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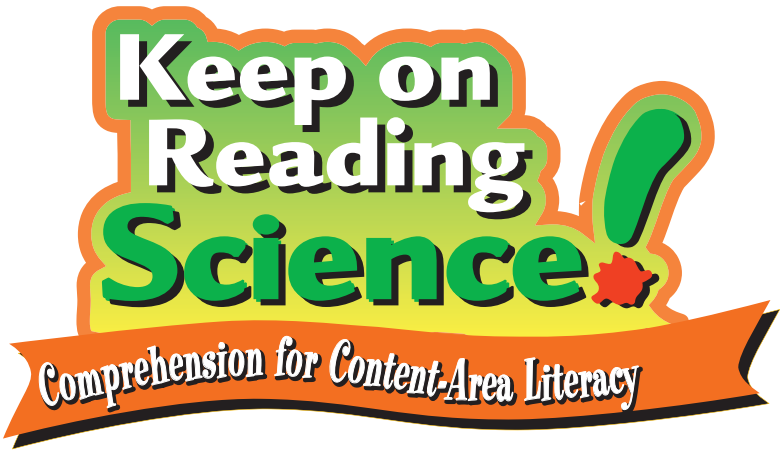

RESEARCH BASE

FOR

Keep on Reading Science!: Comprehension for Content-Area Literacy

Joan Irwin, B.A., M.Ed.

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Keep on Reading Science!
Comprehension for Content-Area Literacy

Evidence of Research Base

Joan Irwin, B.A., M. Ed.

Introduction

The connections between science and literacy have been receiving more attention in recent years. This attention derives from a number of sources including research about the place of nonfiction content in literacy instruction (Duke, 2000, 2004; Kletzien & Dreher, 2004; Moss, 2005; Palmer & Stewart, 2005; Yopp & Yopp, 2006), concerns about student comprehension of nonfiction content (NAEP, 2005), the impact of international comparisons of student a chievement in mathematics and science (TIMSS, 2003), and concerns about government policies directing more time to literacy teaching and learning. With regard to the latter point, Cervetti et al. (2006, p. 221) observe

> American youth need strong literacy skills to State and federal policies have, for better or worse (mostly worse), marginalized disciplinary curricula, including science, in deference to a massive, almost manic, devotion to literacy teaching and learning.

Similarly, Saul (2004, p. 4) comments that science educators are especially sensitive to this issue since that subject is one that seems to be most readily dismissed when the demands on instructional time change. Consequently, there has been an upsurge in the efforts of science and literacy educators collaboratively to examine ways in which to capitalize on the synergy of science and literacy to enhance student achievement (Coskie, 2006). The education community and general public both recognize that American students need to become well-informed about science as well as having strong literacy skills to succeed in school and life (Nelson, 1999).

Keep on Reading Science! is a supplemental literacy program, aligned to state standards and designed to teach essential comprehension skills and strategies to help students become successful readers of science content. The content includes multiple forms of science nonfiction genres including, for example, science textbook lesson, instructions, science experiment, online encyclopedia, brochure, trade-book chapter, and biography. The program is designed to help teachers maximize instructional time by integrating comprehension and science instruction. To achieve this integration, Keep on Reading Science! combines focused strategy instruction, scaffolded comprehension support, and science nonfiction genres. The program's instructional approach and science content reflect current research about comprehension as well as the links between science and literacy.

Science and Reading Connections

Research into instructional practices in science and reading has revealed a reciprocal relationship between reading and writing and learning science content. Science content provides a variety of genres through which students can advance application of reading comprehension strategies. Learning with understanding is a primary goal of both science and literacy. This goal can be elaborated in terms of the forms of mental activity from which scientific understanding emerges:

- Constructing relationships—students use prior knowledge and experience to develop meaning for new ideas.
- Extending and applying knowledge—students acquire strategies that enable them to comprehend what they read and observe and apply their understandings in new contexts.
- Justifying and explaining generalizations and procedures—students experience the procedures and processes that scientists use in their work.
- Making knowledge one's own—students engage in activities that enable them to build knowledge not only of science content but also of reading and writing strategies necessary to communicate effectively.
- Understanding as a community activity—learning in school occurs in groups in which students are called upon to share ideas, respond to questions, and demonstrate their use of skills and strategies (Carpenter et al., 2004, pp. 3–5).

These aspects of mental activity are consistent with research findings about reading comprehension. The RAND Reading Study Group (2002) developed a definition of comprehension that encompasses three elements that interact within a sociocultural context. These elements are interrelated in ways that vary across the dimensions of a reading activity—pre-reading, during reading, and post-reading.

