Engaging Students in Science Phenomena

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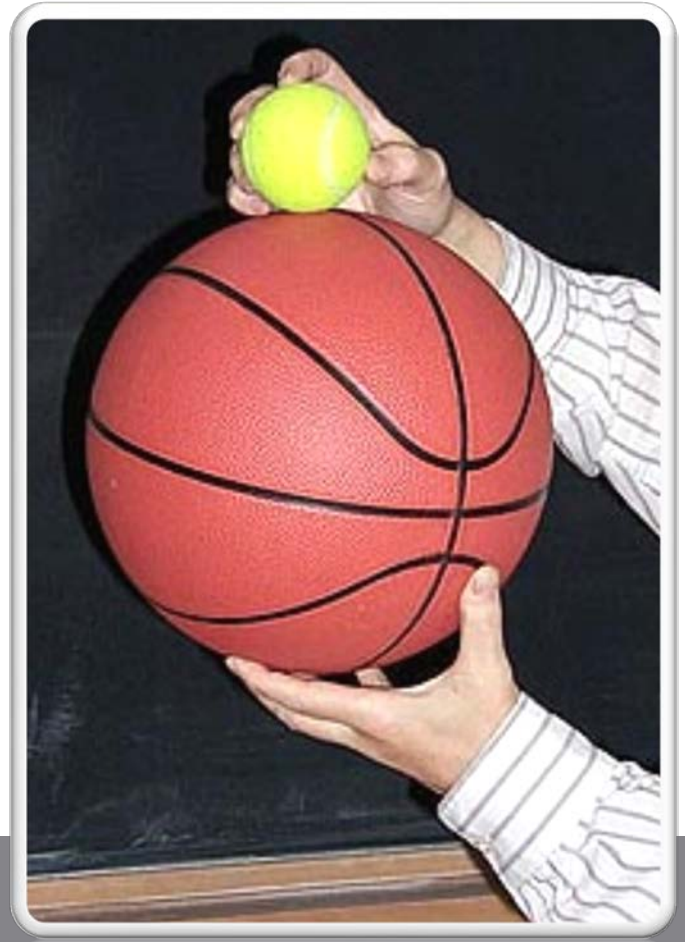
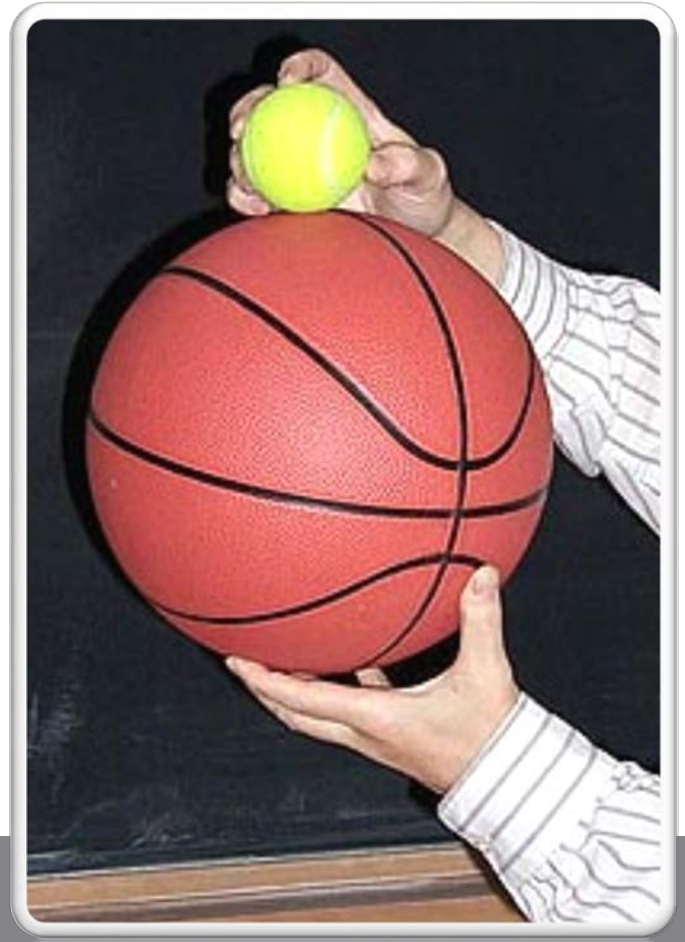


