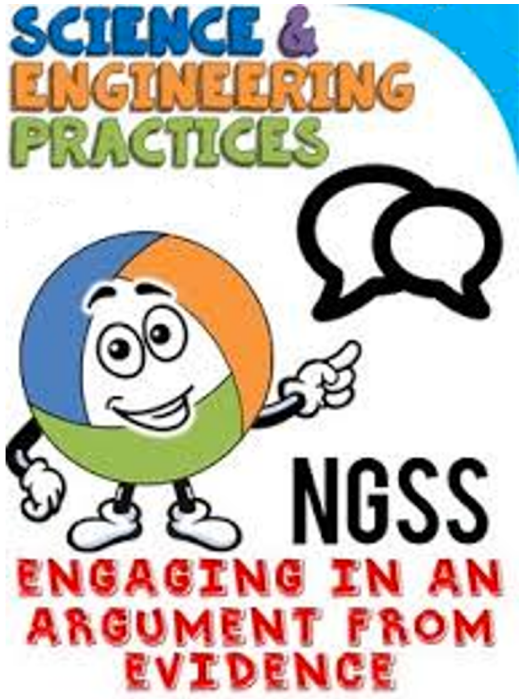
Day 1:
Linking Scientific Models and Evidence

Science and Evidence

The scientific endeavor is by nature based upon the collection and analysis of evidence, and arguments based on evidence form the foundation of scientific thinking.

➢Kuhn, D. (1993). Science as argument: Implications for teaching and learning scientific thinking. *Science Education*, *77*(3), 319-337.

Basis of MELs as an Instructional Strategy



Science & Engineering Practices Frameworks:

- Engaging in Argument from Evidence
  - Argumentation is seen as essential to scientific discourse because it provides a framework for students to make claims supported by evidence and reasoning related to scientific theory
    - ➢ Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, *84*(3), 287-312. doi:10.1002/(SICI)1098-237X

Related Instructional Strategies

Claim-Evidence-Reasoning

- Claims: A proposed answer to a question
- Evidence: The information used in an argument to support the claim
- Reasoning: Justification that links the claim and evidence.

C-E-R Example:

The Question:	
What do plants need to grow?	
Our Claim:	
The plant that received more light grew more.	
Our Evidence:	**Our Justification of the Evidence:**
On average, for the six plants that received 24 hours of light, they grew 20 cm, had six yellow flowers, had fifteen leaves, and they were all bright green. On average, for the six plants that received 12 hours of light, they grew 8 cm, had two yellow flowers, and had four leaves. Also, two of the plants had zero flowers. These plants were still bright green, but they were smaller and with fewer flowers and leaves	*Plants require light to grow and develop. This is why the plant that received 24 hours of light grew more.*

C-E-R Beyond the Classroom:

Think about:

- What is the claim?
- What evidence is presented?
- What reasoning connects the two?

Claims vs. Models

CLAIMS

- An answer to a question
- An assertion based on results of an investigation
- Requires justification to support the claim

MODELS

- An explanation of a phenomenon
- A hypothesis that leads to new questions
- Predicts or describes how and why a phenomenon occurs

EVIDENCE is the foundation for both claims and models!