1. The *reader* who is doing the comprehending. To comprehend, a reader must have a wide range of capacities and abilities. These include cognitive capacities; motivation; and types of knowledge like vocabulary, as well as other types of knowledge, including domain and topic knowledge, and linguistic and discourse knowledge; purpose; interest; and abilities like attention, memory, critical analytic ability, inferencing, and visualization ability. . . . As the reader begins to read and completes whatever activity is at hand, some of the knowledge and capabilities of the reader change.
2. The *text* that is to be comprehended. The features of text have a large impact on comprehension. The proliferation of computers and electronic text has led us to broaden the definition of text to include multimedia documents in addition to conventional print publications. Comprehension does not occur by simply extracting meaning from the text. During reading the reader constructs different representations of the text that are important for comprehension.
3. The *activity* in which comprehension is a part. Reading does not occur in a vacuum. . . . A reading activity involves one or more purposes, some operations to process a text at hand, and the consequences of performing the activity. . . . One important set of reading activities occurs in the context of instruction. In this context, instruction shapes the reader's purposes, operations, and consequences (Sweet & Snow, 2002, pp. 25–28).

Recent collaborative efforts between the science and literacy education communities offer clarification of ways in which literacy and science learning are linked (Yore et al., 2004; Cervetti et al., 2006). Yore and his colleagues made several observations about the links between language and science:

> Language is an essential technology and thus an integral part of science and science literacy, particularly written language. Language is a means of doing science and of constructing science understandings; language is also an end, a fundamental goal of science literacy, in that it is used to communicate about inquiries, procedures, and science understandings to other people so that they can make informed decisions and take informed actions (Yore et al., 2004, p. 348–349).
>
> Scientists rely on printed text for ideas that inform their work before, during, and after experimental inquiries. Cognitive processes that are central to understanding text include activating prior knowledge of the specific topic, genre, and rules of evidence; analyzing and synthesizing the new information; evaluating the new information with respect to criteria for scientific evidence; and integrating the text-based message with prior conceptions (Yore et al., 2004, pp. 348–349).
>
> Writing is an essential feature of all science-related endeavors. . . . Writing in school science can provide opportunities for learners to compose high-quality texts in those discourse forms generated and used by scientists to address a specific purpose. Understanding and using genres such as description, directions, explanation, and argumentation are central components of the fundamental sense of science literacy . . . (Yore et al., 2004, p. 349).

The need for students to develop skill in reading content area texts is obvious and one that has been the focus of research for many years. Some researchers have observed that the need for literacy skills is particularly critical in science because the body of knowledge is largely in text. Kamil and Bernhardt (2004) further suggest that "anyone lacking literacy skills will be unable to access [the scientific] body of knowledge and data" (p. 126).

Inquiry is a critical feature of science teaching and learning. Researchers are beginning to identify how texts can support scientific inquiry and describe functions that are common to inquiry strategies and comprehension strategies (Cervetti et al., 2006). Insights in each of these areas have implications for the way in which teachers approach instruction in reading science material. Observations from the work of Cervetti and her colleagues about the role of text in science learning are summarized in Table 1: Texts Can Support Inquiry.

TABLE 1
Texts Can Support Inquiry

Role of Text	Functions of Text
Providing Science Content	• Texts can introduce the scientific domain and invite students to engage with the context. • Texts can connect firsthand investigations to the world outside the classroom.
Delivering Content	• Texts can present scientific concepts, facts, and patterns to students. • Texts can provide information about phenomena that would be unobservable in a classroom setting.
Modeling Science and Literacy Processes	• Texts can provide models of inquiry skills through descriptions of what careful observation involves, how to compare and classify things, and how to make inferences and explanations based on evidence. • Texts provide access to particular science genres that serve as models of how science information is presented. • Texts can illustrate the nature of science.
Supporting Secondhand Inquiry	• Texts provide experience with data from which the reader is challenged to draw conclusions and develop claims.
Supporting Firsthand Inquiry	• Texts provide information that facilitates firsthand investigations. • Texts support students in making sense of firsthand investigations. • Texts can inspire firsthand investigations.

Adapted from Cervetti et al. (2006, pp. 226–231).

Inquiry and comprehension are both governed by the search for meaning. This observation has led researchers to note that "comprehension strategies are inquiry strategies" (Cervetti et al., 2006, pp. 231–234). Specifically, comprehension strategies and inquiry strategies represent functions that support and sustain learning. These functions include monitoring and regulating learning, acquiring information, solving problems, and making connections among diverse sources of information. Similarly, strategies required for successful comprehension are comparable to inquiry strategies: activating prior knowledge, establishing purposes, making and confirming predictions, inferring, forming conclusions, and recognizing relationships. Science texts, comprehension strategies, and inquiry reflect overlapping goals and functions and share common strategies. Taken together these elements support the construction of meaning and enable students to become both active and strategic readers of science content.

