Next Gen PET

Teaching and Learning Extension F

Dealing with Data

Purpose

This activity includes four sections.

1. Video Analysis Guide. This includes instructions for how to access the video and questions to guide your observations.
2. Transcript of *Dealing with Data* video
3. Reading about NGSS Practice 1: Asking questions (for science) and defining problems (for engineering)
4. Reading about NGSS Practice 4: Analyzing and interpreting data.

In this activity, you will watch and analyze a short video. You will also read about 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.

You should take notes on the video guided by the provided questions and read the descriptions of NGSS Practices 1 and 4 prior to beginning Lesson 3 in class. Bring your notes and the descriptions of NGSS Practices 1 and 4 to class.

Video Analysis Guide: *Dealing with Data.*

Watch the 8-minute video 'Dealing with Data.' This video shows several examples of students working with data in engineering activities as part of the *Engineering is Elementary* curriculum. In each case, something unexpected happens during the investigation that the teacher notices when collecting class data.

The video can be found here: **Dealing with Data**

The transcript is provided at the end of this activity.

During the video, pay attention to how the teachers collects data from students and what the teacher does when he or she notices that the data does not look like he or she expects it to. Take notes on your observations and bring these to class.

Example 1: **Lighting System**

How did students' data differ from what their teachers expected?

How do teachers respond when data differ from what is expected?

Example 2: Bridges

How did students' data differ from what their teachers expected?

How do teachers respond when data differ from what is expected?

Example 3: Parachutes

How did students' data differ from what the student expected?

How do teachers respond when data differ from what is expected?

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

EiE Spotlight Video: Dealing with Data

This transcript is for a video that is part of the online resources for the Engineering is Elementary (EiE) curriculum. The video can be found online at:

https://youtu.be/GLDkw6MMdsg

[00:12.13] Narrator: Students collect data and conduct experiments as part of every inquiry based curriculum including EiE. As educators, we know the importance of engaging students in hands-on experiments. But when elementary students collect data, all sorts of things can happen. When your students produce data that's different, what do you do? Let's take a look at an example from a real classroom.

Example 1: Lighting System

[00:36.07] Narrator: The engineering challenge for these students is to design a lighting system for a model of an ancient Egyptian tomb. They've already done some experiments including shining a flashlight into a box and scoring the light intensity at different locations. Now, their teaching is collecting results.

[00:54.12]Teacher: So I just want to collect some data from you. Make a fist for zero. If your score is 1, give me one finger, 2 for two fingers, 3 for three fingers, 4 for four. Alright

[01:06.15] (kids raise hands indicating scores)

[01:06.29] Teacher: Michael's a three, Brian's two, Iana's three, Olivia's 1.

[01:11.15] Teacher: we can tell that we've got some varying results.

[01:16.01] Narrator: Jessica expected her students to have consistent results, but these numbers are all over the map. Usually, when there's this much variation in the data, it's because it's because students used inconsistent testing methods, or because they didn't understand the scoring system. In this case, that turns out to be what happened. Jessica later learned that one of her students had misinterpreted the scale to measure the light's intensity.

[01:39.10] Teacher: After the sharing at the carpet, the speaking member of that group, she came up to me and she said, "I really think I did something wrong with these scores" so I went over with her - so I said, so really you flipped that scale. Every time you should have had a four, you gave yourself a zero. And every time you should have had a three, you gave yourself a one. And so she said, "oh well that makes a ton more sense.

[02:05.27] Narrator: One strategy you can use to help children accurately collect and score data is to run through an example with them.

Example 2: Bridges

[02:12.06] Narrator: Let's now take a look at a 2nd grade classroom where the teacher is collecting data after his students have built and tested three different types of bridges. Beam bridges, arch bridges, and deep beam bridges. The test involves seeing how many weights each type of bridge could support. Even though Steve thought he had accurately modeled the testing procedure, students' are getting varying results.

[02:35.27] Teacher: take out from your green folder your data sheets please, take out the ones that have all the bridge information on it. Which was the bridge that held the least amount of weight?

[02:48.21] Teacher: Uh, Jayda?

[02:49.09] Jayda: The beam.

[02:50.17] Teacher: How much weight did it support?

[02:53.02] Jayda: Eight

[02:53.02] Teacher: Eight

[02:53.19] Student: The beam bridge.

[02:58.12] Teacher: With how much weight?

[02:58.23] Teacher: three

[03:04.27] Student: arch bridge with four

[03:06.08] Teacher: Oh you guys got something completely different. Wow.

[03:08.26] Narrator: As students shared their results, Steve can't hide his surprise. But he doesn't attempt to explain the discrepancies. Instead he asks his students to come up with explanations. One student realizes that how the weights were placed on their bridge may have affected their results.

[03:26.13] Student: that's kind of confusing because wouldn't it be the same thing if everyone

[03:35.02] Student: maybe they threw it.

[03:37.07] Teacher: Alright, friends, let's talk.

[03:40.13] Student: John was telling me why they have beam bridge and we have the other bridge. He said maybe they were throwing the weights in.

[03:54.11] Teacher: So you're thinking maybe you guys threw in your weights.

[03:54.11] Student: We did.

[03:55.27] Teacher: Ooohhh.

