

IT'S COMPLICATED. THE TERMS SEEM NEARLY IMPOSSIBLE TO UNDERSTAND. THE SUBJECT IS SOMETHING THAT MAYBE ONLY A GENIUS CAN FIGURE OUT. PLUS, IT'S BORING. REALLY, REALLY BORING. SO HOW ARE YOU GOING TO SLOG YOUR WAY THROUGH IT? OR PASS THE TESTS? OR AVOID FAILING THE COURSE ALTOGETHER?

For high schoolers struggling with their science textbooks, for those who aren't naturally drawn to the sciences or who, for whatever reason, can't seem to connect ideas to knowledge, comprehension is usually a major problem. Danielle McNamara, Old Dominion associate professor of psychology, wants these students to know they're not alone. She believes learners should approach complexity without feelings of hopelessness or dread. That's why she and colleagues Raymond Morgan and Irwin Levinstein have embarked on a five-year study to evaluate methods of improving science-text understanding. When they're done, they hope to have a proven methodology available to teachers and students that will be as effective as it is easy to use.

"Readers often learn helplessness. Students are afraid to work through a text themselves," McNamara contends. "One misconception in our society is that to learn, we should never be wrong, that we should never make mistakes, particularly in science. But in order to truly learn, you sometimes have to take the chance of misunderstanding something first so that you can develop a better understanding later."

McNamara has developed one approach, Self-Explanation Reading Training, or SERT, as a means of using "active reading" strategies to improve pupils' ability to self-explain difficult text. SERT provides a step-by-step process to reading aloud, either to oneself or someone else, as a way to gradually build understanding. Although most learners self-explain without verbalizing, the basic approach is similar to that used by anyone attempting to master new material: The best way to truly learn is to teach, to explain something to someone else. In essence, one learns how to learn by helping others, or oneself, to learn.

Understanding is especially daunting where science is concerned. In almost every field of scientific endeavor, practitioners have developed specialized language, a kind of shorthand that habitues use to quickly and efficiently convey abstruse concepts. Although useful in its own right, such language might as well be unbreakable code to neophytes or those not yet acclimated. What's needed is a means to break the complexity into bite-size chunks, mentally speaking, that can be digested without distress.

## Reading Without Intimidation

Because humans devote a large amount of brain processing to visual comprehension, renderings, pictures or drawings that sum up the essentials of a subject can be of immense help in learning. But McNamara points out that the images published in science textbooks can cause more problems than they solve. A good part of the difficulty lies in how they convey complexity in confusing ways, incorpo-

rating information that students have yet to grasp.

"Science texts are different from any other texts. They present unfamiliar ideas in unfamiliar ways," McNamara points out. "We don't talk about science socially. It's not on TV. What we end up with is a lot of low-knowledge readers. They read science, they don't understand it, and they give up. Those are the people we want to help."

To encourage slow learners to persevere, McNamara thinks that more than one methodology must be employed. Readers profit from first previewing unfamiliar material, making predictions (flawed or otherwise) of what may come next, establishing connections between individual points made within the text, explaining out loud to oneself or others what one has just read and, finally, summarizing in plain English the information presented in a given selection. Such an approach, done in concert with a part of the reading process specialists call "comprehension monitoring," is part of a larger strategy known as "metacognitive reading." McNamara and her collaborators will explore the efficacy of SERT, as well as that of two other metacognitive reading strategies: Previewing and the Interactive Notation System for Effective Reading and Thinking, or INSERT. Previewing emphasizes the development and description of an overall concept of what the text entails, while INSERT emphasizes comprehension monitoring by instructing readers to make notes in the margins as reading progresses.

"The goal is not to prove that SERT works. It may or may not," McNamara says. "The goal is to find an effective reader-training program that helps high school students. Then even the struggling students may be able to learn science. Eventually we may be able to develop a community of learners who read without intimidation."

## Mitigating Incoherence

That intimidation isn't likely to go away anytime soon. Textbooks won't be rewritten and science explication will remain dense and difficult to navigate. McNamara points out that, unlike other texts, those written about science are often incoherent, containing conceptual gaps that writers are unable or unwilling to bridge. While such opaqueness can actually be beneficial for bright, interested children, it's a particular bedevilment for the at-risk populations she would like to help.

"Coherent text actually impedes learning for high-knowledge readers. They tend to read coherent text superficially," she says. "But low-knowledge readers aren't able to make inferences. Because they can't make links with the new information, they can't integrate what they've already learned elsewhere with what they're supposed to be learning now."

