

## Research-Based Curriculum Teacher Created Materials Publishing

### Science Readers



## Introduction

*Science Readers* is a research-based supplemental series that combines science and language arts. The collection contains three kits. Each has sets of leveled readers with enriching science content for teachers to use to enhance language arts or science lessons. Each kit is focused on a single science strand: Physical Science, Earth and Space Science, and Life Science.

A recent research study showed a typical fifth grade day was divided into 37% instructional focus on literacy, 25% on math, 11% on science and 13% on social studies – a reality not in harmony with nationally declared aims to improve science and mathematical education (Pianta, 2007). *Science Readers* addresses the need for focused science instruction in classrooms where literacy instruction is being required and emphasized. The program offers core science content in engaging, easy-to-read formats with differentiated lessons and texts, supporting photos, illustrations, and hands-on experiments that make the science clear and easy to follow.

Teacher Created Materials created this program to be used to support core science and reading curricula, to bridge gaps in content and understanding, and to prepare students for science testing. This kit was developed to provide teachers with a way to integrate their teaching of language arts and science while making accommodations for differences in student reading abilities and levels of understanding. Whether the students are above level, on level, below level, or English language learners, *Science Readers* offers lessons and activities that meet standards for reading, writing, and science.

### Why a Focus on Science?

“Having a basic knowledge of scientific principles is no longer a luxury but, in today’s complex world, a necessity” (Miller, 2007). The American Association for the Advancement of Science (AAAS) began Project 2061 in order to develop and promote science literacy. The project was established with the understanding that simply offering more science content is not effective. Rather, it is more important to teach the essentials of science content more efficiently (AAAS, 1989). The authors of the paper stated that most Americans are not “science literate” and that U.S. students do not rank well in comparison to other nations in science and mathematics (AAAS, 1989). Shortly thereafter, the Association developed benchmarks for science literacy. Since every state has its own science standards, these benchmarks were prepared as a tool to assist in the revision of state science, mathematics, and technology curriculum (AAAS, 1993). The project promotes the need for people who are knowledgeable about the most important scientific concepts and it provides resources on which to make curriculum decisions.

As Americans become more knowledgeable about the basics of science content, this can lead to a more sophisticated work force, better consumers, and wiser influences on public policy as it relates to scientific issues (Miller, 2007). Clearly there is a need for students to be educated in science concepts and *Science Readers* is one practical option for teachers to meet this challenge within the instructional day.

## **The Organization of the Program**

Each unit of *Science Readers* is structured in a similar manner. First, there is an overview of the unit with a suggested time line. Each unit outlines the reading, writing, and science objectives that are covered in that particular unit. Every kit has sixteen paired readers. The learning objectives are the same for both of the paired readers, but the activities themselves have been adapted to be appropriate for the differing levels of readability provided by the readers. Each unit has a lab activity that is related to the topic featured in the readers. There is also a lesson plan that serves as a guide for the teacher to lead students through the lesson activities. There are differentiated lesson strategies for the paired readers that reach different levels of readability. These provide step-by- step instructions for leading the students through the process of reading the text. Each lesson also incorporates the use of data analysis activities on reproducible pages as well as a follow-up quiz to check for comprehension. There is a comprehensive teacher's guide and overhead transparencies that provide materials for data analysis. A DVD from The Futures Cannel features science that is applied in the real world. Finally, there is a teacher resource CD with step-by-step lab instructions, PowerPoint® presentations of each reader, and reproducible copies for activities.

## **All Together: Science, Language Arts, Inquiry, and Literacy**

As the expectations for student achievement in both scientific knowledge and reading skills continue to rise, so does the need for quality materials that teach content area knowledge and critical reading skills through meaningful literature. The lessons need to challenge students to employ reasoning, critical thinking and problem-solving skills (Pianta, 2007). The *Science Readers* address these content and literacy requirements through the scientific content in the differentiated leveled readers and the detailed lesson plans and strategies for teachers to employ.

It is important to generate a group of scientifically literate students who can intelligently discuss multi-faceted issues such as the most debated and current scientific issues that arise today – such as stem cell biology, evolution, genetically modified organisms and others. (Wagner and Rissing, 2007) With *Science Readers*, the students proceed through complete and comprehensive units of study. Each unit includes concept application through data analysis and hands-on lab activities. Students see, hear, read, touch, and consider the concepts presented in each lesson. They are offered numerous opportunities to explore the ideas presented and build upon their previous experiences to gain new knowledge. Students then construct personal opinions regarding the advancements in science and the effects on the Earth and society. They also analyze the works of actual working scientists and the advancements they have brought to society. By participating in the lesson activities in these units, students move toward increased scientific literacy.

