Researchers and middle school teachers teamed up to give students effective reading instruction in science class.

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It is mid-November, a time of year when middle school students are normally antsy about the upcoming holidays. But the 6th graders in this science class are eager and engaged. The teacher reminds her students that they learned about different kinds of waves during last week's "reading in science" lesson and asks for the name of the waves that move through a vacuum. "Electromagnetic waves," a boy pipes up. One student compares the movement of electromagnetic waves with the way dominoes fall. Another boy inquires, "Why do we have to wear lead aprons for X-rays?" and a discussion ensues about the medical benefits and health risks of certain types of electromagnetic waves. A girl points to a list of various electromagnetic waves that the class used in a recent reading strategy lesson. The list sparks more discussion about gamma rays and nuclear energy.

This vignette shows how a reading lesson can stimulate lively discussion and inquiry learning in science class. We saw many such instances of reading and science learning reinforcing each other during our academic year working together—as researchers and teachers—to infuse reading comprehension strategy instruction and literature into middle school science classrooms.

In Search of Scientific Literacy

The National Science Education Standards describe scientific literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (National Research Council, 1996, p. 22). Being scientifically literate entails being able to read and understand a variety of science texts to form valid conclusions and participate in meaningful conversations about science.

But too many middle school students have difficulty reading their textbooks and content-area materials in science class.
and other disciplines (Carnine & Carnine, 2004). In a recent report, Biancarosa and Snow (2004) identified 15 components as central to successful adolescent literacy programs and called for schools to combine these elements into effective programs. One of the report’s key recommendations was that teachers provide adolescent learners with a repertoire of comprehension strategies and engage them in extensive reading of complex content-area texts. Because secondary science textbooks tend to be technical, dense, and abstract, they present challenges to adolescent learners. Researchers have found that students engage in little reading of content texts in secondary classrooms (Ivey & Broaddus, 2001). To become scientifically literate, students need to read more science texts and develop strategies for learning from these texts. However, many content-area teachers are wary of taking class time to teach reading strategies. Content-area teachers tend to focus more on covering content than on teaching students how to learn from texts.

With these concerns in mind, in fall 2004, professors and doctoral students in the College of Education at the University of Florida in Gainesville initiated a research project aimed at helping science teachers integrate reading into their curriculums. Our Reading Integration Research Project During the 2004–2005 school year, a group of University of Florida researchers collaborated with two 6th grade science teachers at Westwood Middle School in Gainesville, Florida, to create lesson plans, book lists, and other tools to introduce more reading into science teaching. (For more detailed information on the development of this research project, see Fang, Lamme, & Pringle, 2005.) We gave students in these classrooms explicit instruction in science-related language skills and reading strategies. We also gave students access to award-winning science trade books through a home reading program. At the beginning of the school year, the university researchers assumed major responsibility for the project; by the end of the year, the classroom teachers had assumed the main responsibility, and they have kept the project going.

Our analysis of Westwood students’ achievement before and after we implemented the research project suggests that the students who received reading strategy instruction and access to award-winning science books had higher achievement in science than did students who did not receive such interventions. Three elements of this project—reading strategy instruction, a home reading program, and professional development—brought about this increase in science learning.

Reading Strategy Instruction Our team developed and taught 22 lessons in such comprehension strategies as questioning, think-pair-share, two-column note taking, and paraphrasing. For each strategy, teachers provided direct explanation, modeling, guided practice, and chances to apply the strategy independently. Throughout the year, students were given opportunities to apply targeted reading strategies of their choice in science lessons.

Team members realized how much science information students could gather from a carefully selected read-aloud.

For example, when Westwood Middle School teacher Sara Charbonnet introduced the “thick and thin” questioning strategy in a unit on measuring temperature, she first noted that people ask questions about what they read to help them make sense of what they are reading. She explained,

A thick question asks something big. It often leads to deeper discussion or asks you to look beyond the text to find the answer. A thick question often begins with “Why?” or “I wonder.” A thin question can usually be answered with a simple “yes” or “no.”

