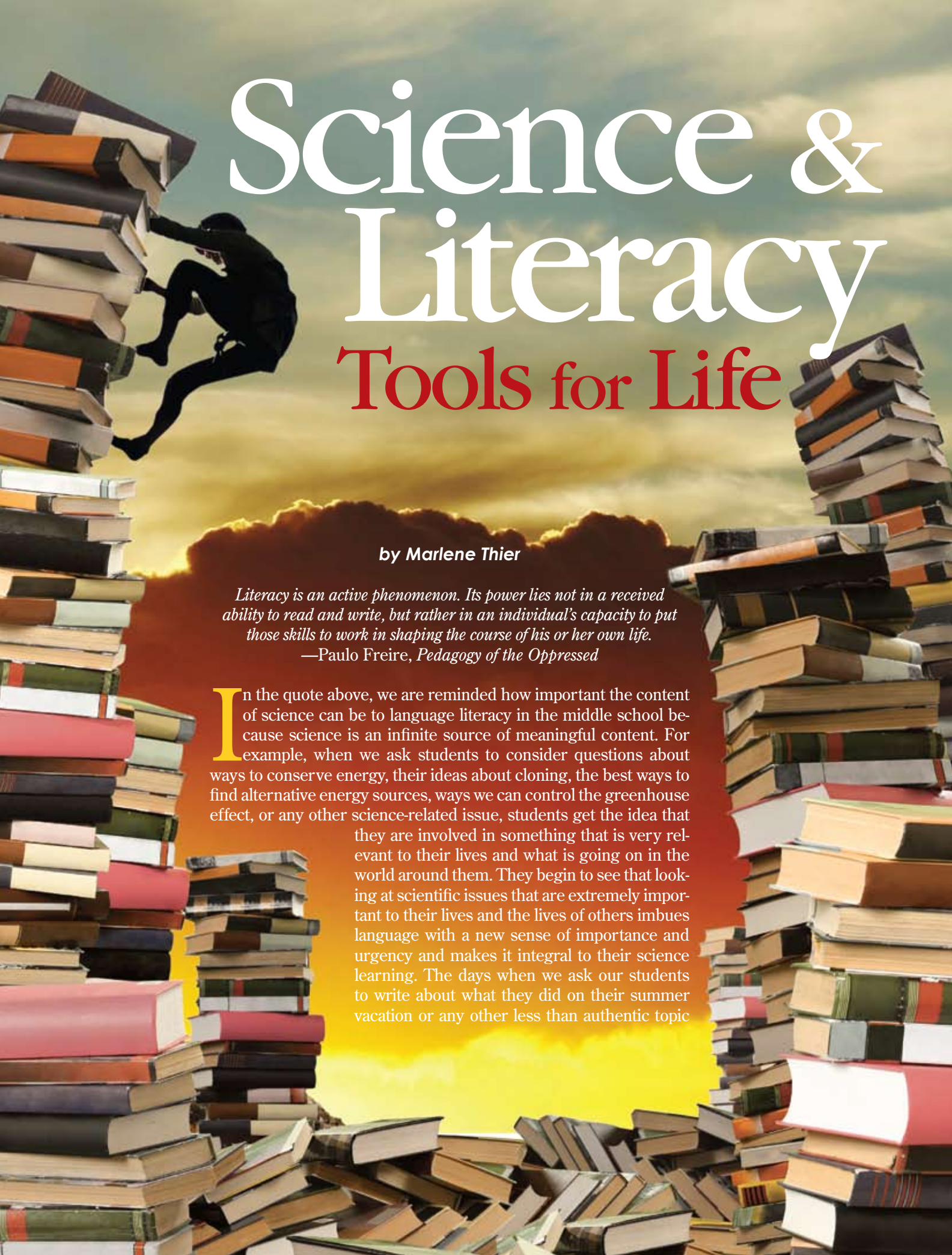

Science & Literacy

Tools for Life

by Marlene Thier

Literacy is an active phenomenon. Its power lies not in a received ability to read and write, but rather in an individual's capacity to put those skills to work in shaping the course of his or her own life.
—Paulo Freire, *Pedagogy of the Oppressed*

In the quote above, we are reminded how important the content of science can be to language literacy in the middle school because science is an infinite source of meaningful content. For example, when we ask students to consider questions about ways to conserve energy, their ideas about cloning, the best ways to find alternative energy sources, ways we can control the greenhouse effect, or any other science-related issue, students get the idea that they are involved in something that is very relevant to their lives and what is going on in the world around them. They begin to see that looking at scientific issues that are extremely important to their lives and the lives of others imbues language with a new sense of importance and urgency and makes it integral to their science learning. The days when we ask our students to write about what they did on their summer vacation or any other less than authentic topic

are long over. Students need to have a compelling reason to read, write, listen, and speak, and meaningful science content offers that reason.