> Whether from a textbook or a nonfiction trade book, informational text can be the fuel that sparks curiosity about and interest in science, thus contributing to the development of scientific attitudes. As students read, they engage in processes common to science and literacy, such as predicting, generating questions, summarizing understandings, and using data to draw conclusions (Yopp & Yopp, 2006, p. 22).

Research in both literacy and science education provides evidence of the similarities in instructional strategies that foster student learning. The National Reading Panel (2000) presented a synthesis of experimental and quasi-experimental research in the areas of phonemic awareness, phonics, reading fluency, reading comprehension, vocabulary, and teacher preparation. The Panel identified eight cognitive strategies for improving reading comprehension, six of which are representative of those used in inquiry: comprehension monitoring, cooperative learning, graphic and semantic organizers, question answering, question generating, and summarization.

Research into how students learn science emphasizes the need for students to develop deep understanding of ideas and relationships among those ideas. Drawing from the report of an expert panel headed by Bransford (1999), the National Research Council (2000) identified the six principles about the learning process that describe what is known about how students learn science. These findings about learning science parallel those of the National Reading Panel about reading comprehension.

1. Students build new knowledge and understanding on what they already know and believe.
2. Students formulate new knowledge by modifying and refining their current concepts and by adding new concepts to what they already know.
3. Understanding science is more than knowing facts; it involves placing and retrieving them in a conceptual framework.
4. Learning is mediated by the social environment in which learners interact with others.
5. The ability to apply knowledge to novel situations (transfer of learning) is affected by the degree to which students learn with understanding in a variety of contexts.
6. Effective learning requires that students take control of their own learning (Pratt & Pratt, 2004, pp. 397–400).

Keep on Reading Science! provides teachers and students with research-based resources that integrate best practices in reading instruction to support learning science content. Science literacy is the ability to read, comprehend, and write about multiple forms of science nonfiction. *Keep on Reading Science!* provides experiences with the functions that texts serve in building students' competence in reading science content. The content includes high-interest science topics that span the most important science strands—earth science, life science, and physical science. The program provides instruction in these key comprehension skills and strategies: distinguish nonfiction from fiction; recognize main idea and details; identify sequence; compare and contrast; summarize; draw conclusions; make inferences; distinguish fact and opinion; recognize cause and effect; identify problems and solutions. Coordinating literacy skills and science content requires careful planning to ensure that neither discipline is subsumed under the other. Saul (2004, p. 5) observes

> When a truly effective literacy-science connection is created in the classroom, both the literacy and the science work undertaken by students makes sense in terms of both disciplines.

Alignment of *Keep on Reading Science!* with Research and National Reading Panel Findings

The program philosophy and instructional strategies of *Keep on Reading Science!* are based on research in science and literacy, including practices described in the National Reading Panel Report (2000). A primary goal of *Keep on Reading Science!* is to support students as they make the crucial transition between learning to read and reading to learn. The program provides opportunities for students to use literacy strategies to further their understanding of science content. This position is consistent with that of researchers in the Textual Tools Study Group of the University of Michigan and Detroit Public Schools.

> The goal in using literacy teaching strategies in science or any content learning is not to have students perform the strategy "correctly," but to support students as they make sense of text and to prompt them to learn to use some of the independent reading strategies modeled through literacy teaching strategy. Drawing from the cognitive studies of good readers, reading comprehension and content literacy theorists have argued that content literacy teaching strategies should engage readers before, during, and after a reading activity in order to elicit knowledge, guide strategy use and build metacognitive strategies, and check or extend comprehension following a reading (Textual Tools Study Group, 2006, pp. 265–266).

Table 2 provides a summary of the research findings and descriptions of ways in which *Keep on Reading Science!* addresses those findings.

TABLE 2

Alignment of ***Keep on Reading Science!*** with Research in Science and Literacy

