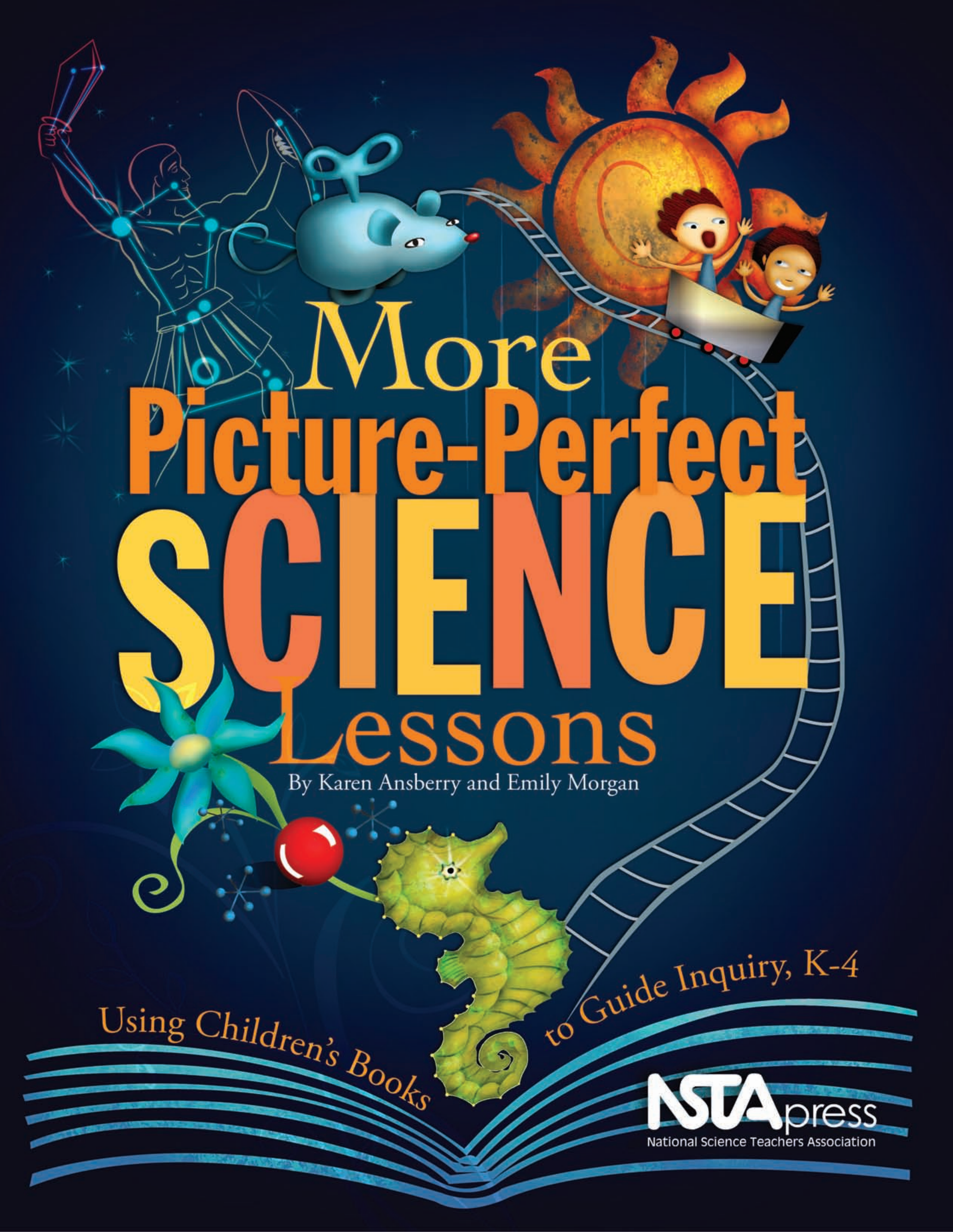

More Picture-Perfect SCIENCE Lessons

By Karen Ansberry and Emily Morgan

Using Children's Books to Guide Inquiry, K-4

NSTApress
National Science Teachers Association

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NATIONAL SCIENCE TEACHERS ASSOCIATION

Arlington, Virginia

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Contents

Foreword

In the mid-1980s, BSCS developed the 5E instructional model. At that time we adapted and extended a model from the Science Curriculum Improvement Study (SCIS) which was a contemporary science curriculum for elementary schools. The 5E model became a standard feature of BSCS programs, beginning with the program for which it was originally designed. That elementary program is now known as *BSCS Science Tracks: Connecting Science and Literacy.*

At the time we developed the BSCS 5E model, we had no idea about National Science Education Standards, the reemergence of inquiry, No Child Left Behind (NCLB) with its emphasis on reading literacy, and the dominating influence that assessment would have on science education. But, the decade of the 1990s did present changes and challenges for science education, especially programs in elementary schools. With NCLB we have witnessed more and more emphasis on reading in lower elementary grades with the result of less and less science. Of course, concerns mounted in the science education community. Statements about the worth and importance of science were heard. "Elementary should realize the importance of science." "Science can enhance literacy." But, the plea went unheard. Or, they were heard and acknowledged without any change in science instruction. Why was this? Teachers provided an answer to the question when they asked—"Where are the lessons?" The teaching community needed examples, in the form of curriculum materials, of how to incorporate literacy into science instruction. This book presents one response to the elementary teacher's question.

Karen Ansberry and Emily Morgan present the science education community with a refreshing and positive remedy to the reduction of science teaching in elementary schools. In *More Picture Perfect Science Lessons: Using Children's Books To Guide Inquiry, K–4,* they present an integrated instructional approach that addresses National Science Education Standards, inquiry, and the need for elementary teachers to enhance the reading skills of children. In short, the authors use the BSCS 5E instructional model to present science lessons. In doing so, they integrate reading strategies. The activities complement topics included in most school science programs—rocks, trees, magnets, and plants.

