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Teaching Students to Think Like Scientists

Twelve-year-old Ruth Garcia rises at 6 a.m., shovels down spoonfuls of cereal, throws on a well-worn T-shirt and jeans, and then slips out the door with her maroon backpack draped across her small back. She boards a familiar yellow school bus and spends twenty minutes traveling from her downtown apartment, through stop-and-go traffic, to her middle school parking lot, where she is dropped off near the street corner patrolled by a rather stern looking crossing guard. Alongside her seventh-grade peers, she plows through the open doors of the local middle school, into Mrs. Lungren's science classroom. This is Ruth's daily routine. And it is the routine of thousands of young people just like Ruth, who brave the early morning "get-ready" and a journey of some sort, by foot or by vehicle, to ultimately slip into a cold wooden or plastic chair where either they will be motivated and engaged or will drudgingly count down the minutes until the bell signals them to escape.

Fortunately, Ruth is in the former category. Her teacher, Mrs. Lungren, plans lessons that involve all students in activities that require them to think about science, talk about science, write scientifically, and do science—just like scientists in the field. It is a method of instructional practice that empowers students to not only dream of themselves as investigators of the world's phenomena but to actually play the role of scientist—*seeker of patterns, developer of cause and effect relationships, and creator of models* (among other things). How does Mrs. Lungren accomplish this? This book shares instructional ideas that teachers just like Mrs. Lungren implement to promote collaboration, conversation, debate, and inquiry thinking—all for the purpose of examining and forwarding scientific knowledge.

HOW WELL ARE U.S. STUDENTS DOING IN SCIENCE?

Think about Ruth in comparison to other middle school students around the world. Are she and her peers as scientifically literate as students from other countries? What made you answer as you just did? Consider the following data to get a perspective of how well U.S. students perform on science assessments.

How Do We Compare Nationally?

The National Assessment of Educational Progress (NAEP) is an ongoing measure of trends in academic achievement of U.S. elementary and secondary students in various subjects, including science. The assessment itself is based on an understanding of what scientific literacy means. According to the *Science Framework for the 2011 National Assessment of Education Progress,* a scientifically literate person

> . . . is familiar with the natural world and understands key facts, concepts, principles, laws, and theories of science, such as the motion of objects, the function of cells in living organisms, and the properties of Earth materials. Further, a scientifically literate person can connect ideas across disciplines; for example, the conservation of energy in physical, life, Earth, and space systems. Scientific literacy also encompasses understanding the use of scientific principles and ways of thinking to advance our knowledge of the natural world as well as the use of science to solve problems in real-world contexts. (National Assessment Governing Board, 2010, p. v)

The assessment measures both science content knowledge and the understanding of science practices. Table 1.1 shows the data from 2009 to 2011. The data displayed in Table 1.1 was shared through the U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009–2011 Science Assessments (http://nationsreportcard.gov/science_2011/).

Between 2009 and 2011 there is a slight increase in average scores for eighth graders. However, it should be noted that at the advanced levels, there was no significant change. Now, let's consider student scores on an international level.

How Do We Compare Internationally?

Notice in Table 1.2, which reports data relayed by The National Center for Educational Statistics (NCES) (Provasnik et al., 2012) (http://nces

.ed.gov/timss/results11_science11.asp), that on the *Trends in International Mathematics and Science Study (TIMSS)* scores have remained relatively flat since 2007. While there is a slight difference between the U.S. average science score at grade 8 in 2007 (520) and in 2011 (525), it is not significant. Additionally, in international comparison shown as Table 1.3, the percentage of eighth-grade students performing at or above the *advanced* international science benchmark in 2011 was higher than in the United States in 12 education systems.

Table 1.1 Trends Among U.S. Students

Year of NAEP Science Assessment	2009	2011
Average Scores in NAEP Science for Public School Students at Grade 8	150	152

Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009–2011 Science Assessments (http://nationsreportcard.gov/science_2011/)

Table 1.2 TIMSS: International Comparisons of Average Scores

	2007	*2011*
United States Students Average Score	520	525
International Average Score	500	500

Source: The National Center for Educational Statistics (NCES) (Provasnik et al., 2012) (http://nces.ed.gov/timss/results11_science11.asp)

Table 1.3 International Comparisons for Students Scoring at *Advanced Levels* in 2011

Number of Countries With Students Scoring Below U.S. Students at Advanced Levels	*Number of Countries With Similar Numbers of Students Scoring at Advanced Levels*	*Number of Countries With Students Scoring Above U.S. Students at Advanced Levels*
33	10	12

Source: The National Center for Educational Statistics (NCES) (Provasnik et al., 2012) (http://nces.ed.gov/timss/results11_science11.asp)

Notice there were 10 education systems in which students scored the same as U.S. students, and students in 33 educational systems scored lower than students in the United States. While U.S. students still score higher than students in many countries, they are not among the very top performing students yet.

