Powerful Practices Series

The POWER of Questioning

Guiding Student Investigations

Julie V. McGough and Lisa M. Nyberg

NSTA press
National Science Teachers Association

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NSTApress
National Science Teachers Association
Arlington, Virginia

Dedicated to all teachers
who inspire children
with minds full of wonder
to seek answers to
a lifetime of questions.

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Contents

Color Coding

Throughout *The Power of Questioning*, the text, illustrations, and graphics are color-coded to indicate the components of the instructional model.

Questioning is printed in **red**.

Investigations are printed in **blue**.

Assessments are printed in **purple**.

When thoughtful **questioning** is combined with engaging **investigations**, amazing **assessments** are produced—just as when **red** and **blue** are combined, **purple** is produced.

We've also provided links and QR codes to the NSTA Extras page where you can view videos related to content throughout the book. Visit *www.nsta.org/publications/press/extras/questioning.aspx* to view all supplementary content.

Learn from yesterday, live for today, hope for tomorrow.

The important thing is not to stop questioning.

Albert Einstein
(Relativity: The Special and the General Theory, 1920)

Why Does Skill in Questioning Engage Students in Purposeful Standards-Based Learning?

Students need opportunities to develop science literacy through solving problems and explaining phenomena and observations (NRC 2000). They also need to see purpose for what they are learning as they engage in literacy practices. Children ask questions and make connections to what is being learned in the classroom every day—on the playground, at home, walking to and from class, and when listening to stories and presentations. Sharing these connections through academic discourse helps students formulate new ideas and reconstruct old ones by adding new information from others' experiences.

Academic subjects are often regulated by national and state standards such as the *NGSS* and the *Common Core State Standards* (*CCSS*). These standards may lead teachers to engage children in higher-level thinking than they otherwise would through questioning, investigations, and authentic performance assessments. The standards build a bridge to connect real-world problem solving to the application of academic knowledge and skills. Additionally, the standards may guide teachers to engage children in complex cognitive processes so students may produce multidimensional work products illustrating higher-level thinking.

For example, during a study of the structure and function of plants, Cienna remembered her experience of noticing the tiny root hairs growing on a carrot while harvesting plants in the garden (photo on opposite page). She applied the information from the experience when building a model plant, deepening her understanding of the concept of how plant roots work. (Visit *www.nsta.org/publications/press/extras/files/practices/questioning/video2.htm* or scan the QR code on p. 18 to see a video.) Table 1.1 (p. 10) illustrates the *CCSS* and *NGSS* relevant to Cienna's discovery.

Table 1.1. Standards-Based Learning: Structure and Function of Plants
Examples of standards used during the study of the structure and function of plants.
DOK = Depth of Knowledge (see p. 22); ELA, English language arts.

National Standards	Standards-Based Learning
***NGSS*: Life Science** **LS1.A:** Structure and Function ***NGSS*: Engineering** **ETS1.2:** Developing and Using Models ***CCSS ELA*: Reading Informational Text** **RI.7:** Use illustrations and details in a text to describe and explain key ideas ***CCSS ELA*: Speaking and Listening** **SL.2:** Ask and answer questions about key details **SL.4:** Describe things with relevant details **CCR.4:** Present information, findings, and supporting evidence **SL.5:** Add visual displays to descriptions to clarify ideas	***NGSS*** Children learn that plants have internal (xylem, phloem, veins) and external (roots, stems, leaves, flowers, fruits) parts that help them survive and grow by investigating (e.g., planting seeds, placing a carrot top in water) and observing real plants over time (e.g., garden experiences) (DOK Levels 1 and 2). Children develop models to describe phenomena (DOK Level 3). ***CCSS ELA*** Children ask questions about the parts of the plant and how the parts work to help the plant grow. The children use informational text to explain the different internal and external plant parts. Students describe how plants work and present their information to others using the model plant as a visual display to clarify ideas.

What does a discussion reviewing the structure and function of plants with a model built by students sound like?

Scan the QR code or visit *www.nsta.org/publications/press/extras/files/practices/questioning/video1.htm* to listen to a discussion with different types of questions.

Connecting Questions and Learning: Structure and Function of Plants

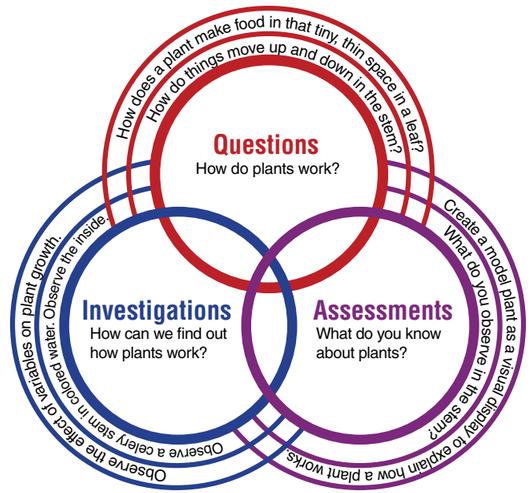
When exploring the concept of structure and function during a unit on plants, students make connections to their world by observing specific details of real seeds, roots, stems, and leaves at home, on the school campus, and in a school garden (McGough and Nyberg 2013b). Students conduct investigations such as examining and labeling the parts of a pumpkin in the fall, observing and comparing different kinds of seeds from the garden, observing a sunflower plant go to seed at the end of its life cycle, and planting seeds.

