

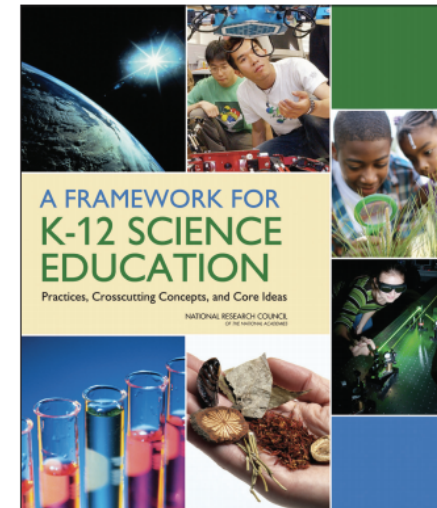
# *Unpacking Science Practices: Explanation and Modeling*

**NSTA Professional  
Development Institute**

**Wednesday, March 11, 2015**

# What we will do...

- Explore the meaning of “science and engineering practice” in the Framework for K-12 Science Education and NGSS
- Learn how to *unpack* practices as an essential step for developing assessment tasks
- Deep dive into 2 practices – scientific modeling and scientific explanation
- Discuss the important aspects of these 2 practices for assessing science proficiency



# Science and Engineering Practices

## ***What are science and engineering practices?***

**The multiple ways of knowing and doing that scientists and engineers use to study the natural world and design world  
(NRC, 2012)**

- An integral piece of science proficiency – NGSS emphasizes using and applying knowledge in the context of disciplinary practice
- Essential for deepening students' conceptual understanding of content as well as their understanding of how to do science and engineering

## ***What does this mean for assessment?***

- Focus on students *doing* the practices – using and applying core ideas and crosscutting concepts in the context of...

# Science and Engineering Practices

... the eight practices considered essential for all students:

1. Asking questions and defining problems

2. Developing and using models

3. Planning and carrying out investigations and designing solutions

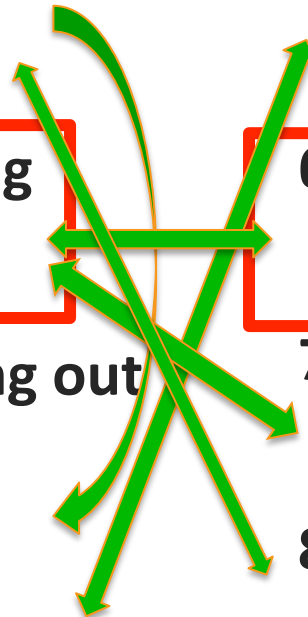
4. Analyzing and interpreting data

5. Using mathematics and computational thinking

6. Constructing explanations and designing solutions

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information



*The practices work together – they are not separated!*

# Why Unpack Science Practices?

## **The unpacking process enables you to:**

- Understand what it really means to “do” the practice
- Identify the essential components of the practice
- Pinpoint the knowledge and skills students need to use in order to show that they can perform the practice
- Describe levels of performance for the practice that can be used to develop rubrics

## **This process is of high value because it:**

- Promotes consistency in your use of practices within items/tasks
- Ensures sustain the essential aspects of the practice across science disciplinary areas

# Our Process for Unpacking Practices

## 1. Describe the practice and its components

- *What does it mean to “do” the practice?*
- *What are the essential components of this practice?*
- *What possible intersection might there be with other practices?*

## 2. Identify the requisite knowledge and skills

- *What knowledge and skills do students need to use in order to show that they can perform the practice?*

## 3. Specify features of a high level of performance

- *What evidence would you expect to see for each component?*
- *What are the different levels of performance for each component?*

**Resources we use:** *NRC Framework, NGSS Appendix F, NSTA publications on science practices, research literature (e.g., NRC reports)*

# Activity: Unpacking Science Practices

## Your task:

- ① in pairs or trios – select a practice (*modeling or explanation*) to “unpack”
- ② Read through the reference documents to begin the process
- ③ Use *Unpacking Science Practices Worksheet* to record your unpacking

