Engineering Practices in Action

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Engineering is Elementary
Museum of Science, Boston
Session Goals

• Overview of Engineering is Elementary curriculum.
• Make sense of the NGSS Engineering Performance Practices.
• Identify the NGSS Engineering Performance Practices while engaging in an engineering activity and observing classroom video.
• Develop a list of lesson characteristics that encourage students to engage in the engineering performance practices addressed by the NGSS.
What is Engineering is Elementary?

Engineering is Elementary is a

• research-based,
• standards-driven,
• classroom-tested

curriculum that integrates engineering and technology concepts and skills with elementary science topics.

Developed for use with grades 1-5.
EiE Unit Structure

Prep Lesson: Technology in a Bag

Lesson 1: Engineering Story

Lesson 2: A Broader View of an Engineering Field

Lesson 3: Scientific Data Inform Engineering Design

Lesson 4: Engineering Design Challenge
The Engineering Design Process

The Goal
To solve a problem by developing or improving a technology.

Criteria
Constraints
Science knowledge

Brainstorming
No evaluation

Ask
Imagine
Plan
Create
Improve

and test
NGSS Engineering Performance Practices:
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 and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating and Communicating Information
With your neighbor, please discuss:

What do you think your practice mean?

Why is it important?
To Get to the Other Side:
Civil Engineering:
Designing Bridges
Goals of the Storybook

- Introduces the field of engineering: civil engineering
- Sets the context for the design challenge
- Supports science vocabulary
- Makes science content related to balance & forces relevant through a practical application: the design challenge
- Inspires students to do the design challenge as they connect with Javier and his family
- Provides jumping-off points for integration across content areas: ELA, social studies
- Introduces the Engineering Design Process
Lesson 2: Pushes and Pulls

Guiding Question:
What are some of the forces that act on structures and how do civil engineers design structures that can withstand these forces?
Observing the Effects of Forces on a One-Story & Tower Structure

<table>
<thead>
<tr>
<th>Structure</th>
<th>Action: What is the push or pull on the structure?</th>
<th>Effect: How does the structure change after the push or pull?</th>
<th>Problem</th>
<th>Civil Engineering Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Story Structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tower Structure</td>
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</tr>
</tbody>
</table>
Lesson 3: Bridging Understanding

Goal:

Work as civil engineers to design a bridge to span a river.

The Engineering Design Process
Questions about design challenge:
Lesson 3: Bridging Understanding

Guiding Question:
How does the structure of a bridge affect its strength and how can we use different materials in our bridge designs?
Lesson 3: Bridging Understanding

Guiding Question:

How does the structure of a bridge affect its strength and how can we use different materials in our bridge designs?
Types of Bridges

What examples do you know? How are they similar? Different?
Bridge Type Models

Beam Bridge

Deep Beam Bridge

Arch Bridge
Testing Procedure

Strength test:
1. Build an arch bridge and mark the abutment locations on handout {3-1}.
2. Build model bridge using four index cards.
3. Place cup in the center of the span.
4. GENTLY add weights to cup, until bridge fails.
5. Record results on appropriate handout {3-8}.

Testing to failure:
• Failure = when the bridge collapses
• Deep beam bridge = when span is compressed
Comparing Bridge Designs

Directions: Compare the three types of bridges that you tested.

- How many weights did each bridge type support?
- Explain what happened to each bridge when you placed the weights on top of it.

<table>
<thead>
<tr>
<th>Bridge Type</th>
<th>How many weights did it support?</th>
<th>What happened when it failed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam</td>
<td></td>
<td></td>
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<tr>
<td>Deep Beam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arch</td>
<td></td>
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</tbody>
</table>
Sharing Our Data

For each of your bridge types:

Place the bridge symbol above the number line to indicate how many weights that bridge model supported.
Testing Procedure

Strength test:
1. Build an arch bridge and mark the abutment locations on handout {3-1}.
2. Build model bridge using four index cards.
3. Place cup in the center of the span.
4. GENTLY add weights to cup, until bridge fails.
5. Record results on appropriate handout {3-8}.

Testing to failure:
• Failure = when the bridge collapses
• Deep beam bridge = when span is compressed
Looking at Our Line Plot...

- Which type of bridge is the strongest? How do you know?
- Which type of bridge is the weakest? How do you know?
- How do the class’ results compare to your group’s results?
- Did all groups get the same results?
Analyzing the Line Plot

• What additional questions do you have after observing the line plot data?

• Why do you think beam bridges exist if they are typically found to be the weakest?
Lesson 3: Bridging Understanding

Guiding Question:
How does the structure of a bridge affect its strength and how can we use different materials in our bridge designs?
## Materials for Bridge Designs

<table>
<thead>
<tr>
<th>Material</th>
<th>Properties</th>
<th>How could you change the shape of the material?</th>
<th>How could you use it in a bridge design?</th>
</tr>
</thead>
<tbody>
<tr>
<td>cellophane tape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>index card</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>copy paper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>craft stick</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>paper clip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>drinking straw</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>string</td>
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</table>
Lesson 4:
Designing a Bridge

Guiding Question:
How can we use our knowledge of materials and their properties, different bridge types, and the Engineering Design Process to design a strong, stable bridge?
Imagine

Designing a Bridge
Engineering Design Process: Imagine!

Directions: Brainstorm some different bridge designs. Write or draw pictures of your ideas in the boxes below. Circle the idea you think will work the best.

<table>
<thead>
<tr>
<th>Idea #1</th>
<th>Idea #2</th>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Idea #3</th>
<th>Idea #4</th>
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The Engineering Design Process

- Ask
- Plan
- Create
- Improve
- Imagine
Designing a Bridge / Grade 2 / Derry, NH

To Get to the Other Side

LESSON 4

Designing Bridges
As you watch the video...

• Think about your experience and record your evidence from the video on your handout about:
  – How were students engaging in the engineering practices in the classroom?
  – What evidence did you observe in students engaging in the engineering practices?
Watch the EDP in action during Lesson 4

Meet Mr. Steve Lebel and his 2nd grade class from Derry, NH
Debrief / Share Out:

• How were students engaging in the engineering practices in the classroom?

• What evidence did you observe in students engaging in the engineering practices?
Contact Info:

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<table>
<thead>
<tr>
<th>Engineering Practice</th>
<th>Was the practice met during activity?</th>
<th>Describe what you did to help meet this practice.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking questions and defining problems</td>
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