Welcome!

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
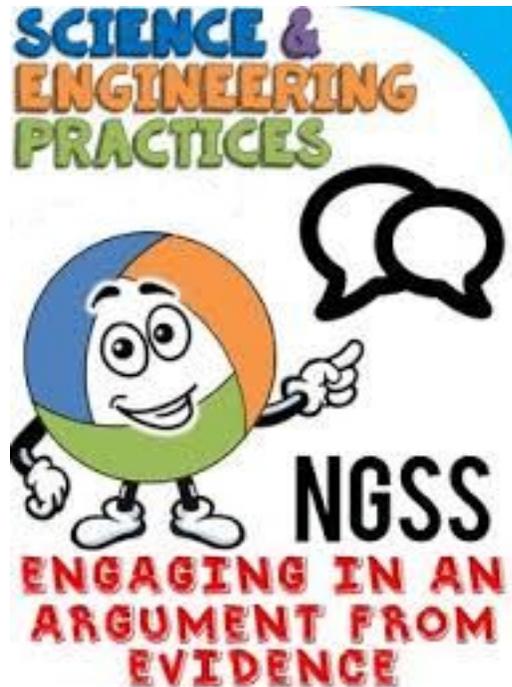
Science & Engineering Practices Frameworks:

- 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.

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
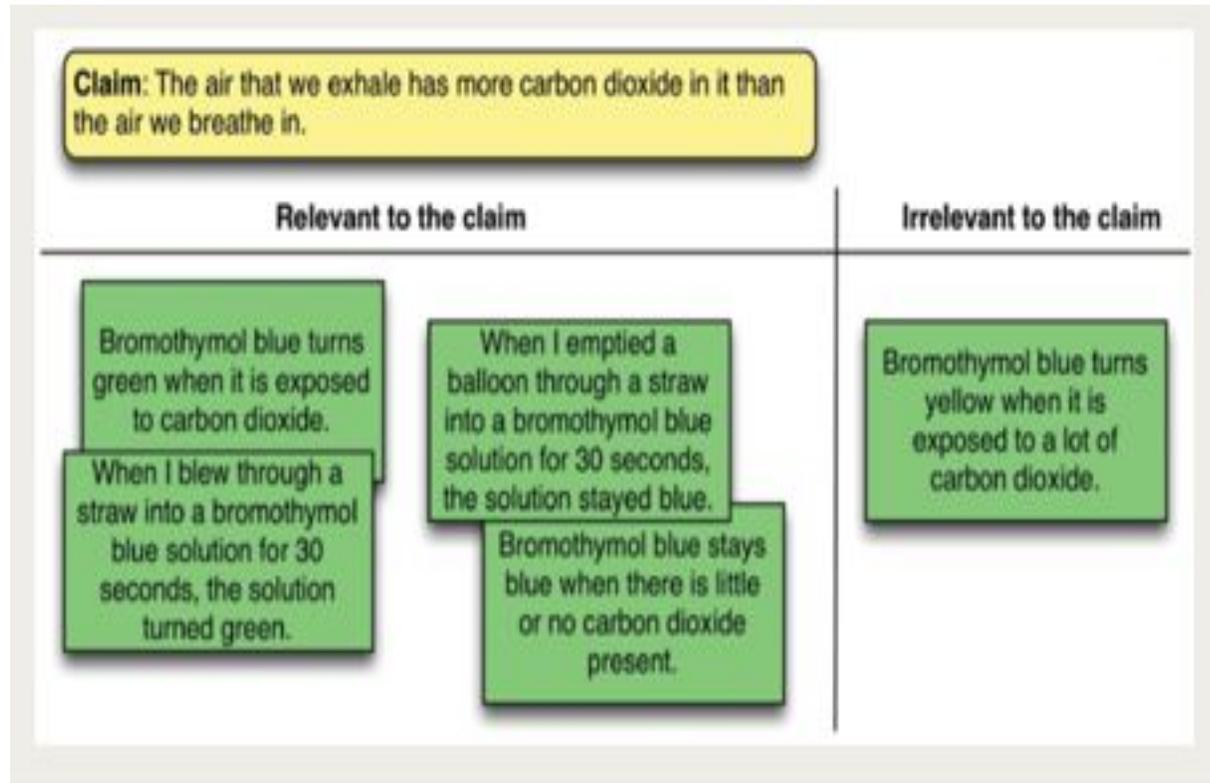
More about Models

Models alone are not sufficient to support scientific thinking. Models must be coordinated with lines of evidence 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.

More than one model may be an acceptable explanation 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

Models Require Evidence

Claim: The air that we exhale has more carbon dioxide in it than the air we breathe in.

Relevant to the claim	Irrelevant to the claim
Bromothymol blue turns green when it is exposed to carbon dioxide.	Bromothymol blue turns yellow when it is exposed to a lot of carbon dioxide.
When I blew through a straw into a bromothymol blue solution for 30 seconds, the solution turned green.	
When I emptied a balloon through a straw into a bromothymol blue solution for 30 seconds, the solution stayed blue.	
Bromothymol blue stays blue when there is little or no carbon dioxide present.	

Criteria for Evidence:

- Quality
- Validity
- Relevance

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

Take a few minutes to read the article.