## Materials you will need:

- Unpacking Science Practices Worksheet
- NGSS Appendix F Excerpts
- NSTA Article on Science Practices: Modeling
- NSTA Article on Science Practices: Explanation

# Pause and Reflect

**What did you find easy, hard, interesting, or perplexing about unpacking a practice?**

**What did you learn about the practice itself?**

**What value do you see – for your own assessment work – in unpacking the practices?**



# Constructing Explanations

## *Describe the practice and its components*

### **Scientific Explanation:**

A written or oral response to a question about how or why a phenomena occurs that is supported by evidence.

### **Components of the Practice:**

A scientific explanation has 3 essential parts –

- **Claim:** a testable statement or conclusion that typically answers the question
- **Evidence:** scientific data that supports the claim; consisting of appropriate and sufficient evidence
- **Reasoning:** a justification that shows why the data count as evidence to support the claim and includes appropriate scientific ideas/principles

# Constructing Explanations (cont'd)

## *Intersection with other practices*

- Results of **data analysis** and output from **models** can be used as evidence for explanations
- **Investigations** may inform the construction of explanations
- **Scientific arguments** critique or defend the strength/validity of explanations

# Constructing Explanations (cont'd)

## ***Knowledge and skills needed by middle school students to perform the practice***

- Ability to state an answer to a question
- Ability to identify valid evidence from multiple sources
- Ability to apply scientific reasoning to show how or why the evidence supports the claim

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## ***Features of a high level of performance***

- Make an accurate and complete claim
- Provide appropriate and sufficient evidence to support claim
- Provide reasoning that links evidence to claim; includes appropriate science ideas/principles

# 3-D Assessment Task Example

Maria found four different bottles filled with unknown pure liquids. She measured the properties of each liquid. The measurements are displayed in the data table below. Maria wonders if any of the liquids are the same substance.

Liquid	Density	Color	Volume	Boiling Point
1	1.0 g/cm <sup>3</sup>	Clear	6.1 cm <sup>3</sup>	100 C°
2	0.89 g/cm <sup>3</sup>	Clear	6.1 cm <sup>3</sup>	211 C°
3	0.92 g/cm <sup>3</sup>	Clear	10.2 cm <sup>3</sup>	298 C°
4	0.89 g/cm <sup>3</sup>	Clear	10.2 cm <sup>3</sup>	211 C°

**Use the data in the table to:**

- 1) Write a claim stating whether any of the liquids are the same substance.
- 2) Provide at least two pieces of evidence to support your claim.
- 3) Provide reason(s) that justify why the evidence supports your claim.

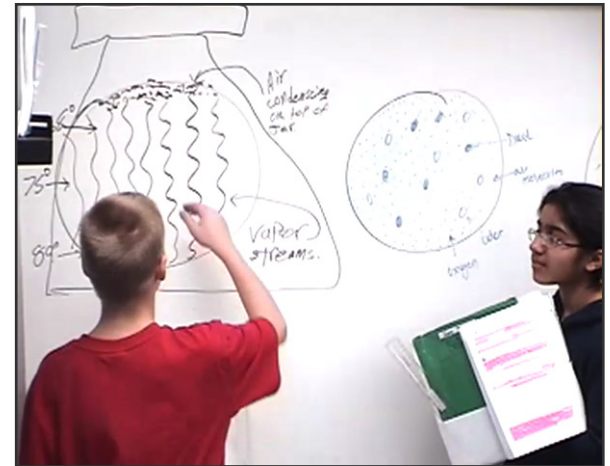
## High level of Performance:

- **Claim** states that Liquid 2 and 4 are the same substance.
- **Evidence** includes at least 2 pieces of evidence (*density, boiling point, or color of Liquid 2 and 4 are the same*).
- **Reasoning:** same substance must have the same set of characteristic properties.