## **Understanding the Values of Scientists**

Scientists work under a distinctive set of values. Therefore, according to the American Association for the Advancement of Science, science education should do the same. (AAAS, 1989) Students should learn under the same values of the scientists that they study. *Science Readers* lesson activities and labs engage students in thought-provoking, open-ended discussions and projects.

AAAS defines sufficient familiarity in science as *science literacy*—this concept “has many facets. These include being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another; understanding some of the key concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes” (AAAS, 1989).

Within the recommendations of skills needed for scientific literacy, the American Association for the Advancement of Science suggests attention to computation, manipulation, observation, communication, and critical response. It is suggested that these skills are best learned through the process of learning, rather than in the knowledge itself (AAAS, 1989). When students engage in the lesson labs in the *Science Readers* program, they follow formulas and calculations, use calculators to apply computation skills accurately, manipulate common materials and tools to make scientific discoveries, express findings and opinions both orally and in writing, read tables, charts, and graphs to interpret data, respond critically to data and conclusions, and use information to organize their own data and draw their own conclusions.

### **Inquiry-based Learning**

The National Science Teachers Association supports the idea that inquiry science is essential so that students can effectively develop the necessary problem-solving skills that empower them to participate in an increasingly scientific and technological world (NSTA, 2002). “Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions” (NSTA, 2004). *Science Readers* lessons encourage this type of inquiry-based learning. Following the nature of scientific inquiry, students are expected to ask questions and collect data. They work within teams of their peers to investigate the unknown. This method of process learning refocuses the students’ learning from knowledge and comprehension to application and analysis. Students may also formulate opinions (synthesis and evaluation) and determine whether their processes were effective or needed revision (evaluation).

The National Science Education Standards view inquiry as “central to science learning” (NAS, 1996). Kreuger and Sutton (2001) also report an increase in students’ comprehension of text when knowledge learning is coupled with hands-on science activities. Each unit in the *Science Readers* program provides an engaging lab activity at the end of the reader. Students should learn how to identify and ask suitable questions that can be answered throughout their scientific investigations (NSTA, 2004). Each lesson plan in the program facilitates this process by including inquiry activities before, during, and after the lab. In addition, the data analysis activity pages reconstruct related experiments and share data that the students can analyze to apply their learning from the readers. This program offers students multiple opportunities to engage in both personal hands-on activities and related experiments.

## **The Need for Differentiation**

With the varied student needs represented in today's classrooms, teachers have to differentiate their instruction. The *Science Readers* lessons provide straightforward ways for teachers to differentiate without all the extra planning that is usually involved. The exciting science topics in *Science Readers* permit students in fourth grade through eighth grade to read engaging scientific information at differentiated levels. These levels correlate with grades three through five in levels of readability. Thus, struggling readers have access to information that is geared toward their appropriate motivational interests. The lessons can be tailored as a replacement of textbook reading or a bridge to the successful comprehension of textbook reading. Research shows that repeated reading of connected texts helps students develop more proficient reading skills (Quatroche, 1999). The teacher can determine the best way to use the program to meet the needs of the students in the classroom.

Furthermore, the paired readers themselves are differentiated by levels of readability. Each covered topic has a pair of readers that are written at different reading levels. For each pair, one features a scientific field of study and the other features a related scientist or group of scientists. While similar in topic, one of the readers can be used for struggling readers and the other from the pair can be used with students who are reading at a higher ability level. While science textbooks tend to be written at challenging levels of readability, the *Science Readers* fulfill the need for exposing struggling readers to nonfiction text and concepts that they can approach at their own reading capability.

## **Nonfiction Reading is Necessary**

*Science Readers* spotlight nonfiction texts about scientific concepts. The detailed lesson plans encourage the teaching of specific nonfiction reading skills in addition to the necessary basic reading skills. These skills include understanding nonfiction text features. The importance of teaching these skills and the need for more nonfiction reading instruction in elementary schools is also supported by *Becoming a Nation of Readers: The Report of the Commission on Reading* (Anderson, Hiebert, & Wilkinson, 1985). In this pioneering document the commission states, "It is only common sense that children would be helped to make the transition to textbooks if early basal readers contained more high quality nonfiction."

