

Science Daybooks

R e s e a r c h B a s e

Introduction

Science achievement and improved science education is a national concern (United States Department of Education, 1994). Students in the United States lag behind students in other industrialized nations in science and mathematics. “As the world becomes increasingly scientific and technological, our future grows more dependent on how wisely humans use science and technology. And that, in turn, depends on the effectiveness of the education we receive. With the exploding impact of science and technology on every aspect of our lives, especially on personal and political decisions that sustain our economy and democracy, we cannot afford an illiterate society” (Nelson, 1999).

Effective comprehension and communication in science includes reading, writing, and discourse. The *Science Daybooks* are effective resources that help students develop reading, writing, and discourse skills in the context of science. Designed by educators and developed in collaboration with the National Science Teachers Association, the *Science Daybooks* are journal-like interactive texts that can help students become active, engaged, critical readers, writers, and thinkers about science. The science topics addressed in the *Science Daybooks* are based on the National Science Education Standards while the strategies and activities in the *Science Daybooks* are based in current research on how to improve student reading and writing ability. The *Science Daybooks* are designed to teach age-appropriate science concepts and skills, to promote scientific literacy, and to build essential skills, such as questioning, summarizing, and finding the main idea. In addition to the science skills taught, *Science Daybooks* also enhance students’ ability to read actively and foster writing skills.

**The National Science Education Standards are based on the understanding
that science is an active process.**

“Learning science is something that students do, not something that is done to them. ‘Hands-on’ activities, while essential, are not enough. Students must have ‘minds-on’ experiences as well” (National Research Council, 1996). The *Science Daybooks* provide students with the opportunity for ‘minds-on’ experiences through critical thinking, brainstorming, researching, analysis, interpretation, observation, description, and inquiry activities. By learning and applying these skills, “students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills” (National Research Council, 1996).

Science Daybooks are based on the National Science Education Standards.

Program Standard B of the National Science Education Standards states: “The program of study in science for all students should be developmentally appropriate, interesting, and relevant to students’ lives; emphasize student understanding through inquiry; and be connected with other school subjects” (National Research Council, 1996). The *Science Daybooks* provide high-interest, age-appropriate, cross-curricular excerpts from journal entries; novels; science books; interviews; and newspaper, magazine, and Web articles. Students are encouraged to think critically about the reading selection and complete activities related to the text (answer questions, draw maps, create graphs, etc.). An example of an age-appropriate, cross-curricular lesson is “Dust in the Wind,” Lesson 14 from the middle school *Earth Science Daybook*. This lesson teaches not only the scientific causes and effects of the Dust Bowl of the 1930’s but also addresses the human side of this natural disaster. The lesson also ties in nicely to topics students are studying in social studies (the history of the Great Plains), health (respiratory diseases), and literature (*The Grapes of Wrath* by John Steinbeck and *Cat Running* by Zilpha Keatley Snyder).

The National Science Education Standards also emphasize the importance of scientific literacy. The standards define 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). The *Science Daybooks* promote scientific literacy by teaching students key skills and strategies such as: collecting, recording, and interpreting data; making inferences; recognizing cause and effect; comparing and contrasting; organizing information; generating questions; developing hypotheses; and predicting outcomes.

Another key component of the National Science Education Standards is scientific inquiry. Scientific inquiry is “a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories” (National Research Council, 1996). Understanding scientific inquiry and learning the skills necessary to apply scientific inquiry are presented throughout the *Science Daybooks*. One example of students learning and applying scientific inquiry can be found in Lesson 3 of the middle school *Physical Science Daybook*, “The Big Drop.” This lesson, which provides an opportunity to do hands-on experiments with potential and kinetic energy, teaches students how to design an experiment to test a hypothesis; measure; collect, record, and interpret data; and draw conclusions.

Teaching students strategies for reading science texts helps them improve both their science comprehension and their literacy skills.