# Developing and Using Models

## *Describe the practice and its components*

A deliberate representation of a phenomenon or system of phenomena that makes its central features explicit and visible. Models can be used to represent, explain, and make predictions about phenomena. They include diagrams, physical replicas, mathematical representations, analogies, and simulations.



## *Intersection with other practices:*

- Models can be used as evidence for **explanations** and **arguments**
- **Scientific arguments** critique or defend the quality or appropriateness of models
- Models can be developed based on results of **data analysis**
- **Investigations** may inform the development of models or involve the use of models

# Developing and Using Models (cont'd)

## Components of the Practice:

- **Model Elements:** *Specify or Identify* the appropriate and necessary elements of the model
- **Relationships:** *Represent or Describe* the relationships or interactions among the elements in the model
- **Correspondence:** *Represent or Describe* the correspondence between model elements and a real world phenomenon or available data
- **Limitations:** *Specify or Identify* the limitations of the model
- **Explanation/prediction:** *Use* the model to explain or predict phenomena or specific aspects of phenomena

# Developing and Using Models (cont'd)

## ***Knowledge and skills needed by middle school students to perform the practice***

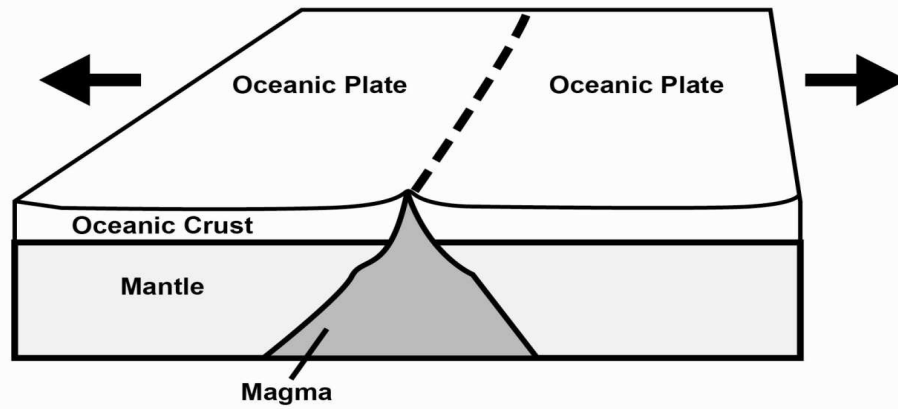
- Ability to label or identify the features (observable and unobservable) of a simple system
  - Ability to apply scientific knowledge/reasoning to show how or why a model is consistent with the phenomena
  - Ability to develop or use a model to predict and/or describe phenomena
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## ***Features of a high level of performance***

- Clearly labels or identifies all necessary features
- Includes all appropriate relationships necessary for describing the phenomenon
- Shows or describes the correspondence between elements and phenomenon
- Uses the appropriate evidence in the model to explain or predict

# 3-D Assessment Task Example

The picture below shows a place on the ocean floor where two plates are moving apart. At this plate boundary (shown at the dotted line), rock material is rising to the surface.



1. Complete the model by drawing on the picture to show what is happening in the mantle that causes the plates to move apart.
2. Based on the model you completed, explain what is happening in the mantle to cause the two plates to move apart.
3. On the model, put an X on the places where the oldest rock can be found in the crust.
4. Describe how the oldest rock got to that location.

## High level of Performance:

- **1:** Specify elements – **yes**
- **2:** Describe relationships or interactions – **yes**
- **2:** Correspondence – **yes**
- **3** Specify elements – **yes**
- **4** Explain/predict – **yes**



# Essential Take Aways

Purpose of unpacking a practice is to really understand the practice and its essential component parts. This helps to ensure:

## **Coherence and consistency**

- Consistency in your use of practices within and across assessment tasks
- Allows you to sustain the essential components of the practice across science disciplinary topics

## **Appropriate Linking of Practices**

- Enables you to see how practices can be brought together in assessment tasks – e.g., data analysis and explanation OR modeling and explanation

# NEXT GENERATION SCIENCE STANDARDS

For States, By States

NGSS Lead States

