Revisiting Phenomena

National Science Teachers Association

*Adapted Presentation

Model for Planning

Phenomena

What was the event(s) in the world that happened that we need to explain?

Question

What about the phenomena do we need to explain?

Science and Engineering Practices

How are we modeling, explaining, etc. the phenomena, or designing a solution to solve the problem?

New Ideas

What did we figure out using these practices?

What pieces of the DCIs or CCCs did we figure out?

What new ideas do we have?

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"Learning About" or "Figuring Out"

- **Explanatory ideas** are important so students can figure out phenomena and not just learn about facts and details. (*we discovered these from unpacking the DCIs*)

- **Science and engineering practices** build explanatory ideas.

Central Role of Phenomena

- Phenomena spark questions.
- A sequence of investigations is required to figure out part of the story.
- An investigation often leads to further questions about phenomena, so each lesson builds on the previous one and enhances students' explanations in a stepwise manner.

Types of Phenomena

- Phenomena can be used to introduce a unit or individual lessons:
  - You can use an **anchoring phenomenon** as the overall *focus for a unit*. But these are complex phenomena that require an understanding of multiple disciplinary core ideas to develop explanations.
  - You also use **lesson-level or investigative phenomena** along the way as the *focus of an instructional sequence or lesson*.

Anchor Phenomena – What are they?

(1 of 2)

Anchor phenomena are puzzling, meaningful phenomena that anchor a unit.

What criteria can we use for anchor phenomena?

- They hook student interest and are comprehensible to them.
- They require a number of lessons to study since they are complex (rich in science content).
- They are observable—an event or a process.
- The best are cases of specific events in specific contexts.
- They are introduced to students through an anchoring activity (e.g., a video, demo, firsthand experience, or reading).
- They can be written as a driving question that students will work to answer over the course of the unit.

Anchor Phenomena – What are they?
(2of 2)

- Talk briefly with a shoulder partner and discuss the criteria for anchor phenomena.
- How can these criteria make a phenomenon an effective focus for a unit of study?

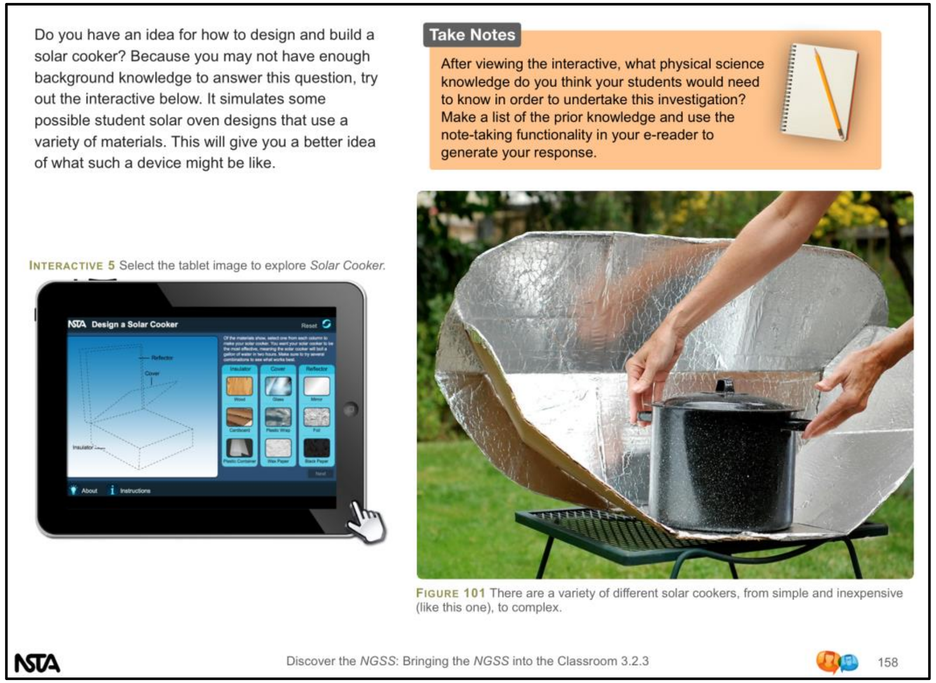
Anchor Phenomena Raise Explanatory Questions (1 of 4)

From *A Private Universe: Minds of Our Own*

- Anchor Phenomenon: A grown tree has tremendous mass compared to the seed from which it came.
- Explanatory Question: Where did the mass come from? How could that happen?