Clearly, as a nation, we are holding steady; however, at the advanced levels there is room to grow. Interestingly, at grade 4, all racial/ethnic groups within the United States performed above the TIMSS scale average. At grade 8, White, Asian, and multiracial students' average scores were above the TIMSS scale average, while Black and Hispanic students' average scores were not measurably different from the TIMSS scale average. At grade 8, students in public schools that have *less than 50%* of their students eligible for free or reduced-price lunch scored higher, on average, than the TIMSS scale average, while schools with *more than 50%* of the students eligible for free or reduced-price lunch had scores that were not measurably different from the TIMMS scale average.

Let's consider our national science performance on another measure. The Programme for International Student Assessment (PISA) offers a global metric that "assesses the extent to which 15-year-old students have acquired key knowledge and skills that are essential for full participation in modern societies" (OECD, 2009, p. 3). It was coordinated by the Organization for Economic Cooperation and Development (OECD). PISA defines science literacy as:

> An individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues; understanding of the characteristic features of science as a form of human knowledge and inquiry; awareness of how science and technology shape our material, intellectual, and cultural environments; and willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen. (OECD, 2009, p. 128)

The top performing 15-year-olds scored at a level 5 or above on a 1 to 6 scale. Twenty-seven percent of students in Shanghai, China, and 23% in Singapore fell into this top category. In the United States, 7% of 15-year-olds scored at level 5 or above. This value approximated the OECD average of 8% (Table 1.4).

Again U.S. students are in the middle, with 17 education systems scoring higher than the United States and 27 scoring lower. Fifteen systems were not measurably different from that of the United States. In eight educational systems, 0% of the 15-year-olds scored 5 or higher. While U.S. students are holding steady, these data are a call to support

Table 1.4 Percentage of 15-Year-Olds Who Scored at Level 5 or Higher in Select Countries

Country	*Percent of 15-Year-Olds Who Scored at Level 5 or Higher*
Shanghai, China	27%
Singapore	23%
United States	7%
International Average	8%

Source: Organization for Economic Cooperation and Development (OECD)

students in excelling at higher levels in terms of science literacy as defined by OECD; average is not good enough for U.S. students.

To begin thinking about the need to increase the scientific performance of our students, let's also look at PISA data at the other end of the spectrum. Level 2 is considered the baseline of science literacy by the OECD (Table 1.5). In Shanghai, China, only 3% of 15-year-old students fell below level 2. In Estonia, only 5% were in this category. In the United States, 18% of 15-year-olds scored below level 2, which was similar to the OECD average of 18%. The U.S. value was higher than in 21 education systems, lower than in 29 systems, and similar in 14 other systems. To sum it up, U.S. students are scoring at a "just average" level. These scores indicate that we must heed these data and design better instruction to support our struggling students as they first acquire baseline science knowledge, and then move beyond this and into the realm of true science literacy.

Table 1.5 Percentage of 15-Year-Olds Who Scored at Level 2 or Lower in Select Countries

Country	*Percent of 15-Year-Olds Who Scored Below Level 2*
Shanghai, China	3%
Estonia	5%
United States	18%
International Average	18%

Source: Organization for Economic Cooperation and Development (OECD)

What Can We Conclude?

These data beg the question, *"How can we help students to stretch and grow when it comes to acquiring science literacy?"* We believe the answer for success depends on every teacher's strategic and thoughtful lesson planning that results in instruction involving reading, writing, listening, and speaking about science while also integrating engineering and science practices that foster critical thinking, inquiry, investigation, and problem-solving abilities. This text is intended to support teachers as they work to achieve this critical task—a task whose accomplishment is not only important for individual students but is also essential if we, as U.S. citizens, are going to continue to be prime contributors to the well-being of our planet. Science literacy is not just for the nerd who is viewed as wearing a lab coat and carrying a calculator. It is for everyday people who care about their neighborhoods, care about their water and air quality, care about their land and trees, and care about the human beings and animals that inhabit Earth. Clearly, science literacy is for each of us and each of our students.