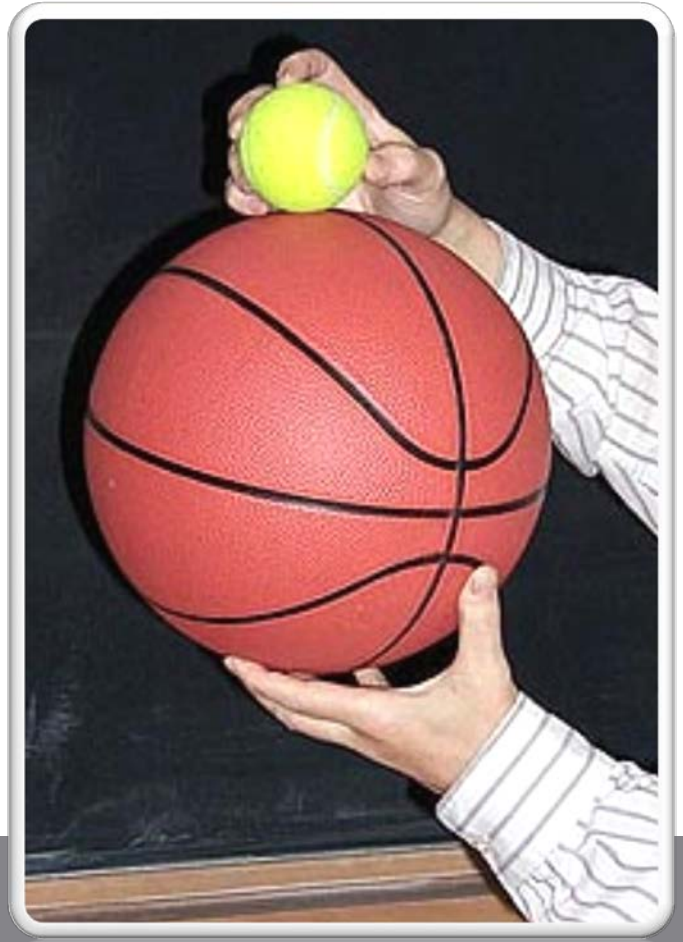
Individual Performance:

- What **patterns** do you **observe** when the tennis ball and basketball are dropped together?
- **Develop a model** (sketch/drawing) that showcases your **observations** of **the system**. Document **anything going into the system** or **going out of the system.**
- **Use the model** (sketch/drawing) to **explain** what is **causing** the **observations** you make about the tennis ball and basketball dropped together



Group Performance:

- **Share your observations** and **explanations** with someone sitting next to you.
- **Use your drawing** to aid you with your **explanation**.



Individual Performance:

- Take a moment to **write a brief explanation** for what **caused** the **observations you made** when the tennis ball and basketball were dropped together. **Use your model** and **any information gained** from your **partner discussion** to **construct your explanation**.
  - If you use a science term in your explanation, explain it in simple terms connected to the observations you made when seeing the tennis ball and basketball dropped together.

Please read the text and answer the following question:

1. What is marfolamine?
2. Where was marfolamine discovered?
3. How is marfolamine chemovated?
4. Why is marfolamine important to us?

Marfolamine is a gadabolic cupertance essential for our jamination. Marfolamine was discovered in a zackadago. It was chemovated from zackadago by ligitixing the pogites and then bollyswaggering it. Marfolamine will eventually micronate our gladivones so that we can homitote our tonsipows more demicly.

Move from teaching about discrete science ideas to exploring, examining, and using science ideas to explain **HOW** and **WHY** the phenomena around us occur.

From….

Curriculum Topics	Explaining Phenomenon
• Ecosystems • Waves • Chemical reactions • Volcanoes • Cells	• Liquid on the outside of a cool glass • The moon looks different tonight than it did last night • A plunger sticks to a surface • A streams winding path looks different over time

What patterns do you notice? What causes these patterns to be different?

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Collection of Responses

- “I think the patterns are different because the directionality of the erosion was different. I base this on the fact that I have seen patterns of erosion in streams be different based on the direction the water is flowing. I'm not sure if the cause of the erosion was different or the same with these two structures.”

- “I think it might have to do with the original orientation of the structures. Maybe at the time of erosion they were oriented the same way and they've shifted throughout geologic time. I'd guess because they are showing different orientations they are not the same age.”