Anchor Phenomena Raise Explanatory Questions (2 of 4)

- Anchor Phenomenon: People in many parts of the world do not have access to safe water.
- Explanatory Question: How can our understanding of energy transfer be used to address the global water sanitation crisis?


Do you have an idea for how to design and build a solar cooker? Because you may not have enough background knowledge to answer this question, try out the interactive below. It simulates some possible student solar oven designs that use a variety of materials. This will give you a better idea of what such a device might be like.

Take Notes

After viewing the interactive, what physical science knowledge do you think your students would need to know in order to undertake this investigation? Make a list of the prior knowledge and use the note-taking functionality in your e-reader to generate your response.

INTERACTIVE 5 Select the tablet image to explore *Solar Cooker.*

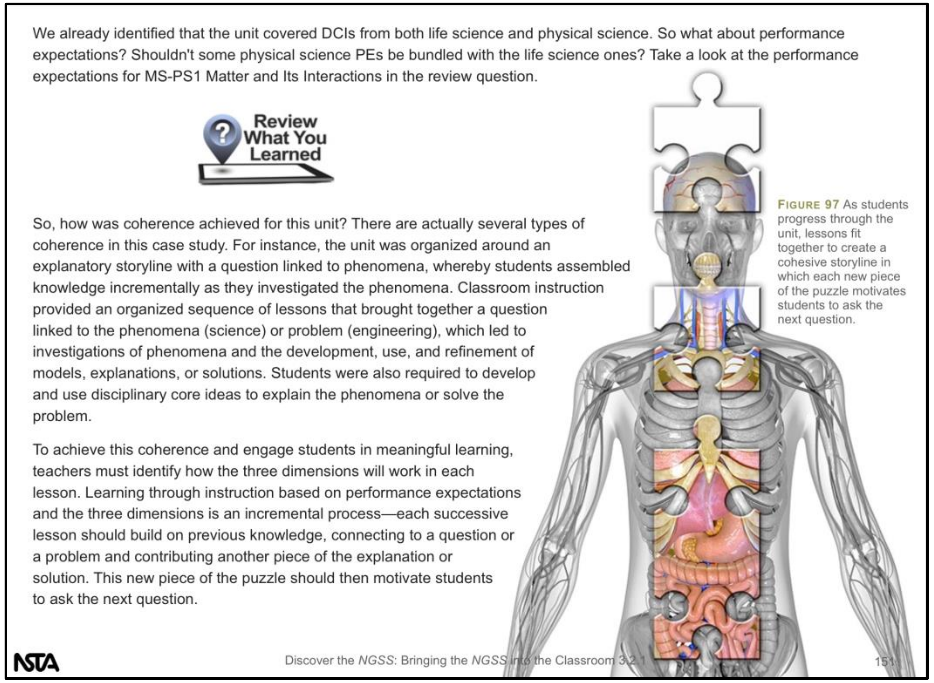
FIGURE 101 There are a variety of different solar cookers, from simple and inexpensive (like this one), to complex.

Anchor Phenomena Raise Explanatory Questions (3 of 4)

- Anchor Phenomenon: "Football Player Dies from Drinking too Much Water/Gatorade," Associated Press, August 2014
- Explanatory Question: If water is necessary for survival, how can such an essential substance kill us?

Anchor Phenomena Raise Explanatory Questions (4 of 4)

- Anchor Phenomenon: Our bodies do important work—such as obtaining energy, growing, and responding to the environment.
- Explanatory Question: What is going on inside our bodies that helps us do the things we do?


We already identified that the unit covered DCIs from both life science and physical science. So what about performance expectations? Shouldn't some physical science PEs be bundled with the life science ones? Take a look at the performance expectations for MS-PS1 Matter and Its Interactions in the review question.

So, how was coherence achieved for this unit? There are actually several types of coherence in this case study. For instance, the unit was organized around an explanatory storyline with a question linked to phenomena, whereby students assembled knowledge incrementally as they investigated the phenomena. Classroom instruction provided an organized sequence of lessons that brought together a question linked to the phenomena (science) or problem (engineering), which led to investigations of phenomena and the development, use, and refinement of models, explanations, or solutions. Students were also required to develop and use disciplinary core ideas to explain the phenomena or solve the problem.