WHAT FOUNDATIONS DO WE NEED TO HAVE IN PLACE?

There are several pieces of the implementation puzzle that need to be in place to ensure that purposeful science instruction will roll out in every classroom. First, there must be an understanding that science learning is a process—one that connects to the natural world and is built upon a sense of curiosity about it. The NGSS Lead States (2013a) and the Framework for K–12 Science Education focus on a few select core ideas in science and engineering. Notice that each core idea is labeled with letters and a number—PS1 or LS2. Letters *PS* stands for physical science. Letters *LS* indicate life science, while *ESS* stands for earth and space sciences. Finally, *ETS* stands for engineering, technology, and applications of science. Each disciplinary core idea has a set of correlated sub-ideas. For instance, *PS1: Matter and Its Interactions* includes concepts related to *the structure and property of matter, chemical reactions,* and *nuclear processes.* Let's consider each of the science branches and the core ideas that correlate with them. First, we have the physical sciences. These are any of the sciences, such as physics and chemistry, that examine the nature and properties of energy and nonliving matter. The study of atoms, the periodic table, forces, motion, sound, light, and many other topics comes under the umbrella of physical sciences. There are several core ideas that cut across the physical sciences. These include the following:

- **Core Idea PS1: Matter and Its Interactions**
    - PS1.A: Structure and Properties of Matter
    - PS1.B: Chemical Reactions
    - PS1.C: Nuclear Processes
- **Core Idea PS2: Motion and Stability: Forces and Interactions**
    - PS2.A: Forces and Motion
    - PS2.B: Types of Interactions
    - PS2.C: Stability and Instability in Physical Systems
- **Core Idea PS3: Energy**
    - PS3.A: Definitions of Energy
    - PS3.B: Conservation of Energy and Energy Transfer
    - PS3.C: Relationship Between Energy and Forces
    - PS3.D: Energy in Chemical Processes and Everyday Life
- **Core Idea PS4: Waves and Their Applications in Technologies for Information Transfer**
    - PS4.A: Wave Properties
    - PS4.B: Electromagnetic Radiation
    - PS4.C: Information Technologies and Instrumentation

Next let's consider the life sciences. These include areas of study that deal with living organisms and their organization, life processes, and relationships of living things to each other and to their environment. The branches of life science include biology, medicine, anthropology, and ecology. There are several core ideas that fall under the category of life sciences. These include:

- **Core Idea LS1: From Molecules to Organisms: Structures and Processes**
    - LS1.A: Structure and Function
    - LS1.B: Growth and Development of Organisms
    - LS1.C: Organization for Matter and Energy Flow in Organisms
    - LS1.D: Information Processing
- **Core Idea LS2: Ecosystems: Interactions, Energy, and Dynamics**
    - LS2.A: Interdependent Relationships in Ecosystems
    - LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
    - LS2.C: Ecosystem Dynamics, Functioning, and Resilience
    - LS2.D: Social Interactions and Group Behavior

- **Core Idea LS3: Heredity: Inheritance and Variation of Traits**
    - LS3.A: Inheritance of Traits
    - LS3.B: Variation of Traits
- **Core Idea LS4: Biological Evolution: Unity and Diversity**
    - LS4.A: Evidence of Common Ancestry and Diversity
    - LS4.B: Natural Selection
    - LS4.C: Adaptation
    - LS4.D: Biodiversity and Humans

Earth and Space Sciences cover the geological sciences, including the origin, structure, and physical phenomena of the earth, as well as the study of phenomena occurring in the upper atmosphere, in space, or on celestial bodies other than Earth. When students study rocks, plate tectonics, weather, weathering and erosion, or the life cycle of a star, they are examining aspects of earth and space sciences. The core ideas covered in this branch of science include the following:

