of effective instructional strategies. They focused on key discourse strategies students needed to learn, such as modeling appropriate forms of discussion by thinking aloud, establishing a single focus of talk, and guiding students in interpreting one another's statements and ideas.

During this session, the facilitators also highlighted how important it is for teachers to have at least a basic understanding of the science content in order to challenge children to think deeply.

Session Three:
Science Notebooks

Notebooks modeled after the notebooks of practicing scientists are becoming more and more common in inquiry-based science classrooms, but teachers need guidance in how to make them effective learning tools. The third session provided teachers with instructional strategies on using notebooks, including modeling and how to give critical feedback on the notebooks.

Teachers reviewed the notebooks created in the first session and examined examples of student notebooks that the facilitators provided. The facilitators identified important components included in a science notebook, such as date and time of the work, a clear statement of purpose, detailed procedures, conclusions, and thoughts.

They discussed some of the issues of classroom use of notebooks, such as the importance of having students use prior entries in their notebooks to review data and the role of teacher modeling and commentary in helping students learn how to keep good science notebooks.

In addition, the facilitators provided practical guidelines for using notebooks with children, including suggesting possible formats and assessment rubrics.

The session also addressed some critical skills and strategies students need to know to create and use notebooks effectively, such as note taking, accurate description, procedural writing, and appropriate use of graphs and charts.

Session Four:
Formal Scientific Reports—Writing Expository Text

Much of the formal writing students currently do in science programs is in the form of factual research reports using secondary resources. Too often students simply find information in books or on the Web and edit it, without thoughtful analysis, to fit the specific requirements set by the teacher. For example, students are often asked to "find four facts about tigers."

The purpose of the fourth session is to have students find information, interpret it, and synthesize it for the audience for which they are writing (Yore et al. 1997). The first half of this session focused on how to include formal report writing based on primary evidence students have gathered themselves (from their notebooks) and/or secondary resources in inquiry-based science programs.

Teachers first shared and discussed the reports they wrote after session one, then turned to an examination of examples of student work. The institute facilitators suggested specific strategies for guiding students in writing reports, such as clarifying the research question, taking notes, identifying key issues, and organizing data.

In addition, the facilitators made explicit the literacy strategies that support formal report writing, such as identifying audience and purpose, establishing voice, using appropriate content-specific language, writing concisely, and creating an appropriate organization and structure.

Session Five:
Expository Text—Reading Informational Text

The use of nonfiction books in the science classroom is growing, but there is still some evidence to suggest that teachers are much more likely to use narrative fiction books even in science (Donovan and Smolkin 2001). There are also many new science, nonfiction trade books emerging that reflect a textbook, fact-based style that demands little thought from the reader and provides no modeling of effective scientific communication.

Connecting to the Standards

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

Professional Development Standards

Standard A:
Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry.

Standard B:
Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching.

Standard C:
Professional development for teachers of science requires building understanding and ability for lifelong learning.

Standard D:
Professional development programs for teachers of science must be coherent and integrated.

Using many examples of high-quality science books on electricity and its use, the fifth session addressed the importance of developing students' abilities to use a range of high-quality informational texts and provided specific strategies teachers can use to develop students' ability to read, ponder, and comprehend such materials.

The facilitators identified important literacy skills, such as identifying text features (index, glossary, table of contents, design of the page, the relationship between photographs and captions, etc.), skimming, identifying important ideas and words, and making inferences.

This final session concluded with an overview of how the various forms of reading, writing, and oral language development should be used throughout an inquiry-based science program. Participants were also asked to think about how they might continue their work with one another or with colleagues at their schools.

Next Steps

These five sessions provide only a starting point for teachers to begin to see the potential for authentic integration of science and literacy. Real change in classroom practice needs ongoing reflection, study, and dialogue among teachers.

From the start of the institute, we strongly encourage biweekly study groups facilitated by master teachers. Through these small groups, teachers can study their own students' work and define the issues that particularly concern them as they explore new ways to integrate science and literacy.

We also encourage inviting school administrators, literacy specialists, and teachers who might otherwise be reluctant to take the time to teach science to participate in the groups. Our hope is that by being increasingly explicit about where good science teaching complements and supports children's literacy learning, science will work its way back to where it belongs—closer to the center of the elementary program. ■

Karen Worth (kworth@edc.org) is a senior scientist at the Center for Science Education (CSE) at the Education Development Center (EDC) in Newton, Massachusetts, and an instructor at Wheelock College in Boston, Massachusetts; Robin Moriarty is a curriculum developer at CSE; and Jeff Winokur is a senior research associate at CSE and an instructor at Wheelock College.

Resources

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