Title: Unpack 3-Dimensional Standards with Phenomenal Science Instruction

Description:
Teachers will learn how phenomena-based science instruction designed around real-world problem solving can incorporate all aspects of the Michigan Science Standards. Teachers will unravel the Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts in how they relate to science curriculum design. This session will engage educators with hands-on activities, digital tools, active reading and dynamic discussion with the purpose to design instruction with 3-Dimensional Statements.

Objectives:
- Support Michigan science teachers with a deeper understanding of 3-Dimensional instruction.
- Provide teachers with the knowledge and practice to meet the expectations of the new standards.
- Engage teachers with phenomena-based instruction with example model units, lessons and activities.
- Provide teachers from all grade levels (K-8) with resources they can take back and use in their classrooms.

Amplify Connection:
Unit focus from Balancing Forces Grade 3
Teachers will engage with hands-on use of magnets, use investigation notebook pages and digital tools.
Teachers will leave with some print resources as well as digital demo accounts.

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.
Amplify Science
Demo Account Access Quick Start Guide

Go to: https://go.info.amplify.com/amplify-science-review

1. Enter the details and click SUBMIT

2. Scroll down the page to click on Preview the Curriculum

3. Click on TEACHER

4. Check I AM NOT A ROBOT and click CONTINUE
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
## Unit Map

**Balancing Forces: Investigating Floating Trains (Grade 3)**

### How is it possible for a train to float?

Students are challenged to figure out how a floating train works in order to explain it to the citizens of Faraday. People in Faraday are excited to hear that a new train service will be built for their city, but concerned when they hear that it will be a floating train. Students develop models of how the train rises, floats, and then falls back to the track, and then write an explanation of how the train works.

### Students figure out:

<table>
<thead>
<tr>
<th>Why does the train rise?</th>
<th>How they figure it out:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A train is a big object. Objects can move when they are pushed or pulled on by a second object. When the train rises, it does so because of a non-touching force: magnetic force. The train rises because the force acts between magnets on the tracks and magnets on the train.</td>
<td>Students plan and carry out hands-on investigations and explore text as they seek explanations for why the train rises. As they figure out what they think causes the train to rise, students create both physical models and diagram models that represent the forces at work. They write their first scientific explanation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Why does the train fall?</th>
<th>How they figure it out:</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the train falls, it does so because a force is acting on it. Since a second object is not pushing or pulling the train, there must be a non-touching force at work. The train falls because of the force of gravity. We know that forces always act between two objects. The force of gravity is acting between the train and Earth. Earth attracts the train, and the train moves toward it.</td>
<td>Students figure out what they think causes the train to fall. They observe chain reactions caused by touching forces and non-touching forces: magnetic force and gravity. They observe that each instance of magnetic force and touching force are between two objects. They analyze which movements are caused by gravity: Students apply what they learned about gravity to make a physical model of the train falling, create diagrams that model what happens when the train falls, and write scientific explanations for why the train falls.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Why does the train float?</th>
<th>How they figure it out:</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than one force can be exerted on the train at a time. The force of gravity is pulling the train toward Earth, and magnetic force is pushing the train up away from the tracks. Those forces work in opposite directions so when the forces are balanced, the train floats and stays in the air.</td>
<td>Students investigate what happens when two forces act on an object at the same time. Students discover that magnetic force can be used to counterbalance gravity. They go on to create physical models and diagrams, then write scientific explanations to describe how the train works. Students apply what they learned about maglev trains to explaining how a hoverboard works.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Why does the train rise, then float, and then fall?</th>
<th>How they figure it out:</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the track’s electromagnet is turned off, magnetic force is no longer exerted and the forces are no longer balanced. When gravity is the only acting force, the train falls.</td>
<td>Students synthesize all they have learned to explain the forces that move the train to the citizens of Faraday. They create physical models as evidence of how the train could work and then create diagram models to show the role that forces play. Finally, they write scientific explanations to answer the question Why does the train rise, then float, and then fall? At the end of the unit, students read a book about a bridge engineer whose job includes communicating about the safety of bridges to the public. Students apply their understanding of balanced and unbalanced forces as they think about bridges that work and bridges that fail.</td>
</tr>
</tbody>
</table>
Correlations to NGSS and CCSS
Balancing Forces:
Investigating Floating Trains (Grade 3)