[03:57.01] Student: Well, at first, and then you told us. Then Louise told us to drop them in lightly so we had to do it all over again.

[04:03.29] Teacher: So you redid your experiment again, so this ended up being when you placed -

[04:08.08] Student: Well, we did redo that one. We did all the others

[04:12.19] Teacher: Wow! wow wow wow. That is a huge realization. They just admitted - which is fine - thank for admitting - I love honesty - that they redid the other experiments using light weight. But they forgot to go back to the arch bridge and gently place it. Is their data off? Did they do something different for one bridge than the rest of the bridges? So, can we use their data?

[04:45.01] Teacher: No. Cause it's not treated equally. That's a hard lesson to learn, isn't it?

[04:52.28] Narrator: In this case, a data discrepancy allowed for a fabulous teaching moment. The unexpected result allowed Steve to guide his students to think about what might have caused their discrepant results and come up with possible explanations. This provides an authentic opportunity to think about variables and build their understanding of what constitutes a fair test.

Example 3: Parachutes

[05:13.29]Narrator: In this next clip, students are designing a parachute to land a payload on another planet. The goal is for the parachute to fall slowly. Students drop their parachutes down a stairwell three times and calculated their average drop speed. The students in this class have already done several EiE units and have experience analyzing data in both engineering and math. As Jean collects the data from the groups, she pushes her students to think about their classmates' data and identify trends.

[05:44.15]Teacher: Average drop speed

[05:49.01] Student: 2.7

[05:50.06] Teacher: two point seven. What was your canopy diameter?

[05:54.02]Student: 14

[05:56.24] Teacher: 14 inches, and your suspension line length? 21.

[06:03.19] Teacher: Alright, I want you to look at this. Can everybody see the data? Alright, look at it for one minute. And I want you talk about it with your team, is there any connection or correlation between these two things and this? Nora?

[06:16.24] Nora: I noticed that the people have shorter suspension lines and a bigger canopies had lower average drop speed.

[06:29.01] Narrator: As the discussion wraps up, Jean gets the opportunity to drive home another important lesson about data. One student notices a discrepancy in the data that he doesn't understand. Two parachutes had identical canopy sizes and identical suspension line lengths, but they dropped at slightly different rates.

[06:46.02] Teacher: Yes?

[06:46.02] Students: How does number four and number eight have the same thing, but they have different numbers

[06:53.28] Teacher: Four and eight have the same what? Same this?

[06:57.17] Student: yeah

[06:58.21] Teacher: okay and different drops. Nathan makes a good point. You would think it would be the same. How would we get data to be really really close to what we think?

[07:08.18] Student: Do it over and over

[07:09.18] Teacher: Over and over and over and over. Test and test and test

[07:12.16] Narrator: Nathan naturally assumes that when all of the variables are held constant, the experiment should get the same results every time. This gives Jean the opportunity to point out one of the realities of scientific research - results can vary. For accurate results, you need to do many iterations of the same experiments. The more opportunities your students get to conduct hands on experiments, the more they'll come to understand why controlling variables and multiple trials are so important. As an engineering educator, you should feel confident that no matter how the results turn out, rich discussions will emerge when your students collect their own data.

Practice 1: Asking questions (for science) and defining problems (for engineering).

Asking questions (for science)

"Students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations. For engineering, they should ask questions to define the problem to be solved and to elicit ideas that lead to the constraints and specifications for its solution." (NRC Framework 2012, p. 56)

From almost the time they learn to talk, children begin asking questions. Many of these are questions about their world: Why is the sky blue? Why do the ants walk in a line? How do birds fly? As children progress through elementary school, these questions become more sophisticated.

Below are the grade level expectations for elementary school students from the Next Generation Science Standards.

Designing Problems (for Engineering)

While science begins with questions about natural phenomena, engineering begins with a problem that needs to be solved or 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.

Grades K-2 Expectations	Grades 3-5 Expectations
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested. • Ask questions based on observations to find more information about the natural and/or designed world(s).	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. • Ask questions about what would happen if a variable is changed. • Identify scientific (testable) and non-scientific (non-testable) questions. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause

• Ask and/or identify questions that can be answered by an investigation. • Define a simple problem that can be solved through the development of a new or improved object or tool	and effect relationships. • Use prior knowledge to describe problems that can be solved. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Practice 4: Analyzing and interpreting data

Once collected, data must be presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others. Because raw data as such have little meaning, a major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence.

Engineers, too, make decisions based on evidence that a given design will work; they rarely rely on trial and error. Engineers often analyze a design by creating a model or prototype and collecting extensive data on how it performs, including under extreme conditions. Analysis of this kind of data not only informs design decisions and enables the prediction or assessment of performance but also helps define or clarify problems, determine economic feasibility, evaluate alternatives, and investigate failures. (NRC Framework, 2012, p. 61-62)

To think about analyzing and interpreting data, it is important to first think about what *data* means.

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, or through a telescope (which helps you see farther) or a motion detector (which helps you see and record where things are at a specific time or 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 the speed against time or the speed against position.

The NGSS describes what young children should be able to do with data.

Grades K-2 Expectations	**Grades 3-5 Expectations**
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing	Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting

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.	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.