The authors have contributed to the goal of more and better science instruction in elementary schools in the United States. This book presents lessons that accommodate every elementary teacher's need to be efficient. You can teach so children learn science AND develop reading abilities.

Rodger W. Bybee
Executive Director, BSCS
Colorado Springs, Colorado

Preface

A class of third-grade students laughs as their teacher reads Doreen Cronin's *Diary of a Worm*. Students are listening to the earthworm reading his diary, "June 15th: My older sister thinks she's so pretty. I told her that no matter how much time she spends looking in a mirror, her face will always look just like her rear end." The third-grade class giggles as the teacher continues to read the worm's hilarious diary entries. After the read aloud, the teacher leads students through a reading comprehension strategy called *questioning the author* (Beck et al. 1997) in which the students learn to think critically about what they are reading. The teacher models this by generating a list of questions to ask the author, such as "Is this accurate—a worm's head and tail look just alike? Can you tell a worm's head from its tail?" Students then observe live earthworms with hand lenses and read a nonfiction book about worms in an effort to find the answer. Through this exciting lesson, students construct their own understandings about earthworm adaptations, how earthworms help the earth, and how to design and conduct simple experiments to answer questions.

What Is Picture-Perfect Science?

This scenario describes how a children's picture book can help guide students through an engaging, hands-on inquiry lesson. *More Picture-Perfect Science Lessons* contains 15 science lessons for students in kindergarten through grade four, with embedded reading comprehension strategies to help them learn to read and read to learn while engaged in inquiry-based science. To help you teach according to the National Science Education Standards, the lessons are written in an easy-to-follow format for teaching inquiry-based science: the Biological Sciences Curriculum Study 5E Instructional Model (Bybee 1997). This learning-cycle model allows students to construct their own understandings of scientific concepts as they cycle through the following phases: *engage, explore, explain, elaborate,* and *evaluate*. *More Picture-Perfect Science Lessons* is primarily a book for teaching science, but reading-comprehension strategies are embedded in each lesson. You can model these essential strategies throughout while you keep the focus of the lessons on science.

Use This Book Within Your Science Curriculum

We wrote *More Picture-Perfect Science Lessons* to supplement, not replace, your school's existing science program. Although each lesson stands alone as a carefully planned learning cycle based on clearly defined science objectives, the lessons are intended to be integrated into a complete curriculum in which concepts can be more fully developed. The lessons are not designed to be taught sequentially. We want you to use *More Picture-Perfect Science Lessons* where appropriate within your school's current science program to support, enrich, and extend it. And we want you to adapt the lessons to fit your school's curriculum, the needs of your students, and your own teaching style.

Special Features of the Book

1 Ready-To-Use Lessons With Assessments

Each lesson contains background for the teacher, engagement activities, hands-on explorations, student pages, suggestions for student and teacher explanations, opportunities for elaboration, assessment suggestions, and annotated bibliographies of more books to read on the topic. Assessments range from poster sessions with rubrics to student-created books to formal multiple-choice and extended-response quizzes.

2 Reading Comprehension Strategies

Reading comprehension strategies based on the book *Strategies that Work* (Harvey and Goudvis 2000) and specific activities to enhance comprehension are embedded throughout the lessons and clearly marked with an icon ( ). Chapter 2 describes how to model these strategies while reading aloud to students.

3 Standards-Based Objectives

All lesson objectives were adapted from *National Science Education Standards* (NRC 1996) and are clearly identified at the beginning of each lesson. Chapter 5 outlines the National Science Education Standards for K–4 and shows the correlation between the lessons and the Standards.

4 Science as Inquiry

As we said, the lessons in *More Picture-Perfect Science Lessons* are structured as guided inquiries following the 5E model. Guiding questions are embedded throughout each lesson and marked with an icon (?). The questioning process is the cornerstone of good teaching. A teacher who asks thoughtful questions arouses students' curiosity, promotes critical thinking skills, creates links between ideas, provides challenges, gets immediate feedback on student learning, and helps guide students through the inquiry process. Each lesson includes an Inquiry Place, a section at the end of the lesson that suggests ideas for developing open inquiries. Chapters 3 and 4 explore science as inquiry and the BSCS 5E Instructional Model.

References

Beck, I., R. Hamilton, L. Kucan, and M. McKeown. 1997. *Questioning the author: An approach for enhancing student engagement with text*. Newark, DE: International Reading Association.

Bybee, R. W. 1997. *Achieving scientific literacy: From purposes to practices*. Portsmouth, NH: Heinemann.

Harvey, S. and A. Goudvis. 2000. *Strategies that work: Teaching comprehension to enhance understanding.* York, ME: Stenhouse Publishers.

National Research Council. 1996. *National Science Education Standards*. Washington, DC: National Academy Press.

Children's Book Cited

Cronin, D. 2003. *Diary of a worm.* New York: Joanna Cotler Books.

Editors' Note:

More Picture-Perfect Science Lessons builds upon the texts of 29 children's picture books to teach science. Some of these books feature animals that have been anthropomorphized—forest animals talk, a worm keeps a diary. While we recognize that many scientists and educators believe that personification, teleology, animism, and anthropomorphism promote misconceptions among young children, others believe that removing these elements would leave children's literature severely underpopulated. Further, backers of these techniques not only see little harm in their use but also argue that they facilitate learning.

Because *More Picture-Perfect Science Lessons* specifically and carefully supports scientific inquiry—"That Magnetic Dog" lesson, for instance, teaches students how to weed out misconceptions by asking them to point out inaccurate statements about magnetism—we, like our authors, feel the question remains open.