THE MEL PROJECT

More about Models

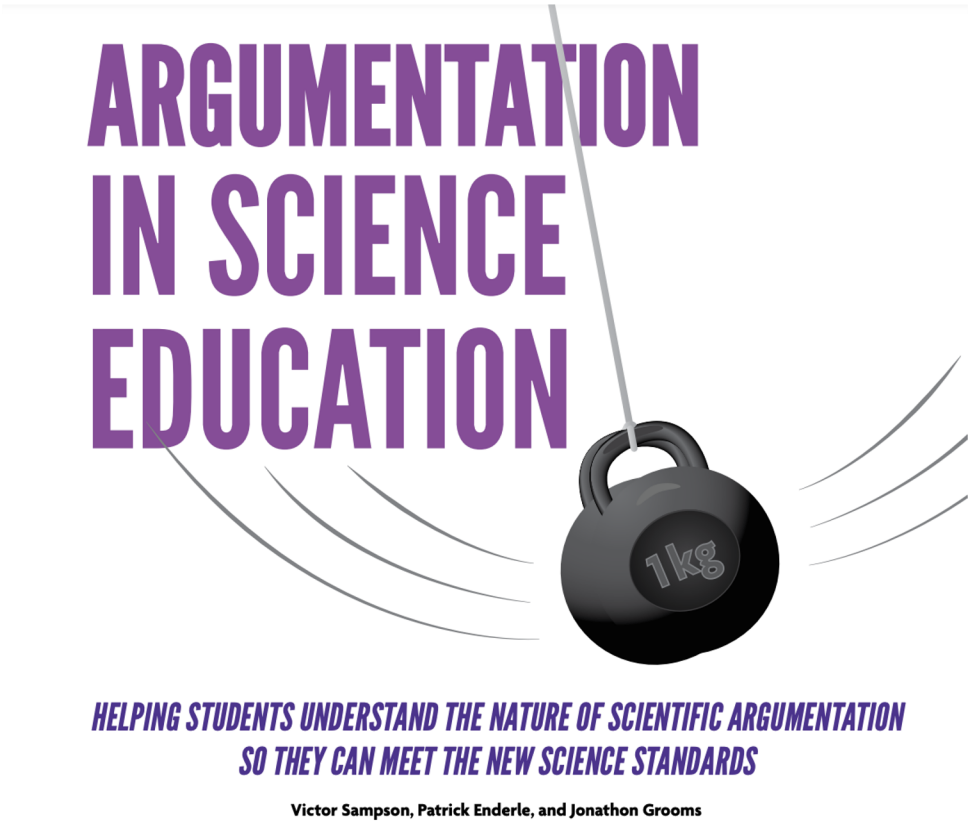
Models alone are not sufficient to support scientific thinking. <u>Models must be coordinated with lines of evidence</u> to help build an argument about the causes and effects of a particular phenomenon and its systematic relationships.

➢ National Research Council [NRC]. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: The National Academies Press.

<u>More than one model may be an acceptable explanation</u> for the same phenomenon. It is not always possible to exclude all but one model – and also not always desirable. *(ex: Dual wave/particle nature of light.)*

➢ National Center for Improving Student Learning and Achievement in Mathematics and Science, (2018). Explanatory Models in Science. http://ncisla.wceruw.org/muse/models/index.pdf Accessed 5/22/18

What Counts as Evidence?



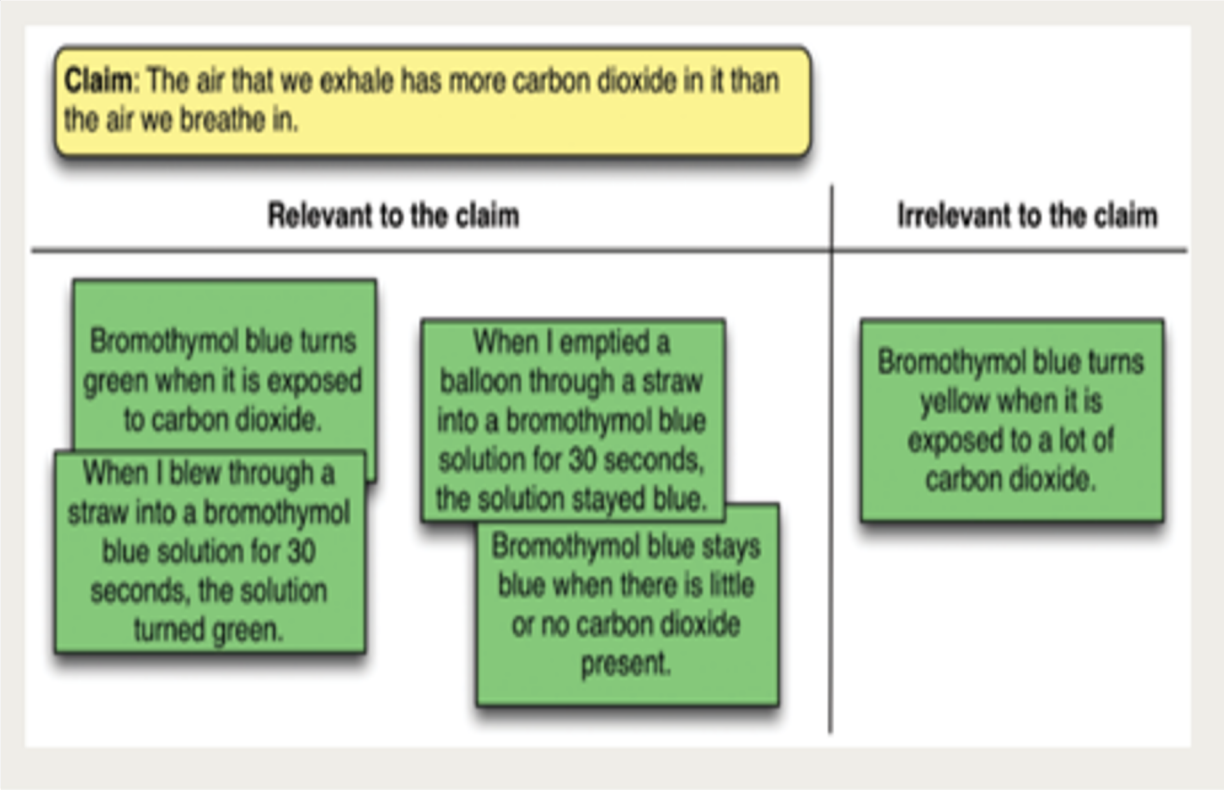
Take a few minutes to read this article.

