Developing Little Engineers! Engineering Design in the K-5 Classroom

Robots that mimic cockroaches, working pinball machines, and more! Engineering Design in elementary classrooms can come alive when teachers focus on the Science and Engineering Practices with lesson design. In this active session, teachers engage in lessons that merge K-5 engineering with the Michigan Science Standards Disciplinary Core Ideas. This exciting session will inspire educators with hands-on activities, digital tools, active reading, dynamic discussion, and reflection on their own teaching practices. Teachers will leave armed with the ability to integrate phenomena-based science instruction around real-world problem solving into their classrooms.

ResourceFolder: https://jmp.sh/NvWQn1C

Objectives

- Support teachers with a deeper understanding of the Science and Engineering Practices.
- Engage teachers with phenomena-based instruction, model units and lessons.
- Provide teachers with usable free resources.

Amplify Connection
Engineering

Engineering design involves a combination of applying science principles in order to design functional solutions and iteratively testing those solutions to determine how well they meet the design criteria set by users or stakeholders. Design units make developing these solutions the central focus.

Students construct an understanding of science ideas from investigation and text and apply those science ideas in designing solutions to an engineering problem. Students then test and/or evaluate their solutions to see how well they meet a set of design criteria. As students move up the elementary grades, they focus on important aspects of engineering practice in an intentional sequence.

Each Amplify Science unit that is focused on design also focuses on a specific aspect of the practice of engineering design, called a focal practice, and supports students in learning about and using that practice. For example, in the third grade Environments and Survival unit, the focal practice is using ideas to plan designs. Specifically, students draw on ideas they have learned about organisms’ traits to inspire designs that solve a problem. The Environments and Survival unit focuses students on iteratively planning, designing, and testing a solution to a problem.

All engineering design units are motivated by an engineering task that has particular criteria for success, where students will:

- Develop and articulate science ideas relevant to intentional construction and/or testing of a solution.
- Construct or revise (prototype) solutions at multiple points during the unit.
- Evaluate solutions in relation to criteria for how well it/they meet them.

Background

The new Michigan K-12 Science Standards, based upon the Next Generation Science Standards, replace the standards adopted in 2006, commonly known as the Grade Level Content Expectations and High School Content Expectations for Science. The new standards are really a set of student performance expectations. These performance expectations incorporate three main elements:

- Disciplinary Core Ideas (science specific concepts in the life, earth, and physical sciences),
- Science and Engineering Practices (the practices of engaging in scientific investigation to answer questions, and engineering design to solve problems),
- Cross-Cutting Concepts (conceptual ideas common to all areas of science).

These expectations are also interwoven across disciplines, including connections to language arts and mathematics.

The adoption of new standards provides a tremendous opportunity in Michigan not only to improve science learning, but also to improve literacy and thinking skills of all children.
1 Scientific and Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
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 (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

2 Crosscutting Concepts
1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change
3 Disciplinary Core Ideas

Physical Sciences
PS1: Matter and its interactions
PS2: Motion and stability: Forces and interactions
PS3: Energy
PS4: Waves and their applications in technologies for information transfer

Life Sciences
LS1: From molecules to organisms: Structures and processes
LS2: Ecosystems: Interactions, energy, and dynamics
LS3: Heredity: Inheritance and variation of traits
LS4: Biological evolution: Unity and diversity

Earth and Space Sciences
ESS1: Earth’s place in the universe
ESS2: Earth’s systems
ESS3: Earth and human activity

Engineering, Technology, and Applications of Science
ETS1: Engineering design
ETS2: Links among engineering, technology, science, and society
To get started, go to: learning.amplify.com

Click on the Log in with Amplify button

Teacher account: t.MSTA2020@tryamplify.net
Master password: AmplifyNumber1

Student account: s1.MSTA2020@tryamplify.net
Master password: AmplifyNumber1

After you log in, you will be taken to the Amplify Curriculum.

Choose which grade level units you would like to access by clicking on the orange chevron and making your selection.
Box Model Diagram:
Drawing the Launcher (continued)
Box Model Diagram:
Drawing the Ball Moving a Short Distance (continued)

long

short
Box Model Diagram: Drawing the Ball Moving to Targets (continued)
Box Model Diagram: 
Drawing a Bumper (continued)
Box Model Diagram:
Drawing Flippers (continued)
Reading About Gravity: Two Objects?