Acknowledgments

We would like to give special thanks to science consultant Carol Collins for sharing her expertise in teaching inquiry-based science, for giving us many wonderful opportunities to share Picture-Perfect Science with teachers, and for supporting and encouraging our efforts.

We would also like to express our gratitude to language arts consultant Susan Livingston for opening our eyes to the power of modeling reading strategies in the content areas and for teaching us that every teacher is a reading teacher.

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About the Authors

Karen Ansberry is the Elementary Science Curriculum Leader and a former fifth- and sixth-grade science teacher at Mason City Schools, in Mason, Ohio. She has a Bachelor of Science in Biology from Xavier University and a Master of Arts in Teaching from Miami University. Karen lives in historic Lebanon, Ohio, with her husband, Kevin, and their two dogs and two cats.

Emily Morgan is a science consultant for the Hamilton County Educational Service Center. She formerly taught second- through fourth-grade science lab at Mason City Schools in Mason, Ohio, and seventh-grade science at Northridge Local Schools in Dayton, Ohio. She has a Bachelor of Science in Elementary Education from Wright State University and a Master of Science in Education from the University of Dayton. Emily lives in West Chester, Ohio, with her husband, Jeff, and their dog and two cats.

Karen Ansberry and Emily Morgan are the authors of *Picture-Perfect Science Lessons: Using Children's Books to Guide Inquiry (Grades 3-6)* published by NSTA Press in 2005. In collaboration with language arts consultant Susan Livingston, they received a Toyota Tapestry Award for their *Picture-Perfect Science* grant proposal in 2002.

Emily and Karen share a passion for science, nature, animals, travel, teaching, and children's literature. They enjoy working together to facilitate Picture-Perfect Science teacher workshops. This is their second book.

For more information on Picture-Perfect Science teacher workshops, go to:

www.pictureperfectscience.com

Picture-Perfect SCIENCE

About the Picture-Perfect Science Program

The Picture-Perfect Science program originated from Emily Morgan's and Karen Ansberry's shared interest in using children's literature to make science more engaging. In her 2001 master's thesis study involving 350 of Emily's third grade science lab students at Western Row Elementary, she found that students who used science trade books instead of the textbook scored significantly higher on district science performance assessments than students who used the textbook only. Convinced of the benefits of using picture books to engage students in science inquiry and to increase science understanding, Karen and Emily began collaborating with Sue Livingston, Mason's elementary language arts curriculum leader, in an effort to integrate literacy strategies into inquiry-based science lessons. They received grants from the Ohio Department of Education (2001) and Toyota Tapestry (2002) in order to train all third grade through sixth grade science teachers, and in 2003 also trained seventh and eighth grade science teachers with district support. The program has been presented both locally and nationally, including at the National Science Teachers Association national conferences in San Diego, Philadelphia, Dallas, and Nashville.

For more information on Picture-Perfect Science teacher workshops, go to: *www.pictureperfectscience.com*

How Big Is a Foot?

Description

Learners explore the history of measurement from the ancient Egyptian use of nonstandard units to the modern-day metric system. They learn why standard measuring tools are useful and that their development was a problem-solving process that took centuries.

Suggested Grade Levels: 2–4

Lesson Objectives Connecting to the Standards

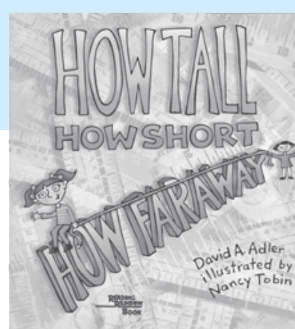
Content Standard E: Science and Technology

- Understand that people have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Understand that tools help scientists make better observations and measurements for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Content Standard G: History and Nature of Science

- Understand that science and technology have been practiced by people for a long time, and that men and women have made a variety of contributions throughout the history of science and technology.

Featured Picture Books



Title	*How Big Is a Foot?*	*How Tall, How Short, How Faraway*
Author	Rolf Myller	David A. Adler
Illustrator	Rolf Myller	Nancy Tobin
Publisher	Young Yearling	Holiday House
Year	1962	1999
Genre	Story	Non-narrative Information
Summary	The King has a problem. He wants to give the Queen a bed for her birthday, but no one knows the answer to the question "How big is a bed?"	Colorful cartoons and easy-to-follow text introduce the history of measurement, from the ancient Egyptian system to the metric system.

Time Needed

This lesson will take several class periods. Suggested scheduling is as follows:

Day 1: **Engage** with *How Big Is a Foot?* read aloud, **Explore** with Measuring With Feet, and **Explain** with A Letter to the King.

Day 2: **Elaborate** with *How Tall, How Short, How Faraway* read aloud and Measurement Activities.

Day 3: **Evaluate** with A Better Way to Measure.

Materials

About 2 m of string or yarn per pair of students

Roll of masking tape

Yardstick

Meterstick

Rulers (1 per student)

Student Pages

A Letter to the King

A Better Way to Measure

Background

The National Science Education Standards suggest that children develop some essential understandings about science and technology, including the idea that people throughout history have invented tools and techniques to solve their problems. In this lesson, students learn how the development of standard measurements was a fascinating but lengthy problem-solving process.

Weights and measures were among the first tools invented by man. Ancient people used their body parts and items in their surroundings as their first measuring tools. Early Egyptian and Babylonian records indicate that length was first measured with the forearm, hand, and fingers. As societies evolved, measurements became more complex. It became more and more important to be able to measure accurately time after time and to be able to reproduce the measurements in different places. By the 18th century, England had achieved a greater degree of standardization in measurement than other European countries. The English, or *customary system* of measurement, commonly used in the United States, is nearly the same as that brought by the colonists from England.