There is a huge increase in reading comprehension skills essential for academic success in the higher grades. The courses in the higher grades are usually dominated by textbooks, which can be difficult for struggling readers and English language learners. For this reason, learning to read and understand nonfiction text is a critical skill that students must learn—and from a very young age. "Scholars have pointed out that informational texts can play an important role in motivating children to read in the first place" (Duke, 2000). Reading informational texts is also particularly helpful to children who are learning English as a second language. The concrete nature of the real world makes it easier for these children to create bridges between their primary language and the English languages. "Children love reading about real things. It gives them an understanding of our world and the way things work. And considering all the newspapers, brochures, guides, maps, Internet sites, and how-to manuals we navigate as adults, it's safe to say that nonfiction is the genre children will read most often when they grow up" (Taberski, 2001). Furthermore, the structural patterns in nonfiction text tend to be very important for students to

understand the meaning of the text. It is necessary for teachers to instruct their students in the strategies of using text structure to enhance learning (Collins, 1994). Explicitly taught strategies are very important for understanding text and monitoring comprehension and this will help struggling readers transfer the learned strategies to other texts (Quatroche, 1999).

One last convincing grounds for using nonfiction text is its emphasis on the reading comprehension sections of state and national tests (Parkes, 2003). Because students are most often tested on their ability to comprehend nonfiction text, it serves to reason that most of their classroom experiences should be with nonfiction text as well. “Reading nonfiction materials would increase students' depth of knowledge in the content areas, and probably help students score higher on the standardized tests that are of such concern to teachers and administrators” (Ivey and Broaddus, 2000). *Science Readers* offer teachers a further resource for helping students of all levels gain competence in the skills necessary for successfully responding to the standardized testing requirements.

### **Science Textbooks Versus Nonfiction Authentic Literature**

As Project 2061 began, researchers questioned the appropriateness and effectiveness of science textbooks and methods of instruction. Since textbook instruction puts more emphasis on learning correct answers and less on exploration, collaboration, and inquiry, the Association for the Advancement of Science asserts that this manner of instruction actually “impedes progress toward scientific literacy” (AAAS, 1989). Others asserted that today’s textbooks are best used as reference books when students need large amounts of information on a particular topic within a subject area. Instead they recommend the use of “authentic, real-world nonfiction” (Daniels and Zemelman, 2004). Likewise, researchers and educators alike suggest using quality nonfiction materials, which “provide the reader with a sense of discovery” (Nevett, 2004). Each of the leveled readers in *Science Readers* provides just that. The paired readers for each unit include real-life photos, charts, illustrations, and sidebars. The information is presented in an interesting manner to foster students’ curiosity and encourage continued exploration of a concept.

### **Guided Reading in the Intermediate Classroom**

As students approach the middle and intermediate grades, their reading focus in the classroom shifts from learning to read to reading to learn. According to the Executive Summary of Reading at Risk, about 70% of adolescent students are struggling readers (NASBE, 2006). This report also cites that two thirds of 8th and 12th graders read below proficiency, and one fourth read at the basic level. The report continues by saying that the lack of proficiency is due in part to these students inability to comprehend factual information within the content areas, form general understandings, develop interpretations, and make text connections. This report also acknowledges that reading rate, vocabulary, background knowledge, and motivation contribute to students’ inability to interact with and learn from their reading (NASBE, 2006).

Additionally, Yudhijit Bhattacharjee (2004) summarized the Trends in Mathematics and Science Study (TIMSS), which compared students’ science achievement among 49 countries. From this study the International Association for the Evaluation of Educational Achievement concluded that U.S. eighth graders improved their ranking from 17th to 9th in science achievement worldwide while fourth graders regressed from 3rd to 6th place. In this same report, the National

Science Teachers' Association blamed an increased emphasis on literacy and omission of science instruction to explain this downward trend at the elementary school level. These are not isolated subjects or skills. With purposeful content area instruction that promotes student engagement with the text, students may improve their literacy skills. In addition, Krueger and Sutton (2001) identify the relationship between reading and science learning. They report that "many of the process skills needed for scientific inquiry are similar to reading skills" (p. 52). When teachers teach reading skills within science content, the processes used to learn both reinforce each other.

