is given to the challenge of feeding the earth's billions. A chapter on "Reshaping Economic Policies" should interest those concerned with staggering debt-and-deficit decisions—an incandescent issue in an election year.

Seventy-six tables and 29 figures provide quick insight into complex data. End notes provide evidence of scholarship and references for further study. While written for adults, the book can be read with interest and profit by teenagers seeking a first-rate reference for classroom discussions and papers.

Available from W. W. Norton & Co., 500 Fifth Ave., New York, NY 10036 for $15.95.

CHARLES SUHOR

Language and Thinking Across the Curriculum

When speaking about thinking skills in the curriculum, subject area specialists focus on thinking skills peculiar to their disciplines. Visual arts specialists discuss imagery and perspective; mathematicians emphasize ability to visualize mathematical processes or estimate results; music educators offer distinctions related to intonation or rhythmic structure. Surely, the claims for distinctive mental skills advanced by scholars like Arnheim and Saloman are valid (Olson, 1974). But they also recognize that some aspects of perception and cognition enter into the learning of more than one school subject.

Interpreting olfactory signs (that is, odors) can be important in chemistry, woodworking, and home economics. Inferring motivation is part of the study of both history and literature; so is a sense of narrative. And skills like comparing/contrasting, tracing cause and effect, categorizing, and sequencing come to play in most academic and artistic pursuits. The assumption that "generic" thinking skills underlie school learning is basic to thinking skills programs like Strategic Reasoning and SOI (Bossone, 1983).

Oddly, though, specialists often overlook the fact that *in school settings, language is essential to all kinds of learning*. Teachers and students use language in order to understand all other symbol systems, from physical education to geography to calculus. Musicians and artists use language to articulate their intentions and discuss their techniques. Students and teachers alike use language to describe their cognitive and affective responses to poems, computer programs, or dissected frogs.

Moreover, we know far more about most subjects when we can talk or write fluently about them than when we merely respond to objective test items or to rapid-fire recitation questions. Why do students (and mass testing programs) favor recognition of information and short-answer responses over involved explanations? Because the latter require inventive resymbolization of knowledge, a demonstration that the learner is genuinely fluent in the subject matter.

Christopher Thaiss (1984) speaks of "the inseparableness of language, thinking, and learning. If we do not apply the full range of language resources to our learning of any subject, then we stifle thought, conscious and unconscious, and so deprive ourselves of more than the most superficial understanding." This full range of language resources, moreover, includes written language. As James Britton (1975) states, "An essential part of the writing process is explaining the matter to oneself."

Verbalization, as the fulfillment of understanding, is the core, not only of many thinking skills programs, but also of much theory and research in classroom interaction, small group instruction, and cooperative learning (Staton, 1984; Moffett and Wagner, 1983; Johnson and others, 1984.) Powerful support for the idea of language across the curriculum comes also from Jean Piaget, who notes that "language is but one among many aspects of the semiotic function, even though in most instances it is the most important." John Carroll points out that nonlinguistic forms "are almost always accompanied by language and often require language to make them intelligible." Umberto Eco feels too that "Language is the most powerful semiotic device that man has invented." (Suhor, in press).

Language as a way of thinking and learning, then, is not an educational buzzphrase. It is an essential aspect of any productive classroom environment, and the most compelling demonstration that thinking skills are, in fact, being taught effectively across the curriculum.□

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Charles Suhor is Director of the ERIC Clearinghouse on Reading and Communication Skills, Urbana, Illinois.

JOHN E. PENICK AND ROBERT E. YAGER

Science at Work in the Real World

Prison! We should be preparing our students to do time in prison. So says Michael Leyden[1] in *The Science Teacher*. Leyden points out that only one percent of 10th grade biology students will become scientists, while more than that will end up in penitentiaries.

With most students somewhere between future prisoners and future scientists, the science curriculum must provide for the majority by preparing science literate citizens for the world of tomorrow. Science literate citizens have an understanding of the nature of science and are able to use it in their daily lives. They appreciate basic research, understand the role of science and development of technology, and feel confident they can use new technology.

Just a few years ago, following Sputnik, program developers consciously removed all traces of technology from curricula. Technology, they thought, was something other than science, something too mundane for classrooms. Now the National Science Foundation is emphasizing technology education as an equal partner with science education in order for students to understand new technology and its role in society.

At present, program planners in several countries are developing and implementing new curricula that reflect not only what we know about the learner and the nature of science but also what we know about society. They recognize that science without societal applications means little to students and citizens alike. These programs incorporate the discovery of scientific ideas with career awareness and preparation, as well as participation in decisions about learning and the usefulness of science applications in particular situations. Students use their learning by taking action to solve community concerns and seeking new information about problems.

An example of this trend—the preparation of science literate citizens—is the Science-Technology-Society (STS) approach, which presents the structure of science in relation to society, spotlighting the troublesome elements, particularly the most subjective and value laden. With an STS approach, students identify real-world problems, formulate solutions and courses of action, and make decisions to take action. In the process they may collect data, read from content sources, survey citizens, and write letters. While learning the content of science, students absorb the values, ethics, human engineering, and social perspectives usually overlooked in the classroom.

At Sheehan High School in Wallingford, Connecticut, for example, students are learning about energy and energy use in their community. After passing the State Energy Auditor Certification Test, these students conduct energy audits of public buildings. As fully certified state auditors, they perform a needed service for their community—definitely not child's play. And the service pays off. Citing their first-year audit of buildings in their own school district, they recommended specific changes in buildings and in energy uses. At the end of one year their district saved $260,000 in energy costs.

At Susan Wagner High School in Staten Island, New York, students also address science-related social problems in "Contemporary Issues in Science," which may be used as enrichment in either science or social studies or as a complete course. Guest lecturers present a variety of topics, while students conduct library research and surveys to determine the status of ideas and innovations. Groups of students identify and seek solutions for familiar community problems. The students then share their findings in a forum with community leaders in business, schools, and other organizations.

In these exemplary programs students learn about science and society while working on the same problems they will later face as adults. Working on community problems, they encounter basic science and research, begin to understand the role of science and the development of technology, and build confidence in their own abilities to use technology. In other words, with strategies at the application, synthesis, and evaluation levels, science curricula can begin to attain the goal of creating science literate citizens without shortchanging those who become scientists. Perhaps, too, if they see schooling as useful preparation for everyday life, these students, as adults, are likely to support their local schools.

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John E. Penick and Robert E. Yager are Professors of Science Education at the University of Iowa, Iowa City.