The need for a single, worldwide measurement system was recognized more than 300 years ago when a French priest named Gabriel Mouton proposed a comprehensive decimal measurement system. A century passed, however, and no action was taken. During the French revolution, the National Assembly of France requested that the French Academy of Sciences "deduce an invariable standard for all the measures and all the weights." A system was proposed that was both simple and scientific: the *metric system.* The simplicity of the metric system is due to its being based on units of 10. The standardized structure and decimal features of the metric system made it well suited for scientific and engineering work, so it is not surprising that wide acceptance of the metric system coincided with an age of rapid technological development. By an Act of Congress in 1866, it became "lawful throughout the United

States of America to employ the weights and measures of the metric system to all contracts, dealings, and court proceedings." By 1900, a total of 35 nations had accepted the metric system. Eventually, the name *Systeme Internationale d'Unites* (International System of Units) with the international abbreviation *SI* was given to the metric system. Although the customary system of measurement is commonly used in everyday situations in the United States, American scientists primarily use the metric system (SI) in their daily work.

Adapted from: A Brief History of Measurement Systems
http://standards.nasa.gov/history_metric.pdf#search='history%20of%20measurement'

Engage

How Big Is a Foot? Read Aloud

Inferring

Show students the cover of the book *How Big Is a Foot?* Ask

? What can you infer from the title and illustration on the cover of this book?

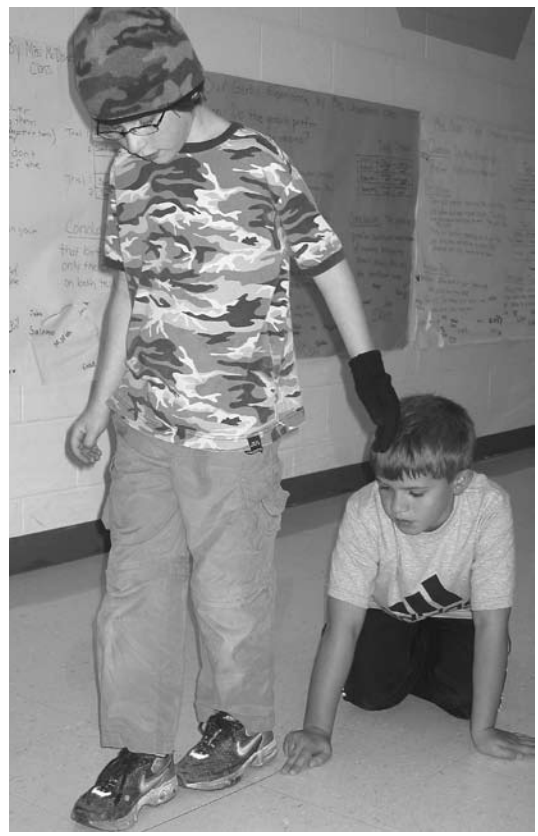
Begin reading the book aloud, but stop after reading, "Why was the bed too small for the Queen?"

Explore

Measuring with Feet

Remind the students that "the King took off his shoes and with his big feet walked carefully around the Queen. He counted that the bed must be three feet wide." Tell students that they are going to determine the length of three feet by using their own feet. Give each pair of students about 2 m of yarn or string. Then demonstrate the steps for measuring three "feet":

1. Have your partner hold the end of the string where the back of your heel touches the floor.
2. Place one foot right in front of the other for three steps, and then freeze.
3. Have your partner stretch the string to the big toe of your third step.
4. Cut the string. It will now represent the length of your three "feet."



Measuring three "feet"

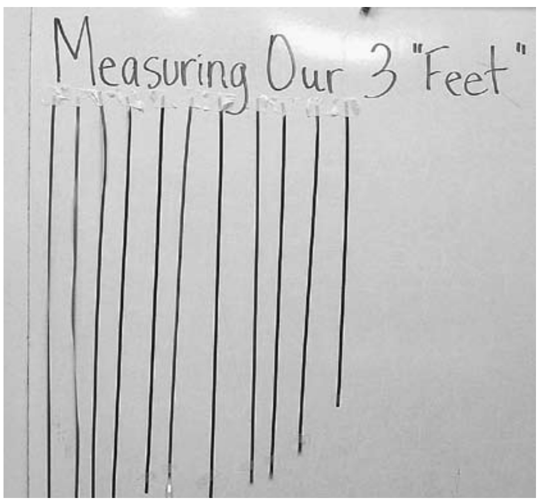
5. Attach a piece of masking tape with your name on it to one end of the string.
6. Hang your string from the board.
7. Help your partner measure his or her three "feet."

When all students have hung their strings on the board, compare the various lengths. Ask

? Are all of the strings the same length? Why or why not?

Hold up a yardstick and ask

- How many feet are in a yard? (Students may know there are three feet in a yard.)
- How does your string compare to three feet as measured by a yardstick?



Comparing the strings

explain

A Letter to the King

Refer back to the book, *How Big Is a Foot?* Ask

- Do you think it is fair that the King put the apprentice in jail? Why or why not?
- What advice would you give the King about how he might be able to get a bed the right size for the Queen?

On A Letter to the King student page, have students write a persuasive letter to the King about why he should let the apprentice out of jail. Ask them to explain why the bed is too small for the Queen and what he could do to get a bed that is the right size. Have students share their letters with a partner. Read the student letters to assess whether or not students understand that the bed is too short because of the difference in foot size between the King and the apprentice. Students should also provide reasonable advice for getting a bed the right size.

Next, read the rest of the book to students. Ask

- How does the apprentice's solution in the book compare to the advice you gave in your letter?
- Is there more than one correct solution? (yes)
- What are some other ways that the King could have had the bed built the right size?

elaborate

How Tall, How Short, How Faraway Read Aloud and Measurement Activities

Making Connections: Text to Text

Show students the cover of *How Tall, How Short, How Faraway.* Ask

- What do you think this book is about?