An effective literacy program as one that "fosters active, responsible learning" and "uses literacy as a tool to find the information [students] need, to express their opinions, [and] to take positions" (Fountas and Pinnell, 2001). Researchers have established that textbooks are far too cumbersome and detailed to provide students with meaningful informational reading. Guided reading can be an effective alternative in the upper grades. Guided reading "allows teachers to model and demonstrate strategies used by proficient readers" (Shanklin, 2002). In a guided reading setting, this reading support provides the scaffold students need to be successful with the content of the text. When students read in a guided reading group, the materials are appropriate for their reading level so they may focus more on making connections and interacting with the text versus struggling to decode and decipher the words without meaning. A strong guided reading lesson includes explicit instruction with before reading, during reading, and after reading activities.

The leveled readers in the *Science Readers* offer both on- and below-level text to support one concept within a unit of study, providing students with informational text at their individual reading levels. The lessons effectively guide teachers through guided reading instructional activities. They draw students' attention to essential vocabulary and offer numerous pictures, graphics, and illustrations to support the text. The units were organized to adhere to the National Science Education Standards; thus the content is relevant and appropriate for their grade level. The reading lessons include before-, during-, and after-reading activities which encourage interaction between the students and the text.

### **Teaching Scientific Vocabulary**

While learning about scientific concepts through activities, inquiry, and hands-on experiences, students often find a stumbling block in scientific vocabulary. Scientists communicate with each other through publication of results and peer review; this communication is just as necessary to the scientific enterprise as gathering data or formulating hypotheses (Goldman & Bisanz, 2002). This vital communication is information dense and often employs highly specialized scientific vocabulary. These unfamiliar and often polysyllabic words can slow student science to a crawl as they struggle to understand each other, their texts, and even themselves. The typical vocabulary activities that are common to language arts and history curricula do not always transfer effectively to the science classroom. Looking up the definition of a difficult word often yields the student additional difficult words and no better understanding.

Additionally, given the specialized nature of scientific terminology, there is little opportunity for students to use the vocabulary in their ordinary lives and thus gain familiarity. However, science teachers can see positive results by making the development of scientific vocabulary a cornerstone of their curriculum. Vocabulary is a key variable in reader comprehension (National Institute of Child Health and Human Development, 2000). The exploration of scientific vocabulary can also provide teachable moments and serve as a thematic hub around which learning may be organized. Perhaps most importantly, reading books rich in scientific vocabulary “fosters scientific understandings and teach students how to express these ideas in scientific language” (Saul 2004).

In order to reap such benefits, the science teacher must foster familiarity with scientific vocabulary and lead students in relating the concepts behind that vocabulary. Glossary terms included in *Science Readers* are bolded, and the glossary definitions can be used as a springboard for deeper understanding. This process steps beyond the common problem where students identify glossary definitions as “the” definition of a word and look no further. Presenting glossary definitions as the first step in an ongoing inquiry process, however, leads to a much more nuanced understanding. True vocabulary development is not a matter of student ability to recite definitions for big words. Instead, it is a part of being “scientifically literate – to possess a set of skills that marries knowledge of science concepts, facts, and processes with the ability to use language to articulate and communicate about ideas” (Their, 2002). Knowledge of definitions is functionally useless without the ability to relate those definitions to each other and to students’ outside experience.

### **Conclusion**

*Science Readers* has combined effective instruction activities and suggestions for teachers to use readily in the classroom. In conclusion, the theories and strategies on which *Science Readers* are based demonstrate that science and language arts curriculum can both be effectively addressed together in order to serve varying student needs in the classroom. *Science Readers* is one valuable and effective supplemental resource toward these goals.