- “this looks more like sedimentary layering rather than fracturing. if that is the case, the vertical walls were created through land movement/mountain building”

Collection of Responses

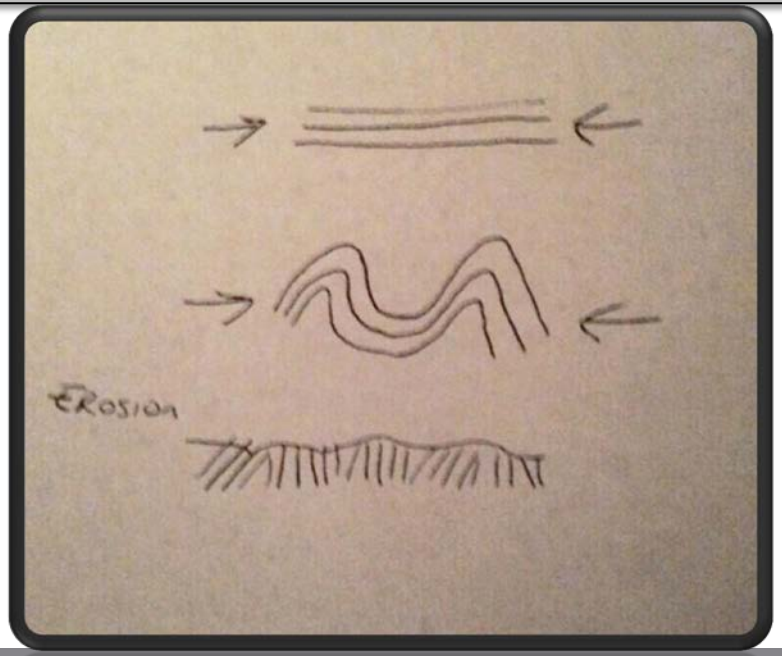
- “I would think that each rock encountered different types of shifting. I think the top picture underwent more uplifting than the bottom picture. Just my amateur conclusion.”

- “I think they were all formed in layering and at some later time the ground shifted forcing some of them upwards. I should add here that I have had exactly 0 hours in earth science since 8th grade.”

- “The Arbuckle Mountains also have similar vertical layers. I always heard (old cowboy tales) that an earthquake caused the tops to buckle or fall over creating the vertical layers. I wonder if that could be the case here?”

Collection of Responses

- “I had to consult with a geologist friend. This is what I got back when I asked why the "fractures" were going different directions. He said "they are bedding planes that have been folded. Now add a river or something and you get the upset layers exposed."



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MS-ESS2-1 Earth's Systems

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **Developing and using models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.** • **Develop and use a model to describe phenomena.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Earth's Materials and Systems:** • All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.	**MS-ESS2-1** *Students who demonstrate understanding can:* **Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.** **Clarification Statement:** Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials. **Assessment Boundary:** Assessment does not include the identification and naming of minerals.

Crosscutting Concepts: Stability and Change

• Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.

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MS-ESS2-2 Earth's Systems

Science & 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) Constructing explanations and designing solutions in 6– 8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.**
   - **Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.**
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Earth's Materials and Systems:
- The planet's systems interact over scales that range from microscopic to global in size. These interactions have shaped Earth's history and will determine its future.

The Roles of Water in Earth's Surface Processes:
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

Performance Expectations

MS-ESS2-2

Students who demonstrate understanding can:

Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Clarification Statement:
Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of a large mountain ranges) or small (such as rapid landslides on microscopic geochemical reactions), and how many geoscience processes usually behave gradually but are punctuated by catastrophic events (such as earthquakes, volcanoes, and meteor impacts). Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.

Crosscutting Concepts: Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

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Dimension 1: Science 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

Dimension 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

Dimension 3: Disciplinary Core Ideas

Physical Science
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 Science
LS1: From Molecules to Organisms: Structures and Processes
LS2: Ecosystems: Interactions, Energy, and Dynamics
LS3: Heredity: Inheritance and Variation of Traits
LS4: Biological Unity and Diversity

Earth and Space Sciences
ESS1: Earth's Place in the Universe
ESS2: Earth's Systems
ESS3: Earth and Human Activity

Consider how (mechanism) this happens.

Practices

- Asking Questions
- Constructing Explanations Supported by Evidence
- Developing Arguments Supported by Evidence

Crosscutting Concepts

- Systems
- Matter and Energy
- Cause and Effect

Disciplinary Core Ideas

- Matter is made of particles
- Energy transfers
- Energy is involved when matter changes
- Matter cycles and flow of energy among living and nonliving parts of an ecosystem.