Your primary task as a science educator is to help students master science concepts and processes. Your role is to be a guide, to trust in your students' intellect, and to continually push them to become more reflective about their learning. Along with this, your job is to encourage students to always question their assumptions and to be self-motivated problem posers and problem solvers. Your secondary task is to help students improve their language skills within the context of science, because all teachers need to support literacy within the context of their discipline. The following three interconnected strategies help form the structure of support that you and your students can use to reach both goals simultaneously: performance expectations for students, explicit teaching strategies that support inquiry-based learning, and student metacognition strategies (Thier 2002).

Performance expectations for literacy in the science classroom

What are performance expectations?

Very simply, performance expectations are brief lists of expectations that serve as short reminders to focus students' attention on key skills of literacy that are called upon in the course of doing good science teaching and learning. The purpose of the expectations is to give you and your students a single, shared list of criteria for good performance in literacy skills while doing and learning science. The performance expectations are designed for both students and teachers to use. As a teacher, you can use the expectations to monitor students' progress over time. With your help, students can use them as road maps to independent learning while developing greater language skills. When both students and teachers measure students' work against the same explicit performance expectations targeted to the grade level, both can closely track students' growth in achieving literacy goals within the science program.

How they work

Performance expectations should be shared with students. When you present them, the expectations show students not only the goals that they are expected to achieve, but also what they need to do in their work to achieve those goals. They can empower students. As teachers, we have all told our students that they need to do better, but very often students are left wondering what "better" looks like. Learners who struggle without success often feel powerless, because they don't know what good learners do in order to succeed. When you share performance expectations with your students, you let them in on the strategies that good learners use intuitively. Students know more clearly what is expected of them, and they have a clear path to follow in improving their own work instead of waiting for you to render judgment. When they know and understand explicit performance expectations, students are empowered to take charge of their own learning and improvement, which also lifts some instructional burden from you. Students need to have performance expectations in all areas of literacy including reading, writing, listening, and speaking.

The following is one performance expectation for reading comprehension:

- Makes accurate interpretation, inferences, conclusions, and real-world connections about the text. (Students can explain in their own words the themes and main points of what has been read and find relevant passages in the text to support their assertions.)
- Supports personal understandings and interpretations of the text with detail and convincing evidence. (Students can find relevant passages in the reading that not only support their assertions, but also convince others that the assertions are correct.)
- Uses evidence to interpret and apply ideas. (Students can see personal meanings in the reading and apply those meanings outside of the classroom.)
- Compares and contrasts themes and ideas. (Students can identify related themes or topics in different passages or texts and explain their similarities and differences. For example, if students are studying the difference between sugar and artificial sweeteners, they make evidence-based decisions about which ones to use based upon readings. They read product labels and information about sugar and sugar substitutes. Students can demonstrate their comprehension of the material by using facts pre-

sented in the reading as evidence in ongoing discussions and group work. They can use the internet to research sweeteners to help them make a personal, evidence-based decision on which one to use. Students can compare and contrast facts from their readings.)
- Makes perceptive and well-developed connections among concepts in the reading and between ideas in the reading and the student's own life (even if the author does not make them explicitly).
- Identifies and evaluates writing strategies to understand how the author presents a point of view. (Students are able to identify the author's assumptions, biases, and intents and critically analyze the effectiveness of the author's message.)

It is important that you customize performance expectations to what is required in your grade level and school for each area of literacy. Particularly in the middle school, it is important for you, the science teacher, to work closely with the language arts teacher to develop a set of performance expectations that are grade-level appropriate, so that the literacy expectations being reinforced in the science class mirror those in the language arts class. This partnership ensures consistency in what is expected of students in language literacy in both academic settings.

Explicit teaching strategies

The second part of this three-part process is called *explicit teaching strategies.* You can use performance expectations to design strategies for explicit teaching that show your students exactly how to help themselves. The strategies for explicit teaching are practical methods you can use in order to incorporate literacy into your science program. Below is an example of a practical strategy that you can use to teach students how to become more active readers by involving them more personally in the textbook's information.

Write as You Read Science is an explicit teaching strategy that asks students to identify and jot down key concepts, words, and passages in their reading as they come across them. Doing this gives students a direction and a purpose—an immediate reason to read actively instead of passively. The technique also leads them to become more adept readers by encouraging the kind of internal monologue that good readers naturally develop. It encourages students to distinguish between main themes or ideas and their supporting details. By writing as they read, students also create their own study guides for review and outlines for report writing. These larger purposes help elevate "reading as usual" to a more active and personal level.