- **Core Idea ESS1: Earth's Place in the Universe**
    - ESS1.A: The Universe and Its Stars
    - ESS1.B: Earth and the Solar System
    - ESS1.C: The History of Planet Earth
- **Core Idea ESS2: Earth's Systems**
    - ESS2.A: Earth Materials and Systems
    - ESS2.B: Plate Tectonics and Large-Scale System Interactions
    - ESS2.C: The Roles of Water in Earth's Surface Processes
    - ESS2.D: Weather and Climate
    - ESS2.E: Biogeology
- **Core Idea ESS3: Earth and Human Activity**
    - ESS3.A: Natural Resources
    - ESS3.B: Natural Hazards
    - ESS3.C: Human Impacts on Earth Systems
    - ESS3.D: Global Climate Change

The category of engineering, technology, and applications of science (ETS) involves the use of scientific and mathematical principles to design, build, and create solutions to problems. These might include the development of structures, devices, systems, and models intended for the purpose of resolving issues in the real world. Students who investigate the design of blades on a wind turbine to determine the best angular position, size, and shape of blades in order to produce optimal output of electricity are engaging in this branch of science. The core ideas included in ETS are as follows:

- **Core Idea ETS1: Engineering Design**
    - ETS1.A: Defining and Delimiting an Engineering Problem
    - ETS1.B: Developing Possible Solutions
    - ETS1.C: Optimizing the Design Solution
- **Core Idea ETS2: Links Among Engineering, Technology, Science, and Society**
    - ETS2.A: Interdependence of Science, Engineering, and Technology
    - ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

This progression of disciplinary core ideas is described in the framework at grade band levels that include K–2, 3–5, 6–8, and 9–12. Centered on any given disciplinary core idea there is an increasing sophistication of student thinking required as one moves through the grades from kindergarten to twelfth grade. More specifically, NGSS Lead States (2013a) are laid out so that students in various grade levels encounter these core ideas. For instance, in kindergarten, students might be exploring the ideas that make up core idea PS2.A: Forces and Motion, by pushing and pulling toy cars. In later elementary grades, they might explore patterns of motion—*when I push with a greater force, the car travels farther.* By middle school, they are quantitatively investigating the role of the mass of an object on the change in motion when a force is applied. Finally, in high school students are using Newton's Second Law of Motion and the conservation of momentum to predict and further explore patterns of moving objects.

Additionally, a teacher must plan for the integration of science and engineering practices. According to the NRC (2012), "Students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourse by which such ideas are developed and refined" (p. 218). The science and engineering practices are combined with relevant core disciplinary ideas and crosscutting concepts. Let's take a look at each of these.

The eight science and engineering practices are the following:

1. Asking questions and defining problems.
2. Developing and using models.
3. Planning and carrying out investigations.

4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

Clearly these practices, while foundational to science work, support critical and creative thinking in all avenues of life. For instance, a young person buying her first car will want to analyze data, such as the miles per gallon on the freeway or steering ratio. She'll want to look at various models to understand features, designs, and function. A seventh grader running the 400 meter dash in an upcoming track meet might want to employ data analysis techniques, too, by looking at her times during the first half of that race and during the last half of the race, to see when she is faster and when she needs to push more. The science and engineering practices are a part of problem-solving and making informed decisions—elements of everyday life. They weave themselves into daily activities in such a profound way that being 'good' at them can only benefit an individual.

A Scientific Perspective

Now let's consider the scientific way of implementing the science and engineering practices. According to the NGSS Lead States (2013a), there are guiding principles that provide insight into the implementation of the science and engineering practices. First, all students in K–12 should engage in all practices in each grade band. Second, practices grow in complexity and sophistication across the grades. Students, therefore, should develop in their corresponding capabilities. Next, each practice reflects science or engineering in terms of a goal or activity. It should also be noted that practices represent what students are expected to do and are not teaching methods of curriculum. Also, the practices are clearly and intentionally connected and overlapping. Performance expectations will focus on some but not all capabilities associated with a practice. Finally, and in concert with the foundations of the Common Core State Standards for ELA, engagement in the practices is language intensive and requires students to participate in classroom science discourse. In order to own language, one must be able to use it to effectively both receive and share ideas. Being scientifically literate involves all of the communication processes.

