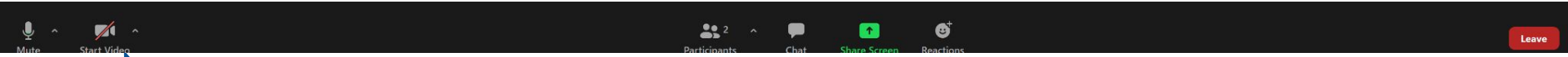
Webinar Participation

As you enter, please review the Zoom controls below. Leave your audio and video off, unless in a breakout room or prompted by a host. Feel free to use the Chat for questions or comments!



Please leave your **audio muted** and **video off** (both indicated by a red slash)

Click to open the Chat. This will allow you to participate in a discussion with all attendees.

Use Reactions to raise your hand, indicate agreement, etc.

THE MEL PROJECT

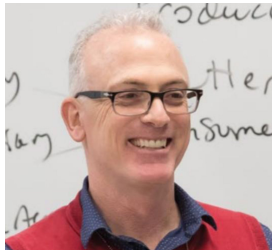
Engaging Students in Scientific Practices:
Evaluating Evidence and Explanation in Secondary Earth and Space Science

Pre-Workshop Webinar

SLRG Investigators

The Science Learning Research Group (SLRG) at the University of Maryland and Temple University conducts classroom-based research in the learning and teaching of Earth and space science.

- 30+ combined years educational research
- 20+ combined years university faculty
- 50+ combined years classroom teaching & PD



Doug Lombardi

Janelle Bailey

Tim Klavon

Archie Dobaria

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Project Investigators

Missy Holzer (NJ)

- PhD Science Education
- 34 years 9-12 Classroom
- 25+ years PD provider
- Science Standards Specialist, Great Minds
- NESTA President (2012-2014)
- NJESTA Board
- Adjunct Prof - Rutgers, Rider, AMNH
- MEL 1 Project Team Member

Donna Governor (GA)

- 32 years K-12 Classroom
- Currently University of North Georgia - Asst. Professor of Science Education
- 2007 PAEMST Awardee
- Past President GSTA
- NSTA District Director
- Author NSTA Press books: “Big Data, Small Devices” and “Staging Family Science Nights”

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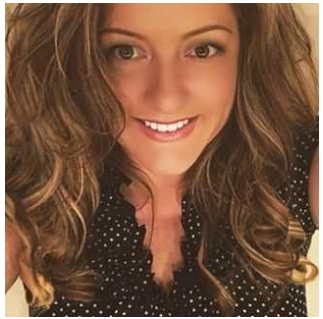
Master Teachers

Christopher Roemmele (NJ)

- Assistant Professor at West Chester University, teaching Science Methods for Educators, Introductory Geology
- PhD in Earth Science Education
- 15 years high school science teacher in NJ
- Former NJESTA President
- Published in The Science Teacher, Science Scope, The Earth Scientist, Science in School

Kristina Strickland (GA)

- Earth Science Teacher @ North Forsyth High School
- 17 years middle & high school
- Ed.S. Curriculum & Instruction
- Facilitator for Ceismc Program @ Georgia Tech



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Project Investigators

Carla McAuliffe

- TERC, Senior Researcher & Curriculum Developer
- PhD Learning & Instructional Technology
- 10+ years Middle & High School Classroom
- 30+ years PD provider

Sanlyn Buxner

- Project Evaluator
- Research Scientist, Planetary Science Institute
- PhD Science Education
- 20+ years PD provider
- Adjunct Prof - University of Arizona

THE MEL PROJECT

Webinar Outline

- 3-D Teaching and Learning
- Science and Engineering Practices
- Crosscutting Concepts
- Making Scientific Evaluations
- Next Steps

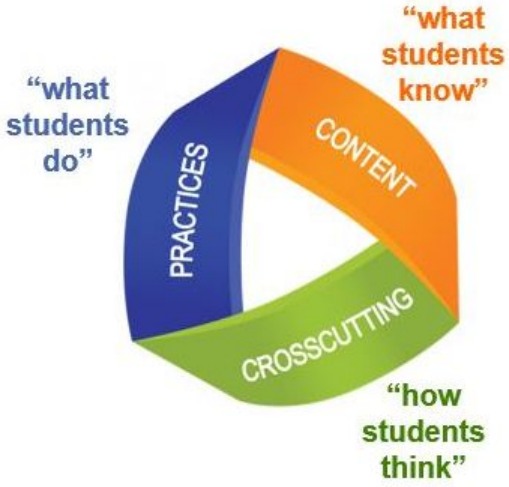
Standards Based Science Education

Conceptual Shifts NSES -> NGSS (3-D)