The Commission on Reading suggests that most reading and thinking strategies should be taught in the content areas, rather than through isolated reading lessons (Anderson & Hiebert). When taught together, reading and science process skills can reinforce one another. “Content area literacy instruction has two primary aims: (1) to teach students information *about* the world and (2) to teach

students *how* to learn about the world on their own” (Moore, Moore, Cunningham, & Cunningham, 1986). The *Science Daybooks* promote critical reading, writing, and thinking skills in the context of engaging lessons focusing on key scientific concepts.

“A thorough understanding of language and literacy is essential for learning in any subject, because it makes the world more understandable, more interesting, and more connected to daily life” (Hamm & Adams, 1998). The process skills needed for reading are similar to the process skills necessary for the study of science. These common skills include activating prior knowledge, synthesizing information, making inferences, drawing conclusions, asking questions, making connections, comparing and contrasting, evaluating resources, and building vocabulary. In the *Science Daybooks*, these reading and science skills are interwoven and students learn to apply them to improve both their reading and science comprehension.

The reading process can be divided into three parts: before reading, during reading, and after reading. The *Science Daybooks* addresses each step in the reading process. In “Before You Read,” students apply pre-reading strategies such as thinking about the topic, organizing their ideas, and drawing maps. The “Read” section of each unit provides students with a passage to read as well as highlighted vocabulary words and notes section where they can jot down ideas or write questions about the reading. Finally, “Explore” and “Take Action” give students the opportunity to reflect on the reading, interpret the reading, and demonstrate what they’ve learned.

In addition, the *Science Daybooks* provide students with the opportunity to practice reading expository texts. Research shows that most students’ difficulty with textbooks results from a lack of knowledge about expository text structures (Cheek, Flippo, and Lindsey, 1997). Expository text structure varies more widely than narrative text structure (Cooper, 2000). Students’ general reading ability does not necessarily indicate how well they will comprehend texts in the content areas (Leal and Moss, 1999). According to Heilman and colleagues, learning from textbooks requires specific skills and strategies for reading in different subjects; study skills; and skills and strategies for collecting, analyzing, and evaluating data (Heilman, 2002).

The Reading-Writing-Science Connection

Educators and researchers have clearly established that reading and writing abilities develop together (e.g., Calkins, 1983; Pearson & Tierney, 1984; Shanahan, 1990; Sulzby & Teale, 1991; Tierney & Shanahan, 1991). Both processes are constructive and require similar kinds of knowledge. Teaching reading and writing together enhances communication, improves academic achievement, and leads to critical thinking (Cooper, 2000). Teachers who foster the construction of meaning through integrated reading and writing activities enable their students to become better thinkers (Tierney & Shanahan, 1991).

“Reading, writing, and oral discourse—important literacy skills—are critical to science inquiry” (Worth, Moriarty, & Winokur, 2004). The *Science Daybooks* connect science, reading, and writing in many important ways. Students are asked to read and respond to excerpts from scientific journals, newspaper articles, and books. Also, students are prompted to jot down questions about the text, to brainstorm on the page, and to annotate the selections by underlining and highlighting. The varied writing activities in the *Science Daybooks* help students become better constructors of meaning. The writing activities included in the *Science Daybooks* are based on reader-response research and theory. Reader-response activities enhance both students’ motivation to read and their ability to comprehend (Ruddell, 2002).

The *Science Daybooks* encourage students to read and write about science frequently, even daily. Research has shown that students improve their literacy skills when they have the time and opportunity to practice these skills regularly. Most teachers agree that students “learn to read and write by reading and writing” (Cooper, 2000, p. 342), which underscores the need for frequent literacy opportunities. In addition, major writing educators emphasize the need for daily writing to enhance writing and reading ability (Atwell, 1998; Calkins, 1994; Graves, 1994). Recently, the U.S. Department of Education, in its summary of evidence-based reading instruction essential to the *No Child Left Behind* initiative, identified frequent writing opportunities as one of the important aspects of literacy instruction (U.S. Department of Education, 2001).