A variety of learning experiences involving plants give students context to engage in thinking and questioning throughout the unit of study (McGough and Nyberg 2013a). Reading informational text in addition to making firsthand observations stimulates even more questions. The teacher asks, "What questions do you have about plants and how they work?" This question causes students to reflect on what they have learned so far and then extend their thinking.

Using Unit Planning Guides

Student questions prompt further investigations, which advance the cycle of learning. As you design a unit, a planning guide can help you determine engaging questions, purposeful investigations, and authentic assessments to push the cycle forward. Students' extensive studies allow for crosscurricular connections. For example, after hands-on learning about plants, students might read informational text that describes and explains key ideas (English language arts standards) about how plants work (science content standards). Then, they could investigate how different variables affect plant growth (water, soil nutrients, and sunlight). Purposeful investigations help students build understanding of key concepts and might lead to an authentic performance task of building a model plant (science and engineering practices) to articulate how the structure of a plant helps a plant function (Figure 1.3).

Figure 1.3. Powerful Practices Model: Structure and Function of Plants
An example of the Powerful Practices model filled out during a unit on the structure and function of plants.



A comprehensive unit planning guide includes such crosscurricular possibilities (Figure 1.4, p. 14, illustrates a visual reference for crosscurricular connections) as well as content and academic vocabulary, resources, and differentiation strategies. An example of a complete unit planning guide for the unit on the structure and function of plants is shown in Figure 1.5 (pp. 15–17).

Figure 1.4. Brainstorming Crosscurricular Connections

Science: Investigate how seeds, roots, stems, and leaves work.

Technology: Produce and publish writing and collaborate with others through a classroom blog.

Engineering: Build a model plant to show how a plant works.

Math: Measure plants growing in the garden.

ELA: Record plant observations in a science journal including labeled drawings.

Social Science: Locate where foods are grown and transported to and from on the map.

Art: Observe leaf shapes and veins. Create a crayon resist of leaves.

Figure 1.5. Unit Planning Guide: Structure and Function of Plants

Unit Planning Guide

Core Idea/Topic: Structure and Function of Plants

Concepts: Plant parts, plant needs, photosynthesis

Timeline

Standards

NGSS

LS.A Structure and function of plants; LS.B Growth and development of organisms (plants); LS.C Organization for matter and energy flow in organisms (plants); LS.D Information processing; ETS1.2 Developing and using models

CCSS ELA

RI.1 Key ideas and details; RI.4, RI.5 Craft and structure; RI.7 Integration of knowledge and ideas; W.5, W.6 Production and distribution of writing; W.7, W.8 Research to build and present knowledge; SL.1, SL2, SL.3 Comprehension and collaboration; SL.4, SL.5, SL.6 Presentation of knowledge and ideas

Questions to Drive the Inquiry

1. What do you know about plants?
2. How do plants work?

Performance Assessment

1. Students will build a model plant using straws, tubes, lids, netting, bubble wrap, and other objects.
2. Students will present their model plant to the class and explain how a plant works.
3. Students will write a report or create a brochure that explains how plants make food, what plants are used for, and why plants are important.

Investigations

1. Observe how different variables affect plant growth (water, soil nutrients, sunlight).
2. Observe a celery stem in colored water.
3. Use straws to suck up water from a cup. Place a finger over the straw when it is in the water. Discuss.
4. Place a plastic bag over a leaf on a plant outside. Observe over time.

Student Questions

1. How does a plant make food in that tiny, thin space in the leaf?
2. How do things move up and down in the stem?
3. How does air go in and out?

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Page numbers printed in **boldface** *type refer to figures or tables.*

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The POWER of Questioning

Guiding Student Investigations

This pedagogical picture book invites you to nurture the potential for learning that comes from children's irrepressible urges to ask questions. Part of NSTA's *Powerful Practices* series for elementary educators, *The Power of Questioning* offers you

- **a solid foundation in both theory and practice.** The book's three-part instructional model is grounded in questioning, investigation, and assessment. Both you and your students will learn how to question effectively, making investigations more engaging.
- **an unusual opportunity to see a model brought to life.** The authors provide vivid pictures as well as links to special videos and audio recordings. You can actually hear teachers and students engage in questioning and watch two easy-to-adapt examples (involving plants and life cycles) of the model in action. Then, you can implement the new strategies right away in your own classroom.
- **standards- and STEM-friendly benefits.** The book also illustrates how to integrate state standards, the *Next Generation Science Standards*, the *Common Core State Standards*, and STEM education practices.

The Power of Questioning is a fresh, lively source of strategies both you and your students will enjoy. The authors are veteran educators who know how busy and demanding today's K–6 classroom is. This easy-to-use volume is proof that sometimes a powerful tool comes in a small package.

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GRADES K–6

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