Next Generation Science Standards

<table>
<thead>
<tr>
<th>Performance Expectations:</th>
<th>3-PS2-1; 3-PS2-2; 3-PS2-3; 3-PS2-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science and Engineering Practices:</td>
<td>Practice 1; 2; 3; 4; 5; 6; 8</td>
</tr>
<tr>
<td>Disciplinary Core Ideas:</td>
<td>PS2.A; PS2.B</td>
</tr>
<tr>
<td>Crosscutting Concepts:</td>
<td>Stability and Change; Cause and Effect; Patterns</td>
</tr>
</tbody>
</table>

Common Core State Standards for English Language Arts

<table>
<thead>
<tr>
<th>Reading Informational Text:</th>
<th>CCSS.ELA-LITERACY.RI.3.1; 3.4; 3.5; 3.7; 3.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing:</td>
<td>CCSS.ELA-LITERACY.W.3.2; 3.4; 3.10</td>
</tr>
<tr>
<td>Speaking and Listening:</td>
<td>CCSS.ELA-LITERACY.SL.3.1; 3.6</td>
</tr>
<tr>
<td>Language:</td>
<td>CCSS.ELA-LITERACY.L.3.6</td>
</tr>
</tbody>
</table>

Common Core State Standards for Mathematics

<table>
<thead>
<tr>
<th>Practices:</th>
<th>CCSS.MATH.PRACTICE.MP1; 2; 4; 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content:</td>
<td>CCSS.MATH.CONTENT.3.MD.2; 3.MD.3</td>
</tr>
</tbody>
</table>
3-D Statements

Balancing Forces (Grade 3)

Crosscutting Concepts
Practices
Disciplinary Core Ideas

Unit Level

Students obtain and evaluate evidence from firsthand investigations and text related to balanced and unbalanced non-touching forces to construct an explanation of how a train can float in the air as one example illustrating the idea of stability and change. (stability and change, cause and effect, patterns)

Chapter Level

Chapter 1: Why does the train rise?
Students analyze data to determine what magnets attract and apply what they learn to construct an explanation of why the train floats. (stability and change, cause and effect, patterns)

Chapter 2: Why does the train fall?
Students make observations of the force of gravity and apply what they learn to explain why the train falls. (stability and change, cause and effect, patterns)

Chapter 3: Why does the train float?
Students investigate how two forces can act on an object at the same time and apply what they learn to explain why the train floats. (stability and change, cause and effect, patterns)

Chapter 4: Why does the train rise, then float, then fall?
Students create physical models and diagrams as evidence of how the floating train may work and use what they learn to explain why the train rises, then floats, then falls. (stability and change, cause and effect, patterns)
Moving Magnets

Directions:
1. See if you can make a magnet start moving without anything touching it.
2. Draw a picture of two ways that you made a magnet move. Include an arrow in each drawing to show the direction the magnet started moving.
Evidence of Non-Touching Forces

Directions:
1. Answer the question below and then record your evidence.
2. Use the words in the Word Bank when you record your evidence.

Can a force make an object start to move without anything touching the object? ________________

<table>
<thead>
<tr>
<th>Word Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>force</td>
</tr>
<tr>
<td>touching force</td>
</tr>
<tr>
<td>flipped</td>
</tr>
</tbody>
</table>

What is your evidence? ____________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
**Predict and Test: What Do Magnets Attract?**

**Directions:**
1. For each row, predict whether the magnet (Object 1) will attract Object 2. Record your predictions in the fourth column.
2. Once you receive your magnet, test your predictions. Record your test results in the last column.
3. Continue this process as you complete the table on the next page.

<table>
<thead>
<tr>
<th>Object 1</th>
<th>Object 2</th>
<th>Is Object 2 metal?</th>
<th>Prediction: Do you think the magnet will attract or not attract this object?</th>
<th>Test: Did the magnet attract or not attract this object?</th>
</tr>
</thead>
<tbody>
<tr>
<td>magnet</td>
<td>wood</td>
<td>no</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>washer</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>penny</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>paper clip</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>fastener 1</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>fastener 2</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Predict and Test: What Do Magnets Attract? (continued)

<table>
<thead>
<tr>
<th>Object 1</th>
<th>Object 2</th>
<th>Is Object 2 metal?</th>
<th>Prediction: Do you think the magnet will attract or not attract this object?</th>
<th>Test: Did the magnet attract or not attract this object?</th>
</tr>
</thead>
<tbody>
<tr>
<td>magnet</td>
<td>foil</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>twist tie</td>
<td>partly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>plastic spoon</td>
<td>no</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>steel spoon</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>balloon</td>
<td>no</td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td>steel wool</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Floating Paper Clip

Directions:
1. Draw the paper clip, string, and magnets to complete the device.
2. Under the diagram, record one force acting on the paper clip and then record the two objects that the force is acting between.
3. Record a second force acting on the paper clip and then record the two objects the force is acting between.