Hold up *How Tall, How Short, How Faraway* and *How Big is a Foot?* Ask

- What do you think these two books might have in common? (Examples of answers include that both are about measurement and about people's height.)

Ask students to signal when they hear or see any connections between the two books. Then read pages 1–19 aloud of *How Tall, How Short, How Faraway* (ending after "5,280 feet are 1 mile") stopping to discuss any text-to-text connections. Students may point out some of the following connections:

How Tall, How Short, How Faraway	***How Big Is a Foot?***
Ancient Egyptians measured with their hands and arms (digits, cubits, palms, spans).	The King measured with his feet.
Measuring with hands and arms caused problems with getting accurate measurements.	Measuring with different-sized feet caused problems in getting a bed the right size for the Queen.
In the past, people often used their leader's or king's cubit or steps as a standard.	The apprentice decided to use the King's foot as a standard to remake the bed.
People made measuring sticks the size of their king's cubit or steps.	The apprentice made an exact marble copy of the King's foot and measured with it.

Measurement Activities

Challenge students by asking

? Can you measure the length of my desk without a ruler?

As a class, brainstorm a list of ways that you could measure the desk without using any traditional measuring tools. Then ask

? How did the ancient Egyptians measure out a span? (A span is the distance from the tip of your thumb to the end of your little finger with your hand stretched wide.)

Make the following data table on the board:

Length of Desk		
Name	Spans	

Call on a student to measure your desk with his or her hand span. Write that student's name and his or her number of spans on the data table. Call on another student, who is either taller or shorter than the first student, to measure the desk in his or her spans. Write that number of spans on the data table. Then measure the desk using your own hand span, and write that number of spans on the data table. Ask

? Which is the correct answer for the length of my desk? (Students should begin to understand that there is no "correct" answer in spans.)

Measuring the desk in spans

❓ Why did we get different answers for the length of the desk in spans? (Each person's span is a different size.)

❓ Why do you think the span is no longer used for measuring length? (It is not an accurate measurement because the length of the span varies from person to person.)

Go back to *How Tall, How Short, How Faraway*, and read from page 20 ("The metric system was first proposed over 300 years ago …") to page 31 ("People have been measuring things for thousands of years."). After reading, state that in different times and parts of the world, there have been many systems of measurement. Ask

❓ What are the two systems of measurement most widely used today? (the customary, also known as the English system, and the metric system)

Explain that the units used in these systems are called standard units. Standard units are units of measurement that are accepted and used by most people. Some examples of standard units are: feet, inches, pounds, centimeters, meters, grams, and liters. The other type of units is nonstandard units, which are everyday objects that can be used to obtain a measurement. Examples include: spans, cubits, paces, and digits.

Explain that most people around the world, as well as scientists everywhere, use the metric system because it is simpler and less confusing than the customary system. Explain that, although the metric system was invented over 200 years ago, the United States has not entirely switched over to it. Some metric units are: grams, kilograms, liters, centimeters, and meters. Ask

❓ What things do you know of that are measured in metric units? (Examples include 2 l bottles of soda, 100 m dash, grams of fat in food, distances in kilometers, and kilometers per hour on a speedometer.)

Finding something one meter long

Comparing spans and centimeters

Give each pair of students a meterstick and a metric ruler. Have students use these tools to find something in the room that is about a centimeter long and something that is about a meter long.

Next, label the third column on the data table "centimeters" and call on a student to measure your desk in centimeters with a meterstick. Write that student's name and the measurement on the data table. Call on another student to measure the desk with the meterstick. Write that measurement on the data table. Then measure the desk yourself with a meterstick and write that measurement on the data table.

? Why were the answers so different for the length of the desk in spans, yet all the same for the length of the desk in centimeters? (Each person's span is a different size, but a centimeter is always the same size.)

evaluate

A Better Way to Measure

Review what students have learned about the history of measurement and the need for standard measuring tools. Then distribute the assessment student page, A Better Way to Measure. Correct responses may include the following:

1. The pirates disagree because, when they measured the distance to the treasure, they each used their own paces. One is tall and one is short, so their paces are different lengths.
2. The pirates could measure in feet, yards, or meters.
3. We wouldn't know the exact distance to anything or anyplace.

Inquiry Place

Have students brainstorm testable or researchable questions such as

- Do taller students always have a longer pace?
- What is the difference between the longest pace and the shortest pace of students in the room?
- What is the relationship between hand span and height of students in the room?
- Which countries have not adopted the metric system as their official system of measurement? Why?

Have students select a question to investigate as a class, or have students vote on the question they want to investigate as a team. After they make their predictions, they can design an investigation to test their predictions. Students can present their findings at a poster session or gallery walk.

More Books to Read

Eboch, C. 2006. *Science measurements: How heavy? How long? How hot?* Minneapolis: Picture Window Books.

Summary: Big or small? Full or empty? Heavy or light? Hot or cold? Things are measured everyday. Learn about the many tools needed for different kinds of measurements in science and at home.

Jenkins, S. 2004. *Actual size.* New York: Houghton Mifflin.

Summary: With his colorful collage illustrations, Jenkins shows the actual sizes of many interesting animals. Some pages show the entire animal, while others show only a part of the animal.

Leedy, L. 1997. *Measuring penny.* New York: Henry Holt.

Summary: Lisa learns about the mathematics of measuring by measuring her dog Penny with all sorts of units, including pounds, inches, dog biscuits, and cotton swabs.

Nagda, A. W. and C. Bickel. 2000. *Tiger math: Learning to graph from a baby tiger.* New York: Henry Holt.