Crosscutting Concepts

Another dimension of the NGSS Lead States (2013a) are the *crosscutting concepts.* The crosscutting concepts are the connections across disciplines. They join together the core disciplinary ideas throughout science and engineering. They are as follows:

1. **Patterns.** These include examining the symmetry of a leaf, the pattern of the seasons over the course of a year, and even bird migration patterns during the winter.
2. **Cause and Effect.** Mechanisms and explanation. Examples include looking at the effects on particle motion when thermal energy is added to a beaker of water or observing the rate of erosion due to the flow of a river moving across a hillside.
3. **Scale, Proportion, and Quantity.** This might include looking at the ratio mass to volume to determine the density of an object or developing computations to predict the motion of Jupiter around the sun.
4. **Systems and System Models.** This could include a model that shows the role of plate tectonic motion in the shaping of the crust and in the formation new crustal material. It might also include providing evidence to argue that gravitational attraction is dependent on the masses of the objects and on the distance between them.
5. **Energy and Matter.** Examples include a look at the role of sunlight in the growth of a plant, or the cycling of water through Earth's systems due to energy from the sun, or even an examination of the energy released during the process of nuclear fusion.
6. **Structure and Function.** This could include an examination of how a breakwater structure reflects and absorbs incoming ocean waves or how the size and shape of tires of a bicycle can function to either cover rough terrain or move swiftly across smooth, flat surfaces.
7. **Stability and Change.** This might include a look at solutions to the problem of water eroding a cliffside with homes or devising ways to protect the coral reef populations from the effects of ocean acidification.

The crosscutting concepts provide the connections between content and grade levels. The crosscutting concept, *patterns,* which exist everywhere in nature, can be identified during science time in first grade, in life science in seventh grade, and in physics in high school. When dark clouds roll in, we often know that rain, thunder, and lightning may follow. That's a pattern. When we look at layers of rock, we can typically identify the youngest rocks at the top of the strata—a pattern commonly seen and known in geological studies. Students get to know the relevance of these concepts as they study physical, life, and earth and space sciences. They are woven throughout all domains of science and help clarify the connections between these domains.

Again, the NGSS Lead States (2013a) have outlined guiding principles for this dimension of the NGSS Lead States—the crosscutting concepts. Crosscutting concepts can help students better understand core ideas in science and engineering through familiarity and resultant perspective. They can also help students better understand science and engineering practices themselves. This is because they address fundamental aspects of nature and inform attempts at understanding. It is also intended that repetition in different contexts will build familiarity. Like science and engineering practices, crosscutting concepts grow in complexity and sophistication across the grades. They provide a common vocabulary for science and engineering. Cross cutting concepts are also assessed alongside practices and core ideas. Because some of the crosscutting concepts are hard to express in performance expectations as you go up in grade level and in sophistication, they are not all included the performance expectations. *Patterns* and *Cause and Effect* are examples of crosscutting concepts that are included in performance expectations. The performance expectations are indicated on the standards themselves. Crosscutting concepts are for all students, not just for a few. They include the nature of science and engineering concepts—from inquiry investigations to designing of solutions to real-world problems.

To clarify, the *performance expectations* are statements that unify the practices, core ideas, and crosscutting concepts. They describe how students can show what they have learned. Let's look at how the three dimensions of the NGSS Lead States come together to support a particular standard. Consider this middle school **performance expectation**:

> MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

A related **science and engineering practice** would be:

> Analyzing and Interpreting Data: Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

A related disciplinary **core idea** would be:

PS3.A: Definitions of Energy

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)

A connected **crosscutting concept** would be:

Scale, Proportion, and Quantity

- Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

All three of these dimensions of the NGSS Lead States (science and engineering practices, core ideas, and crosscutting concepts) connect to data analysis and/or the concept of kinetic energy. They are unified aspects coming under the study of energy and motion.

For every performance expectation, the NGSS Lead States document lays out the related *science and engineering practices, core ideas,* and *crosscutting concepts*. You just have to review the document and determine the ways to instruct students so that they can accomplish the elements of the standard(s). This book is intended to help you through the process of planning instruction to support students as they work toward meeting the expectations of these standards. Purposeful instruction is the key to success.