Writing about science is essential for students’ science comprehension.

The study of science involves reading, writing, and discourse. A report issued by The National Commission on Writing in America’s Schools and Colleges emphasizes the importance of writing as a learning tool in all subject areas. “If students are to make knowledge their own, they must struggle with the details, wrestle with the facts, and rework raw information and dimly understood concepts into language they can communicate to someone else. In short, if students are to learn, they must write” (National Commission on Writing in America’s Schools and Colleges, 2003). The *Science Daybooks* provide students with the opportunity to write about the science they are learning. “Writing is not simply a way for students to demonstrate what they know. It is a way to help them understand what they know. At its best, writing is learning” (National Commission on Writing in America’s Schools and Colleges, 2003).

“Writing is one of the best ways that children learn in science” (Feely, 1993). A biology teacher at Irvington High School in Fremont, California demonstrated this point when he divided his students into an “experimental” group (that was required to keep reading and learning logs, practice writing essays, participate in group writing, and take essay tests) and a “comparison” group (that completed multiple-choice tests only, not essay tests). Although the students covered the same topics and performed the same labs, the end of year comprehension results favored the experimental group. The teacher,

Robert Tierney and his colleague Harry Stookey “concluded that students with the opportunity to write had retained more of what they had learned. Further, they concluded that writing had helped these students ‘learn the subject matter more thoroughly, and their papers, reflecting what the student actually understands, are interesting to read’” (National Commission on Writing in America’s Schools and Colleges, 2003).

The variety of writing exercises that students are required to do in science are present in the *Science Daybooks*. These writing exercises include generating lists, drawing and labeling diagrams, creating flow charts, describing cause and effect, brainstorming, comparing and contrasting, making inferences, interpreting data, and more. Writing in science enables “children to communicate their new ideas and knowledge to others. It also enables them to clarify their thinking and to see for themselves what they have achieved” (Feely, 1993). Students’ ability to write about science also provides teachers with an opportunity to assess what they have learned. “If teachers recognize that children must write to learn, then they also need to recognize the power of writing to help children organize their beliefs, thoughts, impressions and understanding about science” (Jan, 1993).

The National Commission on Writing in America’s Schools and Colleges urges state and local education agencies to greatly increase the amount of time students spend writing. This goal can be accomplished by encouraging writing across the curriculum. “Writing is everyone’s business, and state and local curriculum guidelines should require writing in every curriculum area and at all grade levels” (National Commission on Writing in America’s Schools and Colleges, 2003). *Science Daybooks* promote writing across the curriculum. “We strongly endorse writing across the curriculum. The concept of doubling writing time is feasible because of the near-total neglect of writing outside English departments. In history, foreign languages, mathematics, home economics, science, physical education, art, and social science, all students can be encouraged to write more—and to write more effectively” (National Commission on Writing in America’s Schools and Colleges, 2003).

Interacting with Text

One hallmark of successful learning and reading is the ability to interact with or engage with text. Good readers are able to make connections with text in a variety of ways, whereas less capable readers are not (Wilhelm, 1997). Because comprehension relies on readers’ ability to activate prior knowledge, connecting with text improves comprehension. To understand text, students must be able to link what they are reading to what they already know (Ruddell & Ruddell, 1994).

The *Science Daybooks* introduce and reinforce many skills that promote engagement with the text. Because the *Science Daybooks* belong to the students, they are free to mark up their texts, highlight and underline, jot down notes, or draw pictures in the margins as they progress through their reading. In each lesson, students are cued to respond at certain points in their reading and in specified

places on the page. This level of support and practice helps all students gain a mastery of the active reading strategies they need to be successful readers. The *Science Daybooks* introduce and reinforce strategies for active reading.

Students benefit from using a variety of learning tools.