Write as You Read Science: Guidelines for students

1. Underline the main ideas or topics.
2. Place a dot next to the parts you want to remember.
3. Put a question mark next to the parts you don't understand.
4. Highlight the parts you find interesting.
5. Circle the parts you agree with.
6. Underline the parts you think your teacher wants you to know.
7. Write notes about information you want to remember to remind yourself why it is important to you.
8. Write questions about parts you do not understand.
9. Write notes about your thoughts and feelings.
10. Write a short summary of the reading.
11. For any unfamiliar words, find their definitions and use them in a new sentence.

Metacognition

The third part in this interconnected approach to science literacy involves the idea of metacognition. Metacognition is the ability of students to become aware of their own thinking processes while doing literacy activities in the science classroom. When used effectively, metacognitive reading strategies resemble "a storyteller in your head." As one student put it, "When you read, it should be a little voice in your head like a storyteller is saying it. If that's not there, then you're just looking at the words" (Schoenbach et al. 1999).

Equipping middle school students with metacognition strategies can be extremely important on many levels. Basically, it changes the locus of control from the teacher to the student because students acquire the ability to take charge of their own learning. It can give students a personal understanding of how to help themselves. We know, as teachers working with adolescents, just how important it is to empower

students and reinforce their quest for control because of their basic desire for independence (Ridley et al. 1992).

Writing narrative procedures and lab reports is one example of a metacognitive strategy. Using this can help students explicitly understand the important elements in a lab report. What follows is a metacognitive strategy for writing laboratory reports (Thier 2002):

- Describe the research question you were trying to answer or the prediction or hypothesis you were testing.
- Describe what you did to answer the research question or test the prediction or hypothesis. Include a description of the method and materials you used.
- Describe any observations you made and the data you collected.
- Formulate a conclusion based on the data you collected. Discuss your predictions and their accuracy and how well the data supported your hypothesis.

A report by the National Research Council's Committee on Learning Research and Educational Practice (Donovan, Bransford, and Pellegrino 1999) emphasizes the importance of teaching metacognitive skills explicitly as a part of class discussion and personal reflection. There is also evidence that student achievement and understanding improves when metacognitive strategies are used in physics, written composition, and mathematical problem solving.

One effective strategy is to teach students not only what metacognition is, but also how it can help them directly with problem solving. Students can help each other understand their thinking by engaging in metacognitive conversations. It can be exciting for students to group problem solve. The following is a metacognitive conversation that small groups of students can engage in after completing an inquiry activity or a laboratory experiment:

- What did you find out?
- How did you figure that out?
- How did you get that idea?
- How did you reach that conclusion?

Metacognitive conversations can be very useful to help students understand how other students think when problem solving. After students have discussed their ideas in their small group, one effective strategy is to have students discuss their ideas among groups in a jigsaw configuration to get a broader perspective of how their peers approach and solve problems.

The synergy of the threefold approach

Many ideas have been presented here, and you are probably wondering where you will find the time to add these new elements to your curriculum. Begin by doing it incrementally and trying small changes. Perhaps just start with performance expectations in only one area of literacy, and then gradually add other suggested parts. Most teachers who invest time in trying to communicate these ideas to their students say it is worth the effort. Teachers have reported that the additional time to connect science and literacy is more than repaid in students' accelerated learning and greater gains in knowledge and skills.

The combination of performance expectations, explicit instructional strategies that support inquiry-based learning, and helping students make effective use of metacognitive techniques makes for powerful science and literacy learning. With your modeling and coaching, students can begin to understand the power of self-assessment as a tool for taking charge of their own learning. ■

References

Donovan, S., J.D. Bransford, and J.W. Pellegrino, eds. 1999. *How people learn: Bridging research and practice*. Washington, DC: Committee on Learning Research and Educational Practice, National Research Council.

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

Ridley, D.S., P.A. Schutz, R.S. Glanz, and C.E. Weinstein. 1992. Self-regulated learning: The interactive influence of metacognitive awareness and goal-setting. *Journal of Experimental Education* 60 (4): 293–306.

Schoenbach, R., C. Greenleaf, C. Cziko, and L. Hurwitz. 1999. *Reading for understanding: A guide to improving reading in middle and high school classrooms*. San Francisco: Jossey-Bass.

Thier, M. 2002.*The new science literacy: Using language skills to help students learn science*. With B. Daviss. Portsmouth, NH: Heinemann.

Marlene Thier (*mthier@berkeley.edu*) is an educational consultant and author in Moraga, California.