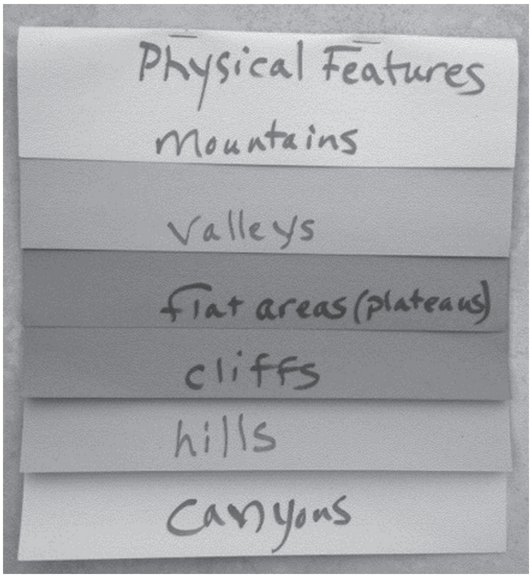
WHAT ARE THE FEATURES OF PURPOSEFUL SCIENCE INSTRUCTION?

Effective science instruction drives students toward inquiry, problem solving, and critical thinking. To support purposeful instruction, teachers must plan lessons that involve purpose setting and modeling, guided instruction, productive group work, and independent work. These components of the *Gradual Release of Responsibility* (Fisher & Frey, 2014; Pearson, & Gallagher, 1983) can be used in any order to realize the goals that teachers and students have for learning (Grant, Lapp, Fisher, Johnson & Frey, 2012). For example, Mr. Wakefield wants his sixth grade students to investigate the foundations of this NGSS Lead States (2013a) in groups of three, before he clarifies and models thinking: *Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales* (MS-ESS2-2). To do this, he asks students to create a group foldable with six tabs (Figure 1.1). On each flap, group members record a physical feature of Earth. Tommy, Julio, and Ciara list mountains, valleys, flat areas (plateaus), cliffs, hills, and canyons. Another group has identified volcanoes instead of cliffs.

Next, students brainstorm how these features might have formed. Ciara notes that mountains form when plates move around. In another group, Michelle notes that erosion can flatten out a plain. In all groups, students record ideas under corresponding flaps. After this significant collaborative group effort, Mr. Wakefield calls the class together and begins his lecture on how processes, like tectonic uplift and weathering and deposition, change Earth's surface. He pauses periodically to let students talk and then add to their foldables.

Mr. Wakefield chooses to engage students in this kind of group work before he provides any new information because he knows that students have background knowledge and some vocabulary they can tap into, and he wants them to engage in science talk that involves predicting, hypothesizing, and coming to conclusions based on their current understanding. Their engagement and heightened interest makes for a more attentive and focused lecture—one with built-in motivation to confirm or refute ideas.

Figure 1.1 Foldable Sample



Notice that he does not use an instructional model that first introduced the content. Instead he invites inquiry, investigation, and collaboration by the students. As he observes and listens, he decides on the information that he needs to share to move his students' base of language and knowledge further with regard to geological processes.

WHAT DO REAL-WORLD SCIENTISTS DO?

The process used by Mr. Wakefield and his students is similar to the scientific inquiry process used by scientists in the field who often spend lots of time conducting research, and this is the image many of us have etched into our minds. Notice, however, that Mr. Wakefield engaged his students in literacy practices, and it's important to remember that scientists also engage in many practices that connect to literacy skills. For example, most scientists participate in extensive reading of research or topic-based content to build background knowledge in an area of study. Additionally, they communicate in writing in a wide array of ways, including through documented field notes, annotations of readings, formal experiment write-ups, journal article writing, and even blogging. They also participate in academic conversations centered on science topics within the assembly of various configurations, including one-to-one discussions, small- or large-group presentations and collaborations, and even as members of global committees with far-reaching goals. Scientists read, write, and talk about science using the language of science. It is critical for all of our young people to be empowered to engage in science-based conversations.

Science issues are local, national, and global in nature. Ocean acidification, the use of genetically modified foods, efficient public transportation, recycling of wastes, water usage—these and many other topics affect all citizens of the planet. Every person should have a chance to engage in conversations that connect to such topics. It is a right and an expectation. To know how to read, write, and talk about science means that you are enabled as an active participant in establishing and maintaining communities that are healthy, productive, and sustainable. By supporting science learning for all students, teachers can help to make this happen. Then all learners, from every neighborhood—urban to suburban to rural, from the wealthy to the impoverished community—can be empowered with an articulate, informed voice on a sweeping number of critical science and environmental issues. It is a goal worthy of every teacher's concerted effort and a direct aim of this book.