Sara read aloud an excerpt from Temperature (Understanding Science) by Joy Frisch and directed students to follow along as she read and to think of one thick question and one thin question. Sara displayed some of her own questions using the overhead projector.
She paused in the reading and asked students to share some of their questions with the group and with one another. Students were excited to share such thick questions as, "How does the liquid cool off?" "Why would Anders Celsius make the Celsius scale when he already had Fahrenheit?" and "How does meteorologists forecast the weather?" Sara had students continue reading the excerpt on their own and note additional thick or thin questions. At the end of the lesson, she compiled all the students' questions into a chart, which the class used to guide discussion and activities throughout this unit.

The classroom teachers believed they could only spare 15–20 minutes each week to model these reading strategies; this gave us just enough time to explain a strategy, model it, and provide guided and independent practice. Our team compensated for the brevity of each strategy lesson by asking the teachers to reinforce the lessons during the week so that students would have a better chance of internalizing the reading strategies through repeated opportunities for practice.

**The Home Reading Program**

The Westwood teachers gave students a choice among a rotating collection of science books; students borrowed a new one each week to read at home with their families. We selected 196 titles from award-winning children's science literature, choosing from such lists as the National Science Teachers Association's list of Outstanding Science Trade Books for Students K–12 (see "A Sample of Science Trade Books"). We chose books that contained accurate science in both text and illustrations and covered a range of reading levels. Most were nonfiction, but a few were poetry, fiction, or biographies of scientists.

When students returned their finished books, the teacher led a short sharing time in which each student could talk with the class about content that he or she had learned from this reading and pose questions the book had raised. Students gleaned much science knowledge from these sessions. For example, a student's review of a book about the Everglades led to a discussion about how the weather patterns over Lake Okeechobee influence the Everglades environment.

**Professional Development Workshops**

During the yearlong action research project, our team met for three professional development workshops to further our knowledge about integrating reading instruction into an inquiry-based science curriculum. We read and discussed significant texts on integrated curriculum and reading instruction. Our four primary resources were Language and Literacy in Science Education (Wellington & Osborne, 2001), Strategies that Work: Teaching Comprehension to Enhance Understanding (Harvey & Goudvis, 1999); Nonfiction Matters: Reading, Writing, and Research in Grades 3–8 (Harvey, 1998); and Real Reading, Real Writing: Content Area Strategies (Topping & McManus, 2002).

We also held monthly meetings to plan instruction, voice concerns, and tweak how we worked in the classroom. At one meeting, a doctoral student shared her observations of a teacher read-aloud using the book Snowflake Bentley by Jacqueline Briggs Martin and Mary Azarian:

You could hear a pin drop while she read. The students were so enthralled with the book that they performed most of the reading strategies themselves. They were previewing the text by looking carefully at the cover, predicting what would happen in the story, summarizing the events, and questioning. Jen also modeled the think-aloud strategy as she read. A boy who sat toward the front of the room was making predictions and asking thoughtful questions throughout the reading. Another boy was very curious about the contraption Snowflake Bentley used to
observe and photograph the snowflakes. He and other students began wondering aloud about the inventing process and about how temperature affected Bentley's work.

By sharing observations, team members realized how much science information students could gather from a carefully selected read-aloud. Without our setting time aside during meetings to discuss our observations, such successes might have gone unnoticed.

**Not Extra but Essential**

The research project integrating increased reading into science learning at Westwood officially ended at the close of the 2004–05 school year, but one of the happiest successes of the research project was that the teachers acquired the resources and momentum from their participation to keep the reading infusion strategies going. The teachers have planned together over several summers, selecting the reading strategies that they perceive worked best with their science students, sharing new reading strategies, and preparing ways to incorporate them into future lessons. They are working with other teachers in the school to further infuse reading into their classrooms.

The unfortunate reality is that not all students are adequately prepared to comprehend the demanding texts used in science courses by the time they enter secondary school. Without the ability to learn from texts, the depth and breadth of knowledge students can gain in any area of science is severely limited. It is time for classroom science teachers to assume responsibility by providing science literature that students can read and enjoy—and by helping students develop strategies to learn more effectively from content texts. And it is time for reading researchers outside the classroom to reach out with support. Content-area teachers need to understand that teaching reading skills is not an “extra” but an essential part of promoting content-area literacy.

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Researchers have found that students engage in little reading of content texts in secondary classrooms.

References

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