Summary: At the Denver Zoo, a Siberian tiger cub named T. J. is orphaned when he is only a few weeks old. The zoo staff raises him, feeding him by hand until he is able to eat on his own and return to the tiger exhibit. The story is accompanied by graphs that chart T.J.'s growth, showing a wonderful example of real-world mathematics.

Pluckrose, H. 1995. *Length*. London: Watts Books.

Summary: Photographs and simple text introduce the concept of length and ways to measure it.

Wells, R. 1993. *Is a blue whale the biggest thing there is?* Morton Grove, IL: Albert Whitman.

Summary: This fun, kid-friendly book describes the relative sizes of a blue whale, Mount Everest, the Earth, and ultimately the universe.

Wells, R. 1995. *What's smaller than a pygmy shrew?* Morton Grove, IL: Albert Whitman.

Summary: In this fun book about the smallest of the small, Wells compares the size of a tiny animal, a pygmy shrew, to an insect, which is in turn contrasted with one-celled animals, bacteria, molecules, atoms, and subatomic particles.

Name: ______________________________

A Letter to the King

Write a letter to the King to convince him to let the apprentice out of jail. In your letter, be sure to

- explain why the bed was made too small for the Queen, and
- tell what the King could do to have a bed made the right size for the Queen.

Your Royal Highness,

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Your Loyal Subject,

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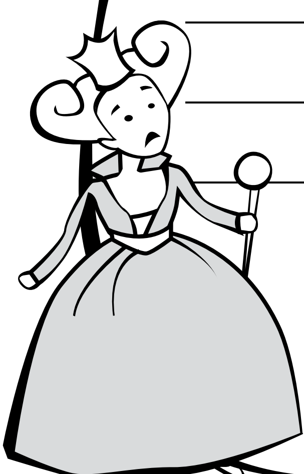

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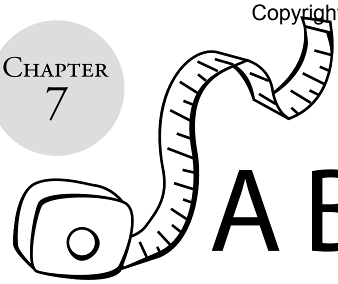

A Better Way to Measure

to Map a Buried Treasure!

1. Why do you think the pirates disagree about the distance to the treasure?

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2. What would be a better way to measure the distance to the treasure?

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3. What would happen if everyone used his or her own paces to measure distance or length?

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Glossary

Anticipation guides—Sets of questions that serve as a pre- or post-reading activity for a text, anticipation guides can activate and assess prior knowledge, determine misconceptions, focus thinking on the reading, and motivate reluctant readers by stimulating interest in the topic.

Assessment—"Assessment, broadly defined, means information gathering. Grading (or evaluating) students is certainly one type of assessment. Tests, portfolios, and lab practicals are all assessment devices. However, teachers assess students in other ways. When teachers check for understanding, to determine whether or not to continue teaching about a particular idea and where to go next with instruction, they are also assessing their students. Ungraded pretests and self-tests likewise represent assessment. Any information that helps the teacher make instructional decisions is assessment.

"Assessment is valuable to students as well as teachers (not to mention parents and other education stakeholders) because it helps students figure out what they do and don't understand and where they need to place their efforts to maximize learning. Assessment is also used to sort or rank students, letting them know how their performance compares to others, both for placement purposes and as a way to ensure minimum competencies in those who have passed particular tests." (Colburn 2003, p. 37)

Chunking—Chunking, just like it sounds, is dividing the text into manageable sections and reading only a section at any one time.

Cloze paragraph—An activity to help readers infer the meaning of unfamiliar words. Key words are deleted from a passage, and students fill in the blanks with words that make sense and sound right.

Constructivism—"Constructivism has multiple meanings, and it's important that when people discuss the concept they be sure they're talking about the same thing! Much of the confusion stems from the fact that constructivism refers to both an explanation (theory) about how people learn and a philosophical position related to the nature of learning (see Matthews 1994, pp. 137–39). Increasingly, people are also using the term to refer to teaching techniques designed to build on what students already know, for example, open-ended, hands-on inquiry (Brooks and Brooks 1993).

"I'd like to focus on constructivism as an explanation about learning; that's probably what is most relevant to readers. In this context, *constructivism* refers to the concept that learners always bring with them to the classroom (or any other place where learning takes place) ideas about how the world works—including ideas related to whatever may be in today's lesson. Most of the time learners are unaware they even have these ideas! The ideas come from life experiences combined with what people have learned elsewhere.

"According to constructivist learning theory, learners test new ideas against that which they already believe to be true. If the new ideas seem to fit in with their pictures of the world, they have little difficulty learning the ideas. There's no guarantee, though, that they will fit the ideas into their pictures of how the world works with the kind of meaning the teacher intends. . . .

"On the other hand, if the new ideas don't seem to fit the learner's picture of reality then they won't seem to make sense. Learners may dismiss them, learn them well enough to please the teacher (but never fully accept the ideas), or eventually accommodate the new ideas and change the way they understand the world. As you might guess, this third outcome is most difficult to achieve, although it's what teachers most often desire in students.

"Seen this way, teaching is a process of trying to get people to change their minds—difficult enough as is, but made even more difficult by the fact that learners may not even know they hold an opinion about the idea in question! People who study learning and cognition often contrast constructivism with the more classical idea that students in our classes are "blank slates" who know nothing about the topics they are being taught. From this perspective, the teacher "transmits" new information to students, who mentally store it away. In contrast, constructivist learning theory says that students are not blank slates; learning is sometimes a process whereby new ideas help students to 'rewrite' the misconceptions already on their slates." (Colburn 2003, pp. 58–59)

Determining importance—One of Harvey and Goudvis' six key reading strategies, determining importance involves identifying essential information by distinguishing it from nonessential details. (See also Inferring, Making connections, Questioning, Synthesizing, and Visualizing.)