In a study conducted by the American Association for the Advancement of Science's Project 2061, none of the nine middle grade level science textbooks reviewed received a satisfactory rating. The textbooks were rated on a variety of criteria, including providing a sense of purpose; taking account of student ideas; engaging students with relevant phenomena; developing and using scientific ideas; promoting student thinking about phenomena, experiences, and knowledge; assessing progress; and enhancing the science learning environment. The three-year study found that "most textbooks cover too many topics and don't develop any of them well. All texts include many classroom activities that either are irrelevant to learning key science ideas or don't help students relate what they are doing to the underlying ideas" (American Association for the Advancement of Science, 2003). Unlike a textbook approach that requires students to read about an array of science topics, the *Science Daybooks* allow the students to focus on specific topics. Each *Science Daybook* is divided into five main units that contain focused and relevant lessons.

Some science textbooks "actually impede progress toward science literacy. They emphasize the learning of answers more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understandings in context, recitation over argument, reading rather than doing. They fail to encourage students to work together, to share ideas and information freely with one another, or to use modern instruments to extend their intellectual capabilities" (Nelson, 1999). The *Science Daybooks* encourage students to "do" the science. Such activities include doing research, interpreting data, brainstorming with peers, building models, performing experiments, and debating different viewpoints. Since the *Science Daybooks* emphasize the importance of scientific inquiry and process over the memorization of facts, students are able to relate to the science better and see themselves as scientists.

In addition, the *Science Daybooks* offer a student-friendly, alternate point of entry for students who struggle with science. Many students have trouble understanding or relating to their primary science textbook. "Students whose main source of information is a textbook laden with facts and written without a voice and style have little opportunity to interpret and justify" (Robb, 2003). The *Science Daybooks* offer these students additional examples or alternative explanations of key concepts. The *Science Daybooks* also present the core science topics through a variety of non-traditional sources such as poems and songs that may be more accessible for some students.

Media literacy and the Internet.

“While more young people have access to the Internet and other media than any generation in history, they do not necessarily possess the ethics, the intellectual skills, or the predisposition to critically analyze and evaluate their relationship with these technologies or the information they encounter” (Considine, 2002). The *Science Daybooks* not only provide students with a variety of media to read—Internet articles, scientific journal excerpts, newspaper articles, and personal journal entries—but also equip students with the skills they need to read these media critically, such as asking questions, evaluating resources, and interpreting data. “If schools want students to spend more time thinking critically and practicing critical thinking skills, then they are missing the boat if they are not teaching media literacy and using the media as a site for this critical analysis” (Kubey, 2002).

The integration of technology media such as the Internet into the curriculum presents an ongoing challenge. eSchool News reported on the issue in May 2003: “We are working on making access more available to the classroom, but many teachers separate the use of technology to a time of the day or week as opposed to it being one of the learning tools, like a book or piece of paper, in the classroom,” said Marc Liebman, superintendent of the Marysville Joint Unified School District in California. “We have a long way to go and a lot of mindsets to change before we will be successful at fully integrating technology and the Internet into everyday instruction.” In the meantime, “we can make technology and the Internet more of an integral part of the instructional program by developing more online curricula, lesson plans, and assessment tools that are easy for teachers to use. Without that, true integration will not happen,” Liebman suggested (Murray, 2003).

Science Daybooks integrate technology through the use of *SciLinks*[®], access codes for students with links to relevant, age-appropriate information on the Internet specifically chosen by the National Science Teachers Association. *SciLinks*[®] web resources are provided at the point of use in the text for additional related information, lessons, and activities available on the Internet. This strategy of placing the link in the midst of materials already engaging students and in the sequence of what they are learning makes it much easier for students to find appropriate online content. *SciLinks*[®], which are consistently updated, give students the opportunity to explore areas of interest in greater depth and provide additional instruction.

SciLinks[®] is a registered trademark of the National Science Teachers Association.

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