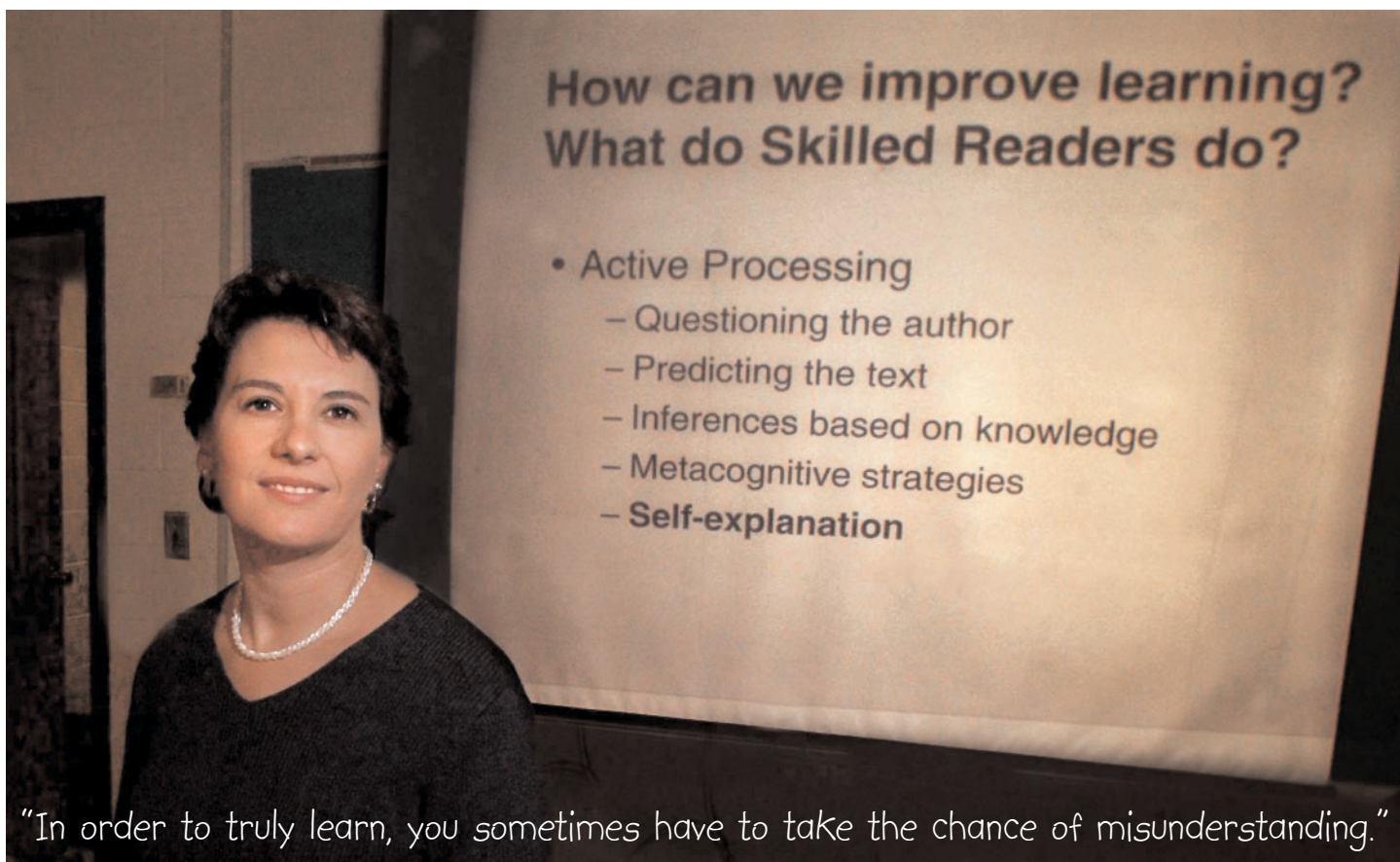
Another issue is the lack of science-specific learning strategies relayed by parents and teachers. Many adults have little experience in and with science, and thus can't relay tips as they otherwise can in other subjects. Were they able to do so, students likely would benefit, since studies have indicated that adoption of a tried-and-true strategy helps in learning, regardless of the subject area.

In three previous experiments, SERT training not only improved text comprehension in the laboratory, but also improved the exam performances in science courses of 1,000 students in five different science courses. SERT-trained students improved their exam scores between 5 percent and 14 percent. Low-knowledge students who did not receive the training usually didn't pass their courses, whereas those who did, passed. Even those participants characterized as "high knowledge" reported making use of SERT strategies in other, more challenging courses.

"We already know SERT training improves students'

ability to explain difficult text, particularly for the low-knowledge readers," McNamara says. "SERT teaches students to use more logic and common sense. For some, that could mean the difference between passing and failing."

The experiments evaluating SERT, INSERT and Previewing are slated to begin later this year and will involve 1,200 students in three states and four municipalities. Those studies will build upon previous research done by McNamara and her colleagues, who in 2001 conducted a baseline study of 1,500 students in four high schools. McNamara expects the current crop of experiments to aid in the refinement of a computer-based automated tutor currently under development. The tutor program should eventually allow students to learn at their own pace, with online updates continually provided. Teachers will thereby be able to better target a pupil's specific needs, providing as much or as little instruction as needed.



—Danielle McNamara