Dual-purpose books—Intended to serve two purposes, present a story and provide facts, dual-purpose books employ a format that allows readers to use the book as a storybook or as a non-narrative information book. Sometimes information can be found in the running text but more frequently appears in insets and diagrams. Readers can enter on any page to access specific facts or read the book through as a story.

Elaborate—See 5E model of instruction.

Engage—See 5E model of instruction.

Evaluate—See 5E model of instruction.

Explain—See 5E model of instruction.

Explore—See 5E model of instruction.

Features of nonfiction—Many nonfiction books include a table of contents, index, glossary, bold-print words, picture captions, diagrams, and charts that provide valuable information. Modeling how to interpret the information is important because children often skip over these features.

5E model of instruction—"The 5E model of instruction is a variation on the learning cycle model, pioneered by the Biological Sciences Curriculum Study (BSCS 1993). The five Es of the model are *engage, explore, explain, elaborate*, and *evaluate*. *Engage* refers to beginning instruction with something that both catches students' attention and helps them relate what is to come with what they already know. *Explore* is virtually identical with the exploration phase of the learning cycle, as *explain* is the concept- or term-introduction phase and *elaborate* is the application phase. *Evaluation* is both formative and summative since it helps determine whether instruction should continue or whether students need more time and teaching to learn the unit's key points." (Colburn 2003, p. 23)

Genre—Picture books are a genre in themselves, but in this text, genre refers to types of picture books: storybooks, non-narrative information books, narrative information books, and dual-purpose books.

Guided inquiry activity—"In a guided inquiry activity, the teacher gives students only the problem to investigate (and the materials to use for the investigation). Students must figure out how to answer the investigation's question and then generalize from the data collected." (Colburn 2003, pp. 20–21)

Inferring—One of Harvey and Goudvis' six key reading strategies, inferring involves merging clues from the reading with prior knowledge to draw conclusions and interpret text. (See also Determining importance, Making connections, Questioning, Synthesizing, and Visualizing.)

Inquiry—"Historically, discussions of inquiry generally have fallen within two broad classes. Sometimes people talk about inquiry as describing what scientists do and sometimes as a teaching and learning process. Authors of the *National Science Education Standards* (NRC 1996) seemed to recognize this dichotomy:

Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also *refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.* [emphasis added] (23)

"To make this distinction less confusing, people also sometimes use the phrase 'inquiry-based instruction.' This term refers to the creation of a classroom where students are engaged in (essentially) open-ended, student-centered, hands-on activities. This means that students must make at least some decisions about what they are doing and what their work means—thinking along the way.

"While most people in the science education community would probably think of inquiry as hands-on, it's also true that many educators would 'count' as inquiry any activity where students are analyzing real-life data—even if the information were simply given to students on paper, without any hands-on activity on their part.

"As readers can begin to see, inquiry and inquiry-based instruction represent ideas with broad definitions and occasional disagreements about their meaning. Two people advocating inquiry-based instruction may not be advocating for the same methods! Some define 'inquiry' (instruction) in terms of open-ended, hands-on instruction; others define the term in terms of formally teaching students inquiry skills (trying to teach students how to observe or make hypotheses, for example); and some define inquiry so broadly as to represent any hands-on activity." (Colburn 2003, pp. 19–20)

Learning cycle—"Different versions of the learning cycle exist today. However, the general pattern is to begin instruction with students engaged in an activity designed to provide experience with a new idea. The idea behind this exploratory phase of the cycle is that learning of new ideas is maximized when students have had relevant, concrete experience with an idea before being formally introduced to it (Barman and Kotar 1989).

"This exploratory phase is ideally followed by a concept- or term-introduction phase. That phase generally begins with class discussion about student findings and thoughts following the previous part of the cycle. Sometimes the teacher can then go on to simply provide names for ideas that students previously discovered or experienced.

"Finally, students expand on the idea in an application phase of instruction in which they use the new idea(s) in a different context. Using a new idea in a new context is an important part of maximizing learning. In addition, some students don't begin to truly understand an idea until they've had the time to work with it for a while, in different ways. The learning cycle model provides these students with time and opportunities that help them learn.

"Ideally, the application phase of the cycle also introduces students to a new idea. In this sense, the application phase of one learning cycle is also the exploratory phase of another learning cycle—hence the 'cycle' part of 'learning cycle.' (Notice that the previous sentence began with the word 'ideally'; sometimes it's difficult for an application phase activity to also encourage students to explore other ideas.)" (Colburn 2003, p. 22)

Making connections—One of Harvey and Goudvis' six key reading strategies, making connections involves having students access their prior knowledge and experience to make meaningful connections to the text when reading. Three types of connections are Text to Self, Text to Text, and Text to World. (See also Determining importance, Inferring, Questioning, Synthesizing, and Visualizing.)

Misconceptions—"[L]earners always bring preconceived ideas with them to the classroom about how the world works. Misconceptions, in the field of science education, are preconceived ideas that differ from those currently accepted by the scientific community. Educators use a variety of phrases synonymously with 'misconceptions,' including 'naive conceptions,' 'prior conceptions,' 'alternate conceptions,' and 'preconceptions.' Many people have interviewed students to discover commonly held scientific ideas (Driver, Guesne, and Tiberghien 1985; Osborne and Freyberg 1985)." (Colburn 2003, p. 59)

Most valuable point (MVP)—An activity in which students are asked to determine the most valuable point after reading a passage. The purpose of this tool is to help readers distinguish between unimportant and important information in order to identify key ideas as they read.

Narrative information books—Narrative information books communicate a sequence of factual events over time and sometimes recount the events of a specific case to generalize to all cases. Teachers should establish a purpose for reading so students focus on the science content rather than the storyline. Teachers may want to read the book through one time for the aesthetic components and a second time for specific science content.