Research Says . . .	***Keep on Reading Science!* Provides . . .**
"Comprehension skills and strategies are necessary for student success, and they do not develop automatically in most students." National Reading Panel Report, 2000 "Instruction should focus on multiple strategies and skills in context."Baker, 2004	Explicit, direct instruction in a single comprehension skill or strategy in each Student Book.Instruction in the application of nine comprehension skills and strategies: tell nonfiction from fiction; main idea and details; sequence; compare and contrast; summarize; draw conclusions/make inferences; fact and opinion; cause and effect; problems and solutions.
"Children of all ability levels need good models of the genres specific to science." Donovan & Smolkin, 2001	Selections in a wide variety of genres, focusing on science. Examples of genres: science textbook lesson, advertisement, science journal, editorial, trade book chapter, Web site, brochure, biography, science experiment, instructions, report. Layout, designs, and graphics that are accurate representations of each genre's characteristics.
"Students will learn to read and write in science if they are given explicit instruction in strategies for· • reading and writing science; • understanding and exemplifying through their own writing the structure with which scientific information is presented; • understanding and exemplifying the ways that thinking is represented in different science texts; • forming a full and flexible knowledge of the vocabulary of science; • understanding the tradition of scientific investigation, including the way scientific information is created, shared, and evaluated by the scientific community through reading and writing. Shanahan, 2004	Presentation of a single comprehension skill in each pair of Student Books across different science selections.Focus on two science topics within each pair of Student Books, with topics from the three major science strands taught in elementary schools today—life science, earth science, and physical science.Activities that engage students in reading, talking, and writing "like a scientist."
"Students who generate questions for the purpose of finding 'answers to questions derived from curiosity about everyday experiences' are participating in scientific inquiry as defined by the NSES (National Science Education Standards)."Alvermann, 2004	Prompts to remind students to form questions and monitor comprehension."Fun with Science" activities that stimulate curiosity and extend students' involvement with science topics.

TABLE 2

Alignment of ***Keep on Reading Science!*** with Research in Science and Literacy

Research Says . . .	***Keep on Reading Science!* Provides . . .**
"Effective text comprehension requires an important metacognitive control component known as comprehension monitoring. Comprehension monitoring involves deciding whether or not we understand something (evaluation) and taking appropriate steps to correct whatever comprehension problems we detect (regulation)." Baker, 2004	Explanations of comprehension skills and strategies readers use to apply those skills. Provocative questions to activate students' prior knowledge and to generate interest in the topic. Consistent lesson format that guides students through stages that enable them to monitor comprehension. "Test Yourself" questions for informal science content assessment. Posttests that assess student knowledge of comprehension skills and strategies.
"Science is an academic language, a way of communicating about the natural world. . . . The specialized language of science, which linguists call a discourse, has its own vocabulary and organization, which are embodied in the ways scientists communicate about their work." Cervetti, Pearson, Bravo, & Barber, 2006.	Definitions of science vocabulary at point of use. Activities that involve students in using science vocabulary to organize and summarize information as they express themselves "like a scientist."
"Children need scaffolded lessons in which the teacher gradually releases the responsibility for using the strategy."Kletzien & Dreher, 2004 "A phased transfer model or gradual release model is a way to present content in meaningful units by phasing the teacher out and allowing the students to apply the new learning to other contexts on their own, independently." Wood, 2002	Built-in scaffolding that enables teachers to support student learning and foster growing reader independence. Pretests that can be used to identify student needs and target instruction to meet those needs.Options for organizing instruction, including small-group instruction, paired reading, independent reading, and whole-class instruction. Suggestions for differentiating instruction and supporting English-language learners.

Overview of *Keep on Reading Science!*

Keep on Reading Science! was designed to meet the needs of students who do not automatically make the transition from reading fiction to reading science nonfiction. The program provides explicit, direct instruction in comprehension skills and strategies and opportunities to practice using nonfiction science content. The program is aligned to state standards and includes pretests and posttests that resemble the format of the state assessments. *Keep on Reading Science!* offers teachers an integrated approach to science and literacy learning that enables them to maximize instructional time.

Keep on Reading Science! is organized in three levels, B, C, and D, for use with students in grades three through five. Each level contains sixteen Student Books with the books paired to teach a single comprehension skill across different science selections. Within each Student Book, a variety of science genres culminate in a science textbook selection. The science content includes topics in earth science, life science, and physical science—the three strands common to elementary science programs. A Teacher Guide accompanies each level in the program.

The Student Books have a consistent instructional format. The sequence of instruction is as follows:

- Explanation of the selected comprehension skill as it applies in science.
- Four nonfiction science genre selections (e.g., brochure, biography, newspaper article, textbook lesson) including scaffolding supports to guide students in applying the comprehension skill and learning the science vocabulary and concepts.
- Activities for students to demonstrate their ability to think and write like a scientist.

The Teacher Guide provides information about the purpose, philosophy, and research-base for *Keep on Reading Science!* as well as instructional suggestions for each section of the Student Books. These suggestions provide support for the teacher in modeling comprehension strategies, scaffolding instruction, differentiating instruction, pacing instruction, assisting English-language learners, and assessment. Pretests and posttests appear at the end of each Teacher Guide. Blackline masters for student use in organizing what they have learned are included in each Guide. Correlation charts show the alignment of *Keep on Reading Science!* with grade-appropriate state standards for English language arts/reading and science. The relevant literacy and science standards are listed with each lesson in the Teacher Guide.

Keep on Reading Science! is a reading program that helps students learn reading comprehension skills and strategies and apply them to science materials. Its scaffolded instruction across a variety of nonfiction genres helps ensure comprehension of essential science concepts.

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