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 ________________________________
# Multiple Meaning Words

**Directions:**
Some words can mean more than one thing. For each word in the chart:
1. Read the sentence from the book *Handbook of Forces* that uses the word.
2. Read the two meanings the word can have.
3. Decide which meaning the word has in the sentence from the book and circle that meaning in the table.

<table>
<thead>
<tr>
<th>Word</th>
<th>Sentence from the book</th>
<th>Meaning 1</th>
<th>Meaning 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>multiple</td>
<td>The movement of the ball up and then down is evidence of <em>multiple</em> forces.</td>
<td>more than one</td>
<td>a number that can be made by multiplying a smaller number (for example, 6 is a multiple of 2)</td>
</tr>
<tr>
<td>acting</td>
<td>The multiple forces <em>acting</em> on an object can have different strengths.</td>
<td>exerted</td>
<td>pretending to be someone else for a movie or play</td>
</tr>
<tr>
<td>wind</td>
<td>When you fly a kite, the <em>wind</em> pushes on the kite while you pull it with the string.</td>
<td>to wrap around something</td>
<td>moving air</td>
</tr>
</tbody>
</table>
Daily Written Reflection

Scientists pay close attention to when things change and when they are stable. If a scientist was looking at the Floating Paper Clip Device, when would she say things are stable? When would she say things are changing?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Make a drawing if it helps you explain your thinking. Label your drawing.
Writing a Scientific Explanation About the Floating Paper Clip

Directions:
1. Write a scientific explanation to answer the question below.
2. Use words from the Word Bank when you are writing.

<table>
<thead>
<tr>
<th>Word Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>attract</td>
</tr>
<tr>
<td>repel</td>
</tr>
</tbody>
</table>

Why does the paper clip float?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
Daily Written Reflection

What do you think would happen if you placed a paper clip in the middle of two magnets—one very strong magnet and one very weak magnet? Explain your thinking.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

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.
## Data Table: Forces on an Object

Directions:
1. Review the data in the table below and discuss it with your partner.
2. Analyze the data by talking about the patterns you notice.
3. You can use the sentence starters on the board to help you analyze the data.

<table>
<thead>
<tr>
<th><strong>Object</strong></th>
<th><strong>Force 1</strong></th>
<th><strong>Force 2</strong></th>
<th><strong>Balanced or unbalanced?</strong></th>
<th><strong>Does the object start moving?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>paper clip</td>
<td>gravity (downward)</td>
<td>magnetic force (upward)</td>
<td>balanced</td>
<td>no</td>
</tr>
<tr>
<td>paper clip</td>
<td>gravity (downward)</td>
<td>none</td>
<td>unbalanced</td>
<td>yes (downward)</td>
</tr>
<tr>
<td>rope in tug-of-war game</td>
<td>touching force (pulling left stronger)</td>
<td>touching force (pulling right weaker)</td>
<td>unbalanced</td>
<td>yes (to the left)</td>
</tr>
<tr>
<td>kite on a string</td>
<td>wind (upward)</td>
<td>touching force of string (downward)</td>
<td>balanced</td>
<td>no</td>
</tr>
<tr>
<td>book held in hand</td>
<td>gravity (downward)</td>
<td>touching force (upward)</td>
<td>balanced</td>
<td>no</td>
</tr>
<tr>
<td>ball magnet</td>
<td>magnetic force (from a ring magnet)</td>
<td>none</td>
<td>unbalanced</td>
<td>yes (toward the ring magnet)</td>
</tr>
</tbody>
</table>
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>
</tr>
<tr>
<td>Analyzing and interpreting data</td>
<td></td>
</tr>
<tr>
<td>Using mathematics and computational thinking</td>
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</tr>
<tr>
<td>Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
</tr>
<tr>
<td>Engaging in argument from evidence</td>
<td></td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information</td>
<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?