National Science Education Standards—"The National Science Education Standards were published in 1996, after a lengthy commentary period from many interested citizens and groups . . .

"The Standards were designed to be achievable by all students, no matter their background or characteristics. . . .

"Beside standards for science content and for science teaching, the *National Science Education Standards* includes standards for professional development for science teachers, science education programs, and even science education systems. Finally, the document also addresses what some consider the bottom line for educational reform—standards for assessment in science education.

"Although the information in the *National Science Education Standards* is often written in a rather general manner, the resulting document provides a far-reaching and generally agreed upon comprehensive starting place for people interested in changing the U.S. science educational system." (Colburn 2003, pp. 81–82)

Non-narrative information books—Factual texts that introduce a topic, describe the attributes of the topic, or describe typical events that occur. The focus is on the subject matter, not specific characters. The vocabulary is typically technical, and readers can enter the text at any point in the book.

Open inquiry activity—"Open inquiry, in many ways, is analogous to doing science. Problem-based learning and science fair activities are often open inquiry experiences for students. Basically, in an open inquiry activity students must figure out pretty much everything. They determine questions to investigate, procedures to address their questions, data to generate, and what the data mean." (Colburn 2003, p. 21)

O-W-L chart—An O-W-L chart ("Observations, Wonderings, Learnings") is one of several organizers that can help learners activate prior knowledge, organize their thinking, understand the essential characteristics of concepts, and see relationships among concepts. It can be used for prereading, for assessment, or for summarizing or reviewing material.

Pairs read—In a pairs read, one learner reads aloud, while the other listens and then summarizes the main idea. Benefits include increased reader involvement, attention, and collaboration and students who become more independent learners.

Picture walk—An activity in which the teacher shows students the cover of a book and browses through the pages, in order, without reading the text. The purpose of this tool is to establish interest in the story and expectations about what is to come.

Questioning—One of Harvey and Goudvis' six key reading strategies, questioning involves readers asking themselves questions before, during, and after reading. This allows readers to construct meaning, find answers, solve problems, and eliminate confusion as they read. (See also Determining importance, Inferring, Making connections, Synthesizing, and Visualizing.)

Questioning the author (QtA)—An interactive strategy that encourages students to question the ideas presented in the text while they are reading, making them critical thinkers, not just passive readers.

Reading aloud—Being read to builds knowledge for success in reading and increases interest in reading and literature and in overall academic achievement. See Chapter 2 for more on reading aloud, including 10 tips on how to do it.

Reading comprehension strategies—The six key reading comprehension strategies featured in *Strategies That Work* (Harvey and Goudvis 2000) are *making connections*, *questioning*, *visualizing*, *inferring*, *determining importance*, and *synthesizing*. See Chapter 2 for fuller explanations.

Rereading—Nonfiction text is often full of unfamiliar ideas and difficult vocabulary. Rereading content for clarification is an essential skill of proficient readers, and you should model this frequently. Rereading for a different purpose can aid comprehension. For example, a teacher might read aloud for enjoyment and then revisit the text to focus on science content.

Sketch to stretch—Learners pause briefly to reflect on the text and do a comprehension self-assessment by drawing on paper the images they visualize in their heads during reading. Teachers should have students use pencils so they understand the focus should be on collecting their thoughts rather than creating a piece of art. You may want to use a timer.

Stop and jot—Learners stop and think about the reading and then jot down a thought. If they use sticky notes, the notes can be added to a whole-class chart to connect past and future learning.

Storybooks—Storybooks center on specific characters who work to resolve a conflict or problem. The major purpose of stories is to entertain. The vocabulary is typically commonsense, everyday language. A storybook can spark interest in a science topic and move students toward informational texts to answer questions inspired by the story.

Structured inquiry activity—"In a structured inquiry activity, the teacher gives students a (usually) hands-on problem they are to investigate, and the methods and materials to use for the investigation, but not expected outcomes. Students are to discover a relationship and generalize from data collected.

"The main difference between a structured inquiry activity and verification lab (or 'cookbook activity') lies in what students do with the data they generate. In structured inquiry activities, students are largely responsible for figuring out what the data might mean—that is, they analyze and interpret the data. Students may ultimately interpret the data differently; different students may come to somewhat different conclusions. In a verification lab, on the other hand, all students are expected to arrive at the same conclusion—there's a definite right answer that students are supposed to be finding during the lab activity." (Colburn 2003, p. 20)

Synthesizing—One of Harvey and Goudvis' six key reading strategies, synthesizing involves combining information gained through reading with prior knowledge and experience to form new ideas. (See also Determining importance, Inferring, Making connections, Questioning, and Visualizing.)

T-chart—A T-chart is one of several organizers that can help learners activate prior knowledge, organize their thinking, understand the essential characteristics of concepts, and see relationships among concepts. It can be used for prereading, for assessment, or for summarizing or reviewing material.

Turn and talk—Learners pair up with a partner to share ideas, explain concepts in their own words, or tell about a connection they have to the book. This method allows each child to be involved as either a talker or a listener.

Using features of nonfiction—An activity in which the teacher models how common features of nonfiction can be used to help the reader. These features include table of contents, index, glossary, bold-print words, picture captions, diagrams, and charts.

Venn Diagram—A graphic organizer, made of two or more intersecting circles, that is used to compare two or more items, such as books, people, animals, or events.

Visualizing—One of Harvey and Goudvis' six key reading strategies, visualizing involves creating mental images while reading or listening to text. This strategy can help engage learners and stimulate their interest in the reading. (See also Determining importance, Inferring, Making connections, Questioning, and Synthesizing.)

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Note: Page numbers in *italics* refer to tables. Page numbers in **boldface** refer to student activity pages.