Next Gen PET

Teaching and Learning

Activity 3: Questions, Problems, and Evidence (Practices 1 and 4)

Purpose

In this activity, we will look at two of the NGSS practices: Practice 1 (*asking questions* (for science) and *defining problems* (for engineering)) and Practice 4 (*analyzing and interpreting data*). Of the eight practices, Practice 1 is one of two that are written differently for science and engineering. The other is Practice 6, which we will discuss in a later lesson.

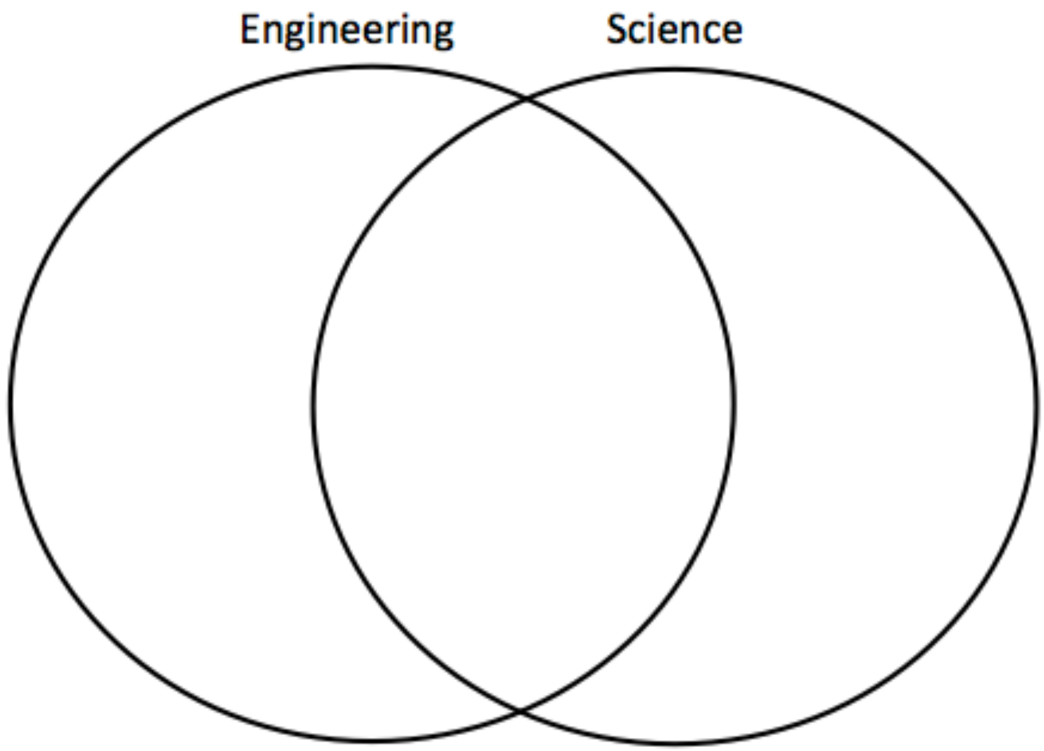
Prior to this lesson you should have read about NGSS Practices 1 and 4 and watched a short video called *Dealing with Data.*

What are scientific questions and engineering problems, and how do these relate to evidence?

Predictions, Observations and Making Sense

Part 1: How Do Engineering and Science Differ?

Think about what you know about the fields of *engineering* and *science.* How do you think these fields are similar and how do you think they are different? You may consider the science and engineering activities you have been doing in Next Gen PET. Represent your ideas in a Venn diagram or another type of representation.



Share your ideas with your group members.

Of the eight science and engineering practices in the NGSS, only two are written differently for the two disciplines. The first of these is Practice 1, *asking questions* (for science) and *defining problems* (for engineering).

Part 2: Asking Questions (for Science)

As described in NGSS Practice 1, children need to learn to ask testable questions. To think about the kinds of questions that *are* answerable in science, let's first think about some types of questions that are *not* answerable in science.

Think of some questions that you **cannot** answer through a scientific investigation. Write them here.

On your own, decide whether each of these questions is testable or not. If so, how could you test it? If not, why not? For some questions, you might decide that they are testable under some conditions (e.g., if you define a word in a specific way) and not others.