To achieve this coherence and engage students in meaningful learning, teachers must identify how the three dimensions will work in each lesson. Learning through instruction based on performance expectations and the three dimensions is an incremental process—each successive lesson should build on previous knowledge, connecting to a question or a problem and contributing another piece of the explanation or solution. This new piece of the puzzle should then motivate students to ask the next question.

FIGURE 97 As students progress through the unit, lessons fit together to create a cohesive storyline in which each new piece of the puzzle motivates students to ask the next question.

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Criteria for Phenomena

The phenomenon …

1. Addresses the targeted DCI element
2. Is observable to students, either through firsthand experiences or through someone else’s experiences (such as a recording or set of measurements).
3. Is likely comprehensible to students. For example:
    - The relationship to the DCI element is clear and easy to comprehend.
    - Any experimental procedure, calculations, and measurements are unlikely to detract from the learning experience.
    - Additional ideas and reasoning skills needed by students are appropriate (given students' grade level and prior experiences).
4. Is attention-getting and thought-provoking, and requires some explanation so that it is likely to engage **all** students and motivate them to focus on the DCI element.
5. Is efficient in that the benefits justify any financial costs and time devoted to using the phenomenon with students.

How Do We Know if a Phenomenon Is Appropriate for Use?

- Use the criteria for evaluating phenomena to help you decide what phenomena might work well.

Criteria for Evaluating Phenomena*

NGSS@NSTA STEM STARTS HERE

A phenomenon is any event, circumstance, or experience that can be observed by one's senses.

According to the *Framework for K-12 Science Education* and the *Next Generation Science Standards* (*NGSS*), teachers should expose students to phenomena and guide them to engage in Science and Engineering Practices in order to explain those phenomena.

By carefully selecting phenomena to share with students, teachers can guide them toward the scientific understanding of the world as described by the elements of the Disciplinary Core Ideas (DCIs) in the *Framework* and *NGSS*.

But some phenomena are much more effective than others at helping all students learn, so it is essential to consider many factors when selecting phenomena. The criteria below are meant as a guide in evaluating the usefulness of phenomena for classroom instruction.

Before beginning, identify the DCI Element you wish to target with the phenomena, and then ask the following questions.

1. The phenomenon…
   - ❑ addresses **the entire** DCI Element (*continue to next step*)
   - ❑ addresses **only part** of the DCI Element (*only continue to next step if the phenomena addresses the parts of the DCI Element you wish to address*)
   - ❑ **does not** address the DCI Element (*end of evaluation, do not use this phenomenon, seek a different phenomenon*)
2. The phenomenon is observable to students, either through firsthand experiences or through someone else's experiences (such as a recording or set of measurements.)
   - ❑ Yes (*continue to next step*)
   - ❑ No (*end of evaluation, do not use this phenomenon, seek a different phenomenon*)
3. The phenomenon is likely comprehensible to students.
   For example:
   - The relationship to the DCI Element is clear and easy to comprehend.
   - Any experimental procedure, calculations, and measurements are unlikely to detract from the lesson.
   - Additional ideas and reasoning skills needed by students are appropriate (given students' grade level and prior experiences).
   - ❑ Yes (*continue to next step*)
   - ❑ No (*end of evaluation, do not use this phenomenon, seek a different phenomenon*)
4. The phenomenon is attention getting, thought provoking and requires some explanation so that it is likely to engage **all** students and motivate them to focus on the DCI Element.
   - ❑ Yes (*continue to next step*)
   - ❑ No (*end of evaluation, do not use this phenomenon, seek a different phenomenon*)
5. Use of the phenomenon is efficient in that the benefits justify any financial costs and/or time devoted to using the phenomenon with students.
   - ❑ Yes (*evaluation completed, the phenomenon is promising*)
   - ❑ No (*end of evaluation, do not use this phenomena, seek a different phenomenon*)

* Based in part on the *Project 2061 Curriculum Analysis Procedure*

Let’s Evaluate Some Examples

Example 1

DCI Element: The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

Possible Phenomenon: Using paper chromatography separates the various pigments of a leaf into different bands.

Example 2

DCI Element: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.