What evidence did you find in the book that helps you answer this question: Does the force of gravity act between two objects?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Make a drawing if it helps you explain the evidence you found.
Reading About Gravity: My Purpose for Reading

Directions:
1. With your partner, choose a purpose for reading and record it below.
2. As you read, use sticky notes to mark evidence in the book that helps you with your reading purpose.

Reading purpose: _______________________________________________________
________________________________________________________________________
________________________________________________________________________

What did you find out about your reading purpose?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Make a drawing if it helps you explain the evidence you found.
Different Forces in a Chain Reaction

Directions:
1. Work with your partner to make a chain reaction.
2. Include at least one touching force, one magnetic force, and one example of the force of gravity.
3. Draw a diagram of your chain reaction.

4. Fill out the table for three of the forces in your chain reaction.

<table>
<thead>
<tr>
<th>Object 1</th>
<th>Object 2</th>
<th>Evidence of a force</th>
<th>Type of force (circle one)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Touching force</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Magnetic force</td>
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<td></td>
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<td>Gravity</td>
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<td></td>
<td></td>
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<td></td>
<td>Magnetic force</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Gravity</td>
</tr>
</tbody>
</table>

Balancing Forces—Lesson 3.3

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Chapter 3: Word Relationships

Directions:
1. Work with your partner to create sentences that use at least two of the Word Relationships Cards in each sentence.
2. Create some sentences that explain how gravity and magnetic force are the same or different.
3. Record several of the sentences you created.

1. __________________________________________

2. __________________________________________

3. __________________________________________

4. __________________________________________

Make a drawing if it helps you explain your thinking. Label your drawing.
Floating Paper Clip

Directions:
1. Draw a diagram to show how you made the paper clip float on the end of the string.
2. Under the diagram, record one force exerted on the paper clip and then record the two objects that the force is exerted between.
3. Record a second force exerted on the paper clip and then record the two objects the force is exerted between.

Diagram:

First force:
_____________________________ is one force acting on the paper clip.
What two objects is this force acting between?
_____________________________ and ________________________________

Second force:
_____________________________ is another force acting on the paper clip.
What two objects is this force acting between?
_____________________________ and ________________________________
Chapter 4: Word Relationships

Directions:
1. Work with your partner to create sentences that use at least two of the Word Relationships Cards in each sentence.
2. Create some sentences that are about balanced forces.
3. Record several of the sentences you created.

1. ____________________________________________
   ____________________________________________

2. ____________________________________________
   ____________________________________________

3. ____________________________________________
   ____________________________________________

4. ____________________________________________
   ____________________________________________

Make a drawing if it helps you explain your thinking. Label your drawing.
Diagramming Balanced and Unbalanced Forces

Directions:
1. On each diagram, draw arrows to represent the direction of the force or forces acting on the paper clip.
2. Label each arrow with the name of the force.
3. At the top of each box, label each diagram either balanced forces or unbalanced forces.
Planning an Investigation

Directions:
1. With your partner, plan what you will do to investigate how far the paper clip can be from the magnet before the forces become unbalanced in the Floating Paper Clip Device.
2. Answer the questions below.

How far do you think the paper clip can be from the magnet before the forces become unbalanced?

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

Draw a diagram that shows how you will do your investigation.

Describe what you will do for each test.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________
Planning an Investigation (continued)

What will you observe, measure and record? Add a label for what you will measure to your diagram.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

What will you keep the same each time you run a test? Add labels to your diagram.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

How many tests will you run? Why?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
Results of the Investigation

Record your observations and measurements:

How far can the paper clip be from the magnet before the forces become unbalanced? Use the results of your investigation to support your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
Science and engineering practices are the practices that scientists and engineers use when investigating real world phenomena and designing solutions to problems. There are eight science and engineering practices that apply to all grade levels and content areas.

1. Read the scientific and engineering practices.
2. Use the chart to indicate your perception about how you promote these practices in your classroom.
3. Discuss these practices with your table partners/group.
4. At the bottom of the page reflect on your own practice with the guided questions.

<table>
<thead>
<tr>
<th>Scientific and Engineering Practices</th>
<th>Degree for Fostering the Practice in my Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking questions (for science) and defining problems (for engineering)</td>
<td>Never</td>
</tr>
<tr>
<td>Developing and using models</td>
<td></td>
</tr>
<tr>
<td>Planning and carrying out investigations</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Reflection**

What can I do to increase the fostering of these practices? Which SEPs could I address more easily as a starting point? Which ones will be challenging for me and I could use more support?