- Sampson, V., Enderle, P., & Grooms, J. (2013). Argumentation in science education. *The Science Teacher*, *80*(5), 30

Read for the following:

1. What is the criteria for evidence in scientific claims?
2. What is the difference between data and evidence?
3. What are the implications for teaching students to engage in scientific argumentation?

Models Require Evidence



Criteria for Evidence:

- Relevance
- Quality

Difference between Evidence & Data

- Data is foundation for evidence
- Data must be analyzed, interpreted and applied
- Must justify the link between the evidence and explanation

Evaluating Evidence-to-Model Links

Evaluating the Evidence-to-Model Connection:

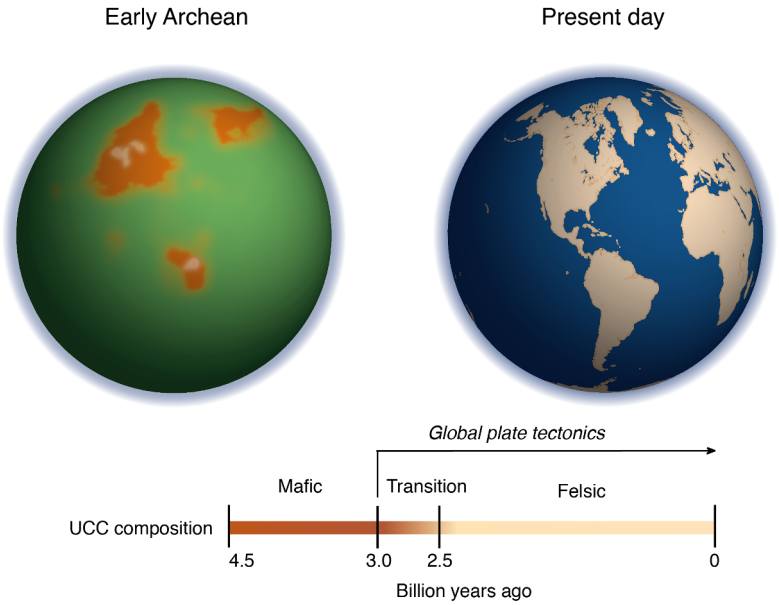
- Is the evidence relevant to the model?
- Does the evidence support the model? How well?
- Does the evidence contradict the model?
- What theory, law or concept guides the analysis of the evidence?

Evaluating Evidence-to-Model Links in the News

New Study Zeros in on Plate Tectonics' Start Date

Analysis of trace elements places the onset of plate tectonics about 3 billion years ago

- **Date:** January 21, 2016
- **Source:** University of Maryland
- **Summary:** A new study suggests that plate tectonics began about 3 billion years ago. By analyzing trace element ratios that correlate to magnesium content in ancient Earth's crust, the researchers provide first-order geochemical evidence for when plate tectonics first got underway.



Take 10 minutes to read the article before we discuss….