Evaluating Evidence-to-Model Links

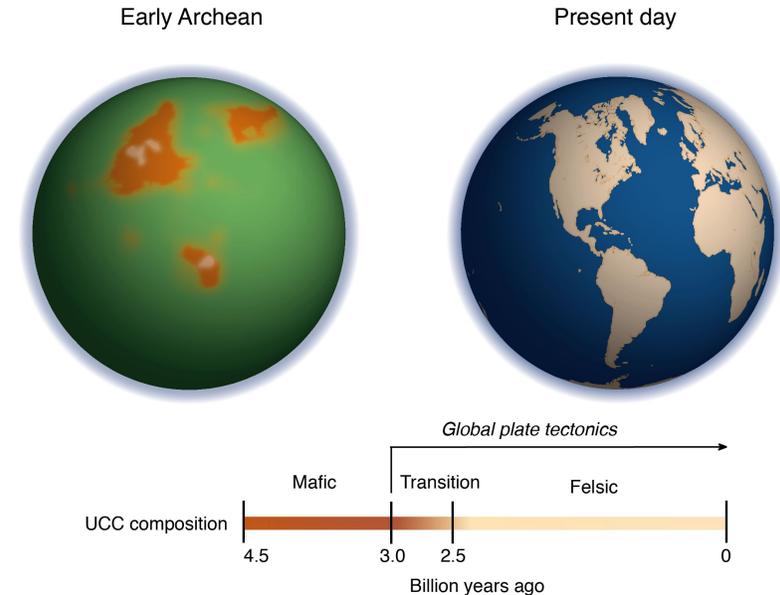Evaluating the Evidence-to-Model Connection:

- Is the evidence relevant to the model?

- Does the evidence support the model? How well?

- Does the evidence contradict the model?

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.

Early Archean   Present day

Global plate tectonics

Mafic   Transition   Felsic

UCC composition

4.5   3.0   2.5   0

Billion years ago

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. Classify 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 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:					
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?					

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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.*				
		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?					
Does Evidence Support the Alternative?					

HOW WOULD YOU CLASSIFY THESE?

WHAT DO YOU THINK?

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Let's Look at a Few More….

Instructions:
- Each group is assigned an article
- Complete Evidence Linking Task
- Discuss with table
- Prepare to share with the whole group
- Time: 20-30 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?

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

- Work with your group
- Evaluate the Evidence-to-Model links in your group's article
- Copy results to chart paper
- 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?	

Let's take a short break....

Activity: Just ONE More….

Instructions:

- Choose ONE of the three articles
- Complete Evidence Linking Task
- Time: 15 Minutes

IN THE NEWS:

- Republican lawmaker: Rocks tumbling into ocean causing sea level rise
- Climate Change Deniers Present Graphic Description of What Earth Must Look Like For Them To Believe
- The Flat Earth Theory has seen a resurgence, with people trying to prove our planet is not a sphere

Sharing Final Articles

- What model was presented?
- What was the evidence?
- How did you evaluate it?
- What was different?
- What are the alternative models?

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?					

Review & Reflect

From this activity….
- How did your evaluation classification vary among group members?
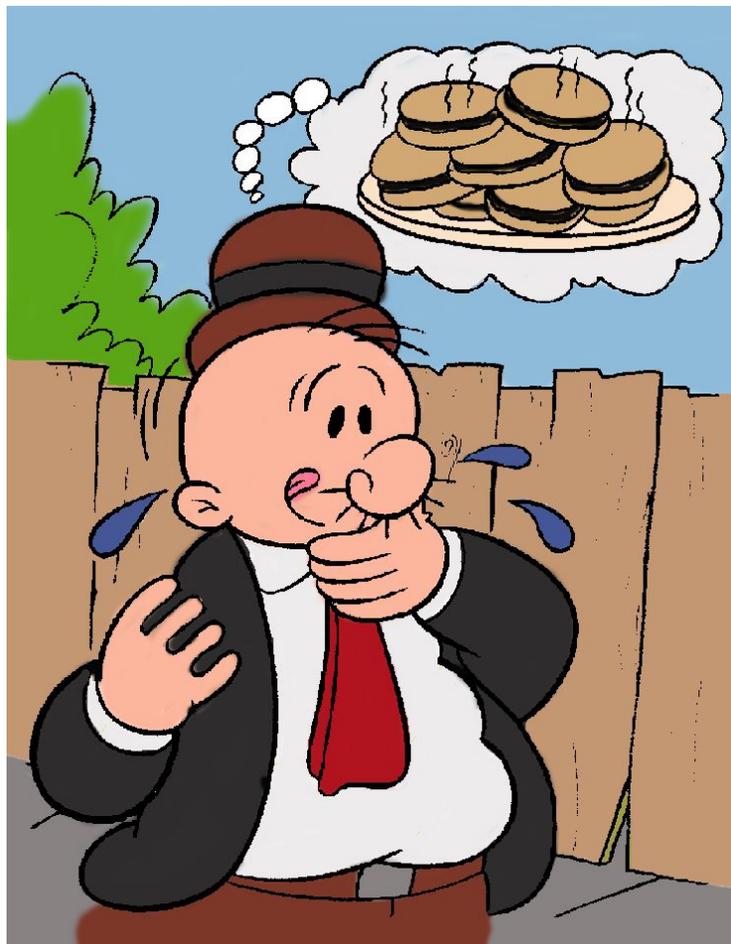- How did your discussion help develop conceptual understanding?

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:

➢ Newsela:
  ○ Identify topics, reading level, news source
➢ Elife:
  ○ Peer reviewed & led by scientists
➢ Science in the Classroom:
  ○ Free annotated papers from *Science* journals
➢ Google Scholar:
  ○ Peer reviewed articles
➢ Pockethits:
  ○ Updated daily- current events on scientific topics

➢ Science Buddies:
  ○ Integration with Google Classroom
➢ DOGO News:
  ○ Science articles for struggling learners
➢ Science News for Students:
  ○ Articles on a wide range of topics written for students
➢ Science Daily:
  ○ Science articles from various sources
➢ Jstor:
  ○ Digital library of primary sources (subscription required)

What's Next?

LUNCH!