- Research on teaching and learning
- Separation of science process and science content not effective
- Advances in cognitive science: knowledge is constructed from experience
- ***RESULT:*** *Framework for K-12 Science Education*
- Emphasizes "3-Dimensional Learning"

Documents available at: https://www.nap.edu/

Aspects of 3-D Teaching & Learning



- **Core content:** What students learn
- **Science & engineering practices:** How students engage in learning
- **Cross-cutting concepts:** Concepts that link domains of science; Conceptual tools that help students organize learning

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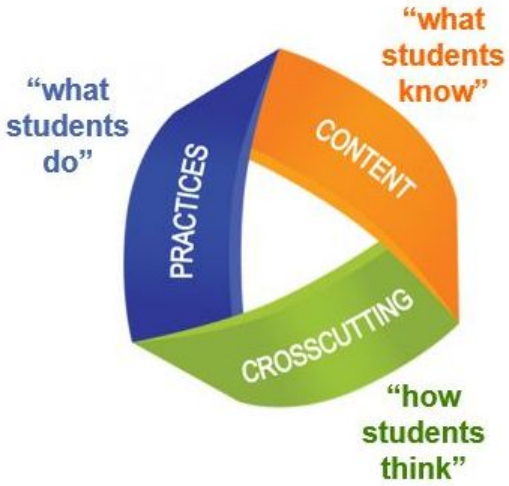
NJ SLS for Science and GA GSE for Science



What does 3-D Teaching and Learning look like?

- Students DOING science
- Phenomena based
- Solving problems
- Real-world applications
- Project based learning

Webinar Outline

- 3-D Teaching and Learning
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- Crosscutting Concepts
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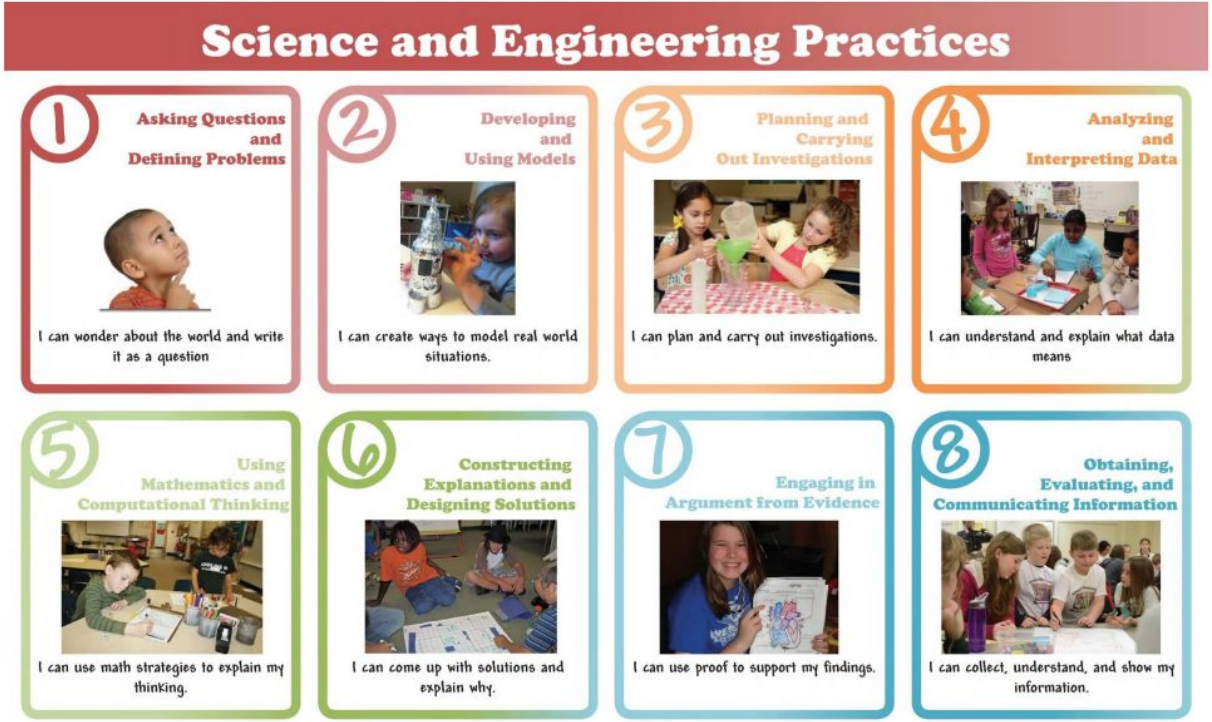
Science & Engineering Practices