Group Activity: Evidence Linking Task

1. Identify the claim or model being presented in the article.
2. Identify evidence statements that are used to support the model.
3. Evaluate each evidence statement based on how well it links to the model
4. Finally, identify any alternative models, if any are being presented by the article and explain if any of the evidence presented supports the proposed or alternative model.

Evidence Linking Task: Work in Groups

Evaluation Classification:
1 - Strongly Supports
2 - Supports
3 - Contradicts
4 - Has nothing to do with the model

Article:	**New study zeros in on plate tectonics' start date**	
Claim or Model Presented:		
		Evaluation
Evidence #1:		1 2 3 4
Evidence #2:		1 2 3 4
Evidence #3:		1 2 3 4
Is an Alternative Model Presented?		
Does any of the Evidence Support the Alternative?		

Evidence Linking Task: Possible Responses

Evaluation Classification:
1 - Strongly Supports
2 - Supports
3 - Contradicts
4 - Has nothing to do with the model

Activity 1: Whole Group

Article:	***New Study Zeros in on Plate Tectonics Start Date***	
Claim or Model Presented:	*Plate tectonics began about 3 billion years ago.*	HOW WOULD YOU CLASSIFY THESE?
		Evaluation
Evidence #1:	*An analysis of trace element ratios that correlate to Mg content suggests that plate tectonics began about 3bya.*	1 2 3 4
Evidence #2:	*Earth's continental crust contains less Mg than Mars, Mercury, Venus, Moon, but it had more earlier in its evolution.*	1 2 3 4
Evidence #3:	*Rock samples from 4 and 2.5 bya used in the computer model*	1 2 3 4
Is an Alternative Model Presented?	WHAT DO YOU THINK?	
Does Evidence Support the Alternative?		

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Let's Look at a Few More….

Instructions:

- Each group is assigned an article
- Complete Evidence Linking Task
- Discuss with your group
- Prepare to share with the whole group
- Time: 20 Minutes

IN THE NEWS:

- Growing Greenland's Deltas
- Fracking -- Not Wastewater Disposal -- Linked to Most Induced Earthquakes in Western Canada
- Creeping Danger: Peruvian Landslides
- What do we Know About the Origin of the Earth's Oceans?
- New Source of Global Nitrogen Discovered

Group Activity: Linking Evidence-to-Models in another article!

- Work with your group
- Evaluate the Evidence-to-Model links in your group's article
- Prepare to report out to everyone

Article:					
Claim or Model Presented:					
		Evaluation			
Evidence #1:		1	2	3	4
Evidence #2:		1	2	3	4
Evidence #3:		1	2	3	4
Is an Alternative Model Presented?					
Does any of the Evidence Support the Alternative?					

Activity: Just ONE More….

Instructions:

- Check out this article
- What claim does Congressman Brooks (R-AL) make?
- What is the evidence?
- How do you rate the evidence?

IN THE NEWS:

- Republican lawmaker: Rocks tumbling into ocean causing sea level rise

Article:					
Claim or Model Presented:					
		Evaluation			
Evidence #1:		1	2	3	4
Evidence #2:		1	2	3	4
Evidence #3:		1	2	3	4
Is an Alternative Model Presented?					
Does any of the Evidence Support the Alternative?					

Evaluation Classification:
1 - Strongly Supports
2 - Supports
3 - Contradicts
4 - Has nothing to do with the model

Review & Reflect

From this activity….

- How did your evaluation classification vary among group members?
- How did your discussion help develop conceptual understanding?

Applied to your students….

- How do your students evaluate evidence when presented with alternative models?
- What are some of the challenges for getting students to evaluate evidence?

Finding Articles:

- Science News for Students:
  - Articles on a wide range of topics written for students
- Elife:
  - Peer reviewed & led by scientists
- Science in the Classroom:
  - Free annotated papers from *Science* journals
- Google Scholar:
  - Peer reviewed articles
- Pocket Hits:
  - Updated daily- current events on scientific topics
- Science Buddies:
  - Integration with Google Classroom
- DOGO News:
  - Science articles for struggling learners
- Science Daily:
  - Science articles from various sources
- Jstor:
  - Digital library of primary sources (subscription required)
- Newsela:
  - Identify topics, reading level, news source (account required)

What's Next?

Break!

See you in 15 minutes