**The following references were employed in the creation of this research-based program:**

- Anderson, R.C., Hiebert, E.H., Scot, J. & Wilkinson, I.A.G. (1985). *Becoming a Nation of Readers: The Report of the Commission on Reading*. Center for the Study of Reading.
- American Association for the Advancement of Science. (1989). *Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology*.
- American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy: Project 2061*. Oxford University Press.
- Bhattacharjee, Y. (2004). *U.S. Gets Mixed Marks for Science Education*. *Science Now*, December (4-5). Retrieved from <http://search.ebscohost.com>.
- Collins, N.D. (1994). *Metacognition and Reading to Learn*. Bloomington IN: ERIC Clearinghouse on Reading English and Communication. ERIC Digest ED 376-427.
- Daniels, H, and Zemelman, S. (2004). *Out With Textbooks, In With Learning*. *Educational Leadership*, December 2003/January 2004. (36-40).
- Duke, N. (2000, April - June). *3.6 Minutes per Day: The Scarcity of Informational Texts in First Grade*. *Reading Research Quarterly*, v. 35, p. 202-224.
- Fountas, I. and Pinnell, G. (2001). *Guided Readers and Writers: Grades 3-6*. Heinemann.
- Goldman, S.R. & Bisanz, G.L. (2002). *Toward a functional analysis of scientific genres: Implications for understanding and learning processes*. In J. Otero, J.A. Leon, & A.C. Graesser (Eds.), *The psychology of science text comprehension* (pp. 19-50). Mahwah, NJ: Erlbaum.
- Ivey, G. & Broaddus, K. (2000, September). *Tailoring the Fit: Reading Instruction and Middle School Readers*. *The Reading Teacher*, v. 54, p. 68-78.
- Krueger, A. and Sutton, J. (2001). *EDThoughts: What We Know About Science Teaching and Learning*. McREL.
- Miller, J. (2007). *Scientific Literacy – How do Americans Stack Up?* EurekaAlert internet article. Public Release Date February 17, 2007. Michigan State University. Retrieved May 22, 2007 from [http://www.eurekaalert.org/pub\\_releases/2007-02/msu-slh021207.php#](http://www.eurekaalert.org/pub_releases/2007-02/msu-slh021207.php#)
- National Academy of Science. (1996). *National Science Education Standards*. National Academy Press. Retrieved from <http://www.nap.edu/readingroom/books/nses/>.
- National Association of State Boards of Education. (2006). *Reading at Risk: The State Response*

to the Crisis in Adolescent Literacy, Executive Summary. Retrieved from <http://www.nasbe.org>.

National Institute of Child Health and Human Development (2000). *TEACHING CHILDREN TO READ: An Evidence-Based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction* (NIH Publication No. 00-4769). Washington, DC: US Government Printing Office.

National Science Teachers Association. (2002) *Elementary School Science*. NSTA position statement adopted by the board of directors July, 2002. Retrieved May 31, 2007 from <http://www.nsta.org/about/positions/elementary.aspx>

National Science Teachers Association. (2004) *Scientific Inquiry*. NSTA position statement adopted by the board of directors October, 2004. Retrieved May 31, 2007 from <http://www.nsta.org/about/positions/inquiry.aspx>

Nevett, M. (2004). *Professionally Speaking*. Booklinks. January, Vol. 13 Issue 3, p7. Retrieved from <http://search.ebscohost.com>.

Parkes, Brenda. (Accessed August 1, 2003). *Real-world Reading and Writing: Nonfiction Opens Doors to a Life of Learning*, Creative Classroom Online, Creative Classroom Publishing, LLC, [www.creativeclassroom.org](http://www.creativeclassroom.org).

Pianta, Robert. (2007). *Elementary School Classrooms Get Low Rating on High-Quality Instruction*. EurekAlert internet article. Public Release Date March 29, 2007. University of Virginia. Retrieved May 22, 2007 from [http://www.eurekalert.org/pub\\_releases/2007-03/uov-esc032807.php#](http://www.eurekalert.org/pub_releases/2007-03/uov-esc032807.php#)

Quatroche, D. J. (1999). *Helping the Underachiever in Reading*. Bloomington, IN: ERIC CLEARINGHOUSE on Reading English and Communication. ERIC Digest ED 434-331.

Saul (2004) *Crossing Borders in Literacy and Science Instruction*. St Louis, MS: International Reading Association, Inc.

Shanklin, N. (2002). *An Inquiry Study into Adolescent Literacy: Encouraging the Development or Adolescent Readers*. National Council of Teachers of English. Retrieved from <http://www.ncte.org>.

Taberski, S. (2001, March). Fact and Fiction Read Aloud. *Instructor*, v. 110, p.24-26, 105.

Their, Marlene (2002) *The New Science Literacy*. Portsmouth, NH: Heinemann.

Wagner, Holly and Steven Rissing. (2007). *Scientific Literacy Happens – When Students Think for Themselves*. EurekAlert internet article. Public Release Date February 18, 2007.

Ohio State University. Retrieved May 22, 2007 from  
[http://www.eurekaalert.org/pub\\_releases/2007-02/osu-slh021307.php#](http://www.eurekaalert.org/pub_releases/2007-02/osu-slh021307.php#)