Possible phenomenon: Biobottles that contain a balance of biotic and abiotic factors can self-sustain.

Developing a Coherent Storyline: Planning Lessons and Units

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Developing a Coherent Explanatory Storyline (1 of 2)

- As we start our work we'll use the example of *seed to log*:
  - Anchor Phenomenon: A grown tree has tremendous mass compared to the seed from which it came.
  - Explanatory Question: Where did the mass come from? How could that happen?

Developing a Coherent Explanatory Storyline (2 of 2)

Anchor Phenomenon: *A grown tree has tremendous mass compared to the seed from which it came.*

Explanatory Question(s): *Where did the mass come from? How could that happen?*

Lesson	Phenomena	Lesson-Level Question	Activities and Concepts	Practices That Students Engage In	What We Figured Out and What Questions We Have	Student Products and How We Know What They Know
1						
2						
3						

Our Process

- We identified and sequenced DCI elements that aligned well with the phenomenon.
    - We can use this information to complete the first three cells.
        - We can identify an element of a practice to engage students in the learning.

Lesson	Phenomena	Lesson-Level Question	Activities and Concepts	Practices That Students Engage In	What We Figured Out and What Questions We Have	Student Products and How We Know What They Know
1					Determine what aspects of the DCI and CCC elements students would learn and what questions they might still have.	Determine how we would know what students know.

Example
After Unpacking a DCI Element

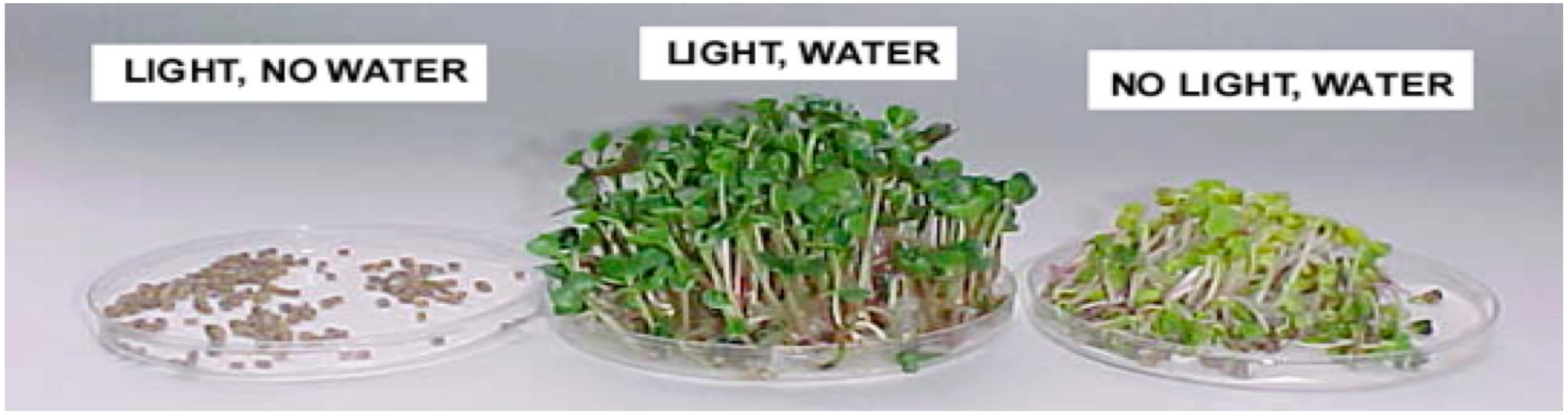
Anchor Phenomenon: *A grown tree has tremendous mass compared to the seed from which it came.*

Explanatory Question(s): *Where did the mass come from and how did that happen?*

Lesson	Phenomena	Lesson-Level Question	Activities and Concepts	Practices That Students Engage In	What We Figured Out and What Questions We Have	Student Products and How We Know What They Know
1	A seed changes into a grown plant.	Where does the plant's mass come from?	Radish seed mass activity Increase in mass, water requirement for plant growth			
2						
3						

Radish Seed Activity

1.5 g of seeds were placed on moist paper towels under the following conditions for one week. The final biomass (dried in the oven overnight so no water is left) measured in grams as follows. Explain the results.



1.46 g   1.63 g   1.20 g

Ebert-May (2003)