1) Is coffee hot?
   Testable **Not testable**
   Method for testing, reason not testable, or conditions under which it would be testable:

2) How much does a penny weigh?
   Testable **Not testable**
   Method for testing, reason not testable, or conditions under which it would be testable:

3) Is skydiving or surfing more fun?
   Testable **Not testable**
   Method for testing, reason not testable, or conditions under which it would be testable:

4) How long does it take for a golf ball to fall 1 meter?
   Testable **Not testable**
   Method for testing, reason not testable, or conditions under which it would be testable:

Participate in a whole class discussion about whether the questions above are testable or not testable.

Questions may be untestable for multiple reasons. When questions include opinions (e.g., is something fun, pretty, likable?), they may not be testable. Also when they have ambiguous or undefined terms, they are untestable without further defining the terms.

In the above list "Is coffee hot?" falls into this later category (as it is written) because "hot" is not defined. Even if we are considering a specific cup of freshly brewed coffee (as opposed to a cup that has been sitting around for a day) that we could measure the temperature of, we do not know what the threshold of "hot" is. The coffee is hot compared to an ice cube but cold when compared to the surface of the Sun. However, if the question was reworded or the criteria were defined earlier, this question would be testable.

Come up with a testable question about energy. [You may need to define one or more terms.]

Part 3: Designing Problems (for Engineering)

While science begins with questions about natural phenomena, engineering begins with a problem that needs to be solved or with a desire to improve something. Engineering problems related to energy include "How can we make more energy efficient light bulbs?" and "How can we create a solar powered cell phone charger?" However, once an engineering problem is defined, the problem often suggests scientific questions that need to be answered to proceed.

Helmets protect sports players from injuries. If you were tasked with the engineering design challenge of designing a helmet to protect a soccer player's head, what kind of testable scientific questions might you ask to help you design a better helmet? [Write down at least two examples of testable questions.]

Part 4: Collecting Data

Data include representations of information you can collect through your senses or tools that augment your senses. For example, things you can see through your eyes, through a telescope (which helps you see farther), or on a motion detector (which helps you see and record where things are at a specific time or record their speed). You may observe that as a soccer ball rolls across the grass, it slows down and comes to a stop. That observation may be represented by drawing a picture of where the ball starts and stops in relation to other landmarks like trees. Or it could be represented by measuring the distance travelled and writing down the final distance, or by using a motion detector to measure the ball's speed and graphing its speed against time or speed against position.

Think about all the different ways you have collected data so far in Next Gen PET. List a few examples.

Consider an experiment where students are testing how the temperature of a hot liquid changes over time when placed in different containers.

Using the grade level expectations for Practice 4 as a guide (reproduced on the next page for your reference), what kinds of questions might you ask children to help guide their collection of data around temperature?

Grades K-2 Expectations	Grades 3-5 Expectations
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Record information (observations, thoughts, and ideas). • Use and share pictures, drawings, and/or writings of observations. • Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. • Compare predictions (based on prior experiences) to what occurred (observable events). • Analyze data from tests of an object or tool to determine if it works as intended.	Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. • Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. • Analyze data to refine a problem statement or the design of a proposed object, tool, or process. • Use data to evaluate and refine design solutions.

Part 5: Analyzing and Interpreting Data

In this section we will discuss the video *Dealing with Data*. You should have watched this video at home. This video shows several examples of students working with data in engineering activities. In each case, something unexpected happened during the investigation that the teacher notices when collecting class data.

Using your notes on the video, discuss with your group the ways that data differed from what was expected to happen in each of the three scenarios: Lighting System, Bridges, and Parachutes.

Using your notes on the video, discuss with your group the ways that the teachers responded when unexpected data were collected in each of the three scenarios: Lighting System, Bridges, and Parachutes.

What are some things that children can learn about data when the collected data differ from what they expected?

Summarizing Questions

S1: How do you think science questions and engineering problems are similar and different?

S2. How can engineering design challenges lead to students analyzing and interpreting evidence?

References

Achieve (2012). *Next Generation Science Standards.* Available at http://www.nextgenscience.org