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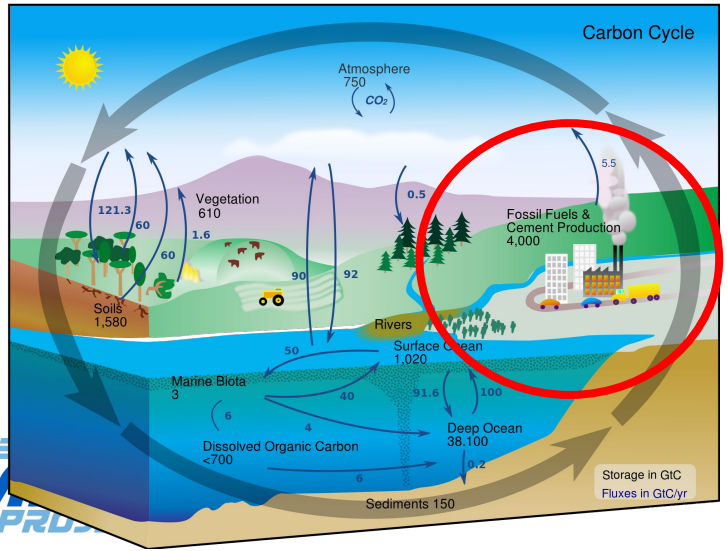
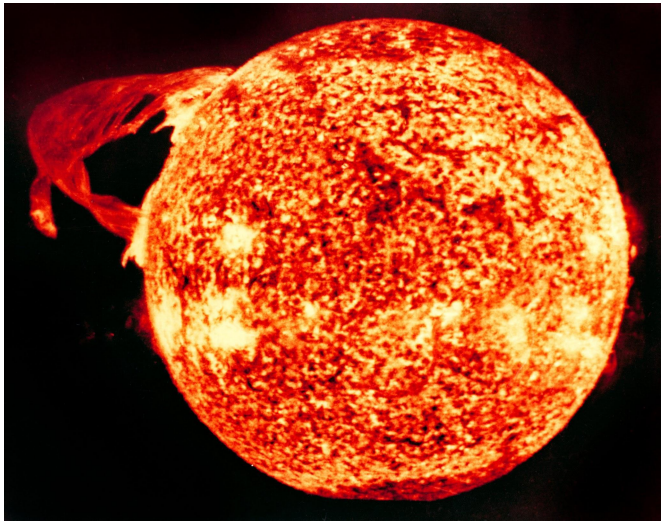
Science & Engineering Practices & MELs

- Developing and Using Models
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence

Focus: Developing and Using Models

- Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence.





Science & Engineering Practices & MELs

- Developing and Using Models
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence

Focus: Analyzing and Interpreting Data

- Consider limitations of data analysis when analyzing and interpreting data

Focus: Analyzing and Interpreting Data

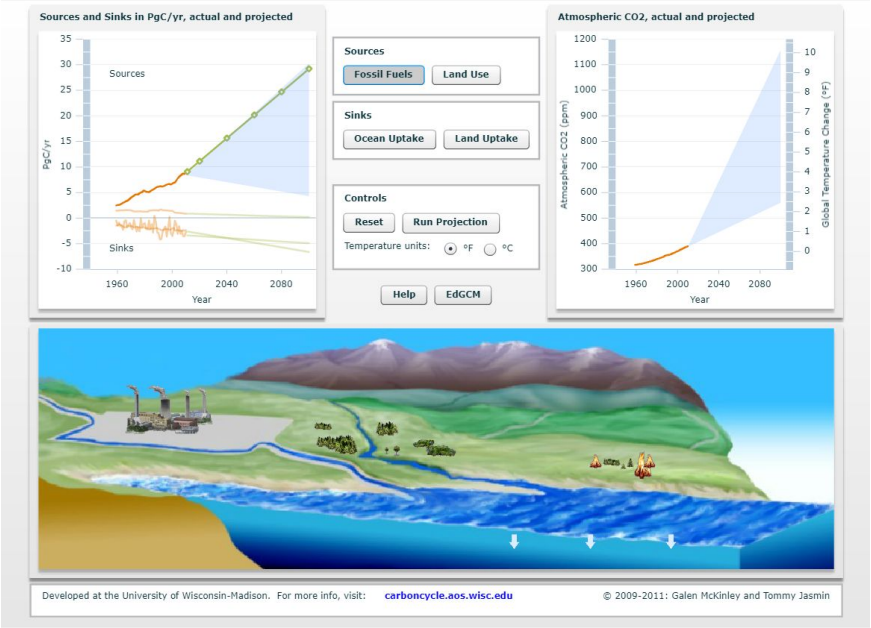
- Compare and contrast various types of datasets to examine consistency of measurements and observations

The Yoretown Landfill

Team	Site A	Site B	Site C	Site D
1	2.4	2.3	2.5	2.7
2	2.3	2.2	2.3	3.0
3	2.6	1.8	2.7	2.8
4	2.5	1.9	2.5	3.1
5	2.2	2.3	2.1	3.3
6	2.7	2	2.4	2.8
Avg	2.6	2.1	2.4	2.9

Focus: Analyzing and Interpreting Data

- Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

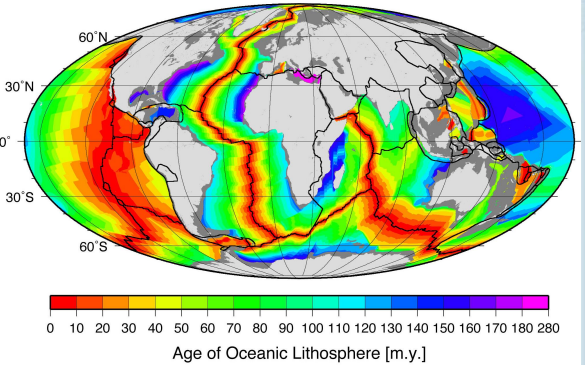


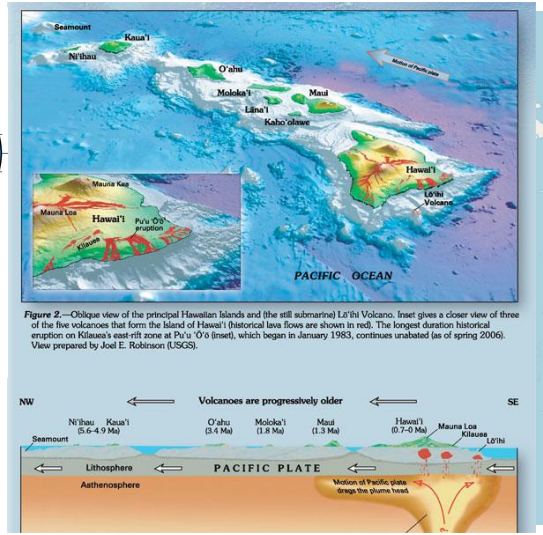
Science & Engineering Practices & MELs

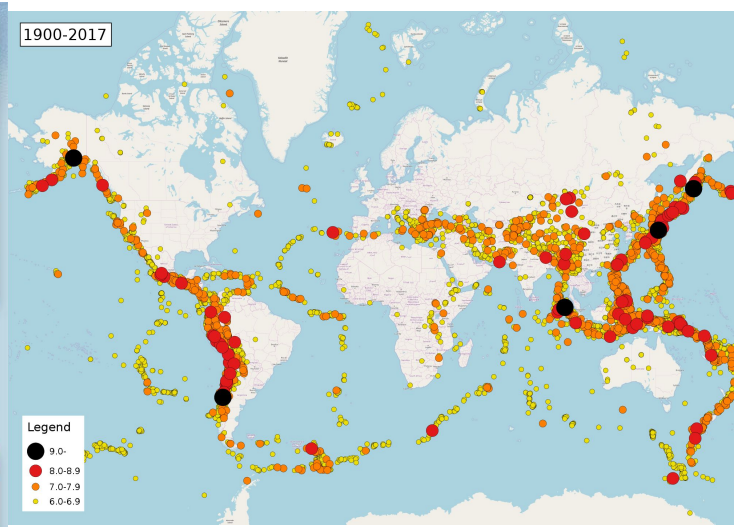
- Developing and Using Models
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence

Focus: Constructing Explanations

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources 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

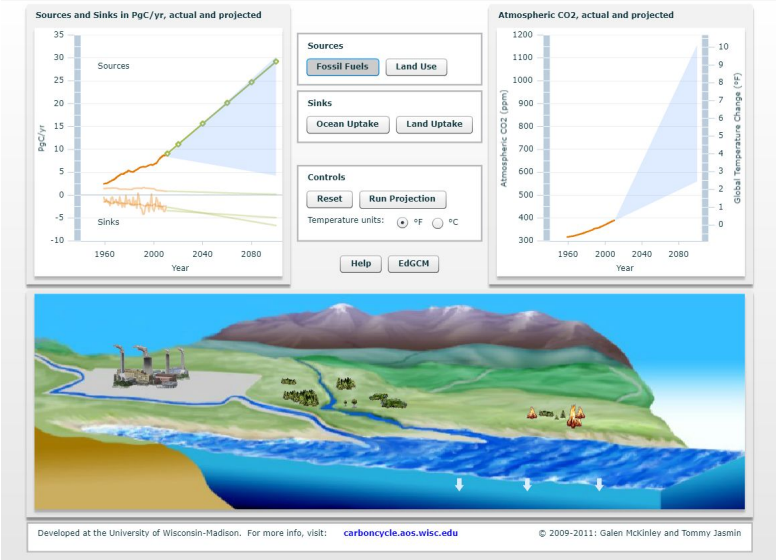






Focus: Constructing Explanations

- Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion



Science & Engineering Practices & MELs

- Developing and Using Models
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence

Focus: Engaging in Argument from Evidence

- Compare and evaluate competing arguments in light of currently accepted explanations, new evidence, limitations, constraints, and ethical issues

Focus: Engaging in Argument from Evidence

- Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations to determine the merits of arguments

Climate change & loss of food supply or meteor impact?

Science & Engineering Practices & MELs

- Developing and Using Models
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence

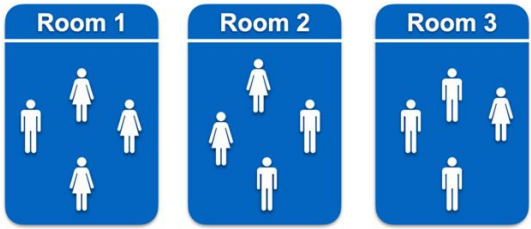
Science & Engineering Practices & MELs

In your Breakout Room, discuss the following:

- In what ways are you already integrating the science and engineering practice (SEP) into your classroom?
- What are the most challenging aspects of integrating this SEP?

(10 min - introduce yourselves (name, HS/MS, location) & select a person to report out!)

Please remember which Breakout Room number your are in so you can join that room again

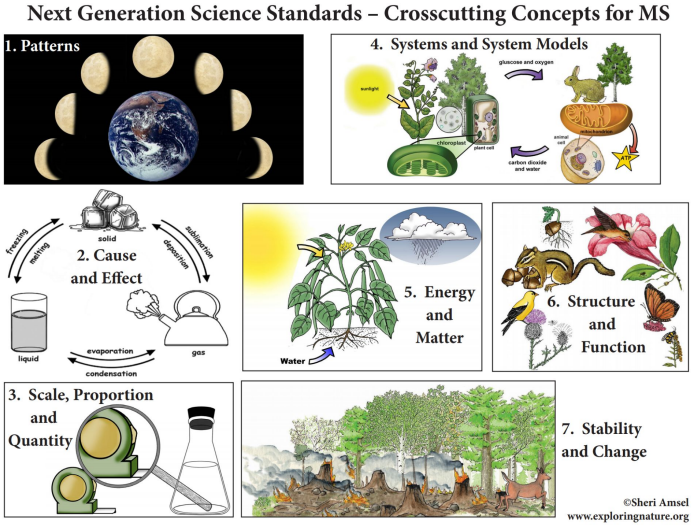


Webinar Outline

- 3-D Teaching and Learning
- Science and Engineering Practices
- Crosscutting Concepts
- Making Scientific Evaluations
- Next Steps

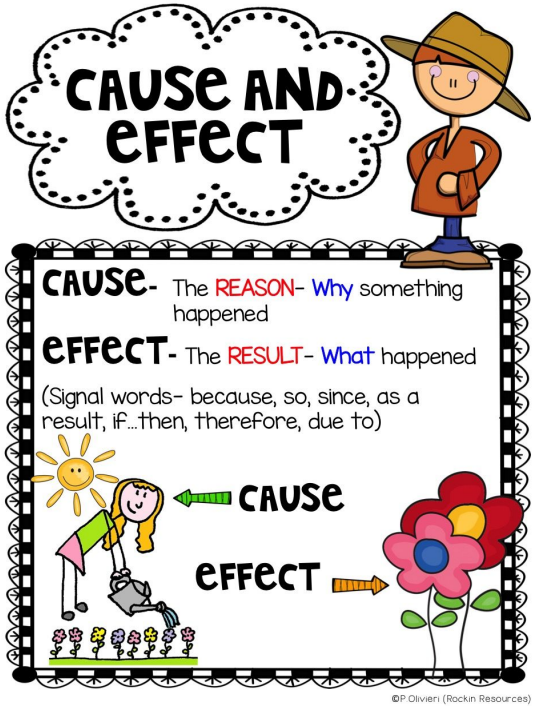
Crosscutting Concepts Supported by MELs

1. Patterns
2. Cause & Effect
3. Scale Proportion & Quantity
4. Systems & System Models
5. Energy & Matter
6. Structure & Function
7. Stability & Change

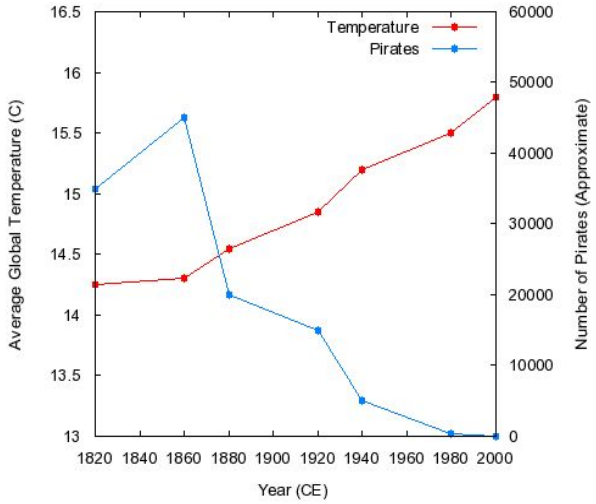


Crosscutting Concepts with MEL Activities

- Cause and Effect
- Stability and Change



Focus: Cause & Effect



Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects.

Criteria for causality:

- Cause precedes effect
- Cause & effect are empirically correlated
- Correlation is legitimate
- Cause and effect have a plausible interaction

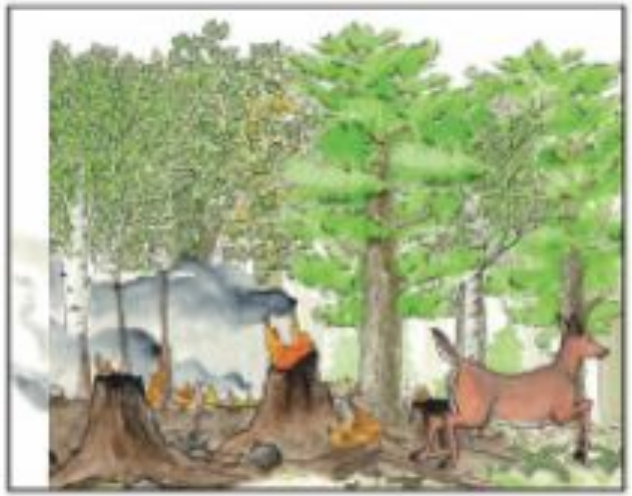
Focus: Cause & Effect

Cause and effect relationships explain and predict behaviors in complex natural and designed systems.

- Phenomena may have more than one **cause**
- Some **cause and effect** relationships can only be described using probability
- Changes in systems may have various causes that may not have equal effects