Perhaps the thinking may follow a path such as:

- ✓ Ask Questions: *How does the breath change the appearance? Where did the fog-like vapor come from? Why does it not appear on hot days? Where else does this phenomena happen? Would any warm air make fog?*
- ✓ *Develop data using investigations (e.g., observe at various temperatures, breath into a bag and then release air into a refrigerator, breathe on a cold water bottle on a warm day, release cold air on a hot day.)*
- ✓ Develop relationships between matter and energy in a system from Core Ideas.
- ✓ Construct explanations and models supported by evidence (e.g., *heat energy transfers from high to low, matter is conserved, matter changes state, water appears as droplets in the cold air, organisms give off water vapor.)*
- ✓ Communicate explanations using models and arguments.

Implementation Timeline

Summer 2014
OAS-Science
Adopted

2014-2015
Assessments
aligned to
PASS

2015-2016
Assessments
aligned to
PASS

2016-2017
Assessments
aligned to the **new**
OAS-Science

Suggested Criteria for a Phenomenon

- Must hook student interest
- Be rich enough to study over a number of lessons
- Be written as a question that students will work to answer over the course of the unit
- Be introduced to students through an anchoring activity (i.e., a video, photos, demonstration, first hand experience, reading, ect.)

Selecting a Phenomenon to Anchor Units

- **Determine Key Concepts:** *Standards Documents (Disciplinary Core Ideas)*
- **Brainstorm Topics** – *What real world topics, issues, and events come to mind when you hear the key concepts you identified?*
- **Research** – *Conduct internet searches entering key concepts/terms and topics to build your background knowledge and to help you identify possible puzzling phenomenon.*

Selecting a Phenomenon to Anchor Units

- **Cross Reference phenomenon with the following criteria:**
  - *Do students have experience with the phenomenon?*
  - *Will students be interested in the phenomenon?*
  - *Does the explanation of the phenomenon encompass a rich set of science concepts aligned with your selected Disciplinary Core Idea concepts?*
- **Write the phenomenon as a question** – *Try to narrow it to a specific scenario.*
- **Write an underlying explanation for how and why the phenomenon occurs** – *Consider which science ideas are crucial for students to learn and which are secondary.*

Instructional Sequence for Engaging Students with Phenomenon

Gathering	**Gather information** through **asking questions and defining problems** about the **cause and effect relationships** of phenomena in a **system**. **Planning and carrying investigations that include**: *reading, listening, planning and carrying out investigations, using models to gather data and information, using mathematical and computational thinking to organize data.*
Reasoning	**Construct explanations** for the **cause and effect relationship** of phenomenon **using observations**, **core ideas**, **models**, and crosscutting concepts to develop **evidence** that **supports an explanation**. **Analyze and evaluate data** and **information** to establish the best **evidence to support an argument** for a specific **explanation**.
Communicating	**Communicate information** and **use evidence to support arguments**. **Utilize models** to **communicate explanations**.

-Molding, Bybee & Paulson (2015)

Group Performance

1. Make Prediction about how the *system* of two balloons connected by a tube will *change* when the valve is opened.
2. **Ask questions** to gather information to **develop an investigation** of the *system.*
3. Formulate questions and investigate **explanations** for what causes *changes in the system*.
4. Develop **evidence** and **use Core Ideas** to support **explanations** for the *change in the system*.

Individual Performance

5. Write in your journal or on your device your individual **explanation** that may be used to explain this phenomena to others. Use a **model to communicate** the **explanations**. Include **evidence** to support your **explanation** for the *changes in the system.*

Group Discussion

Reflection

6. Reflect on the nature of science instruction that leads students to use the practices to: a) Gather information through **Exploring phenomena,** b) develop **explanations** based on **evidence,** and c) communicate using **models and writing**.
7. Reflect on the **Core Ideas** that were needed to make sense of the phenomenon.

Gather	• Obtain Information • Ask Questions/Define Problems • Plan & Carry Out Investigations • ***Use Models to Gather Data*** • Use Mathematics & Computational Thinking
Reason	• Evaluate Information • Analyze Data • Use Mathematics and Computational Thinking • Construct Explanations/Solve Problems • Developing Arguments from Evidence • ***Use Models to Predict & Develop Evidence***
Communicate	• Communicate Information • Argue from Evidence (written & oral) • ***Use Models to Communicate***

Grade Level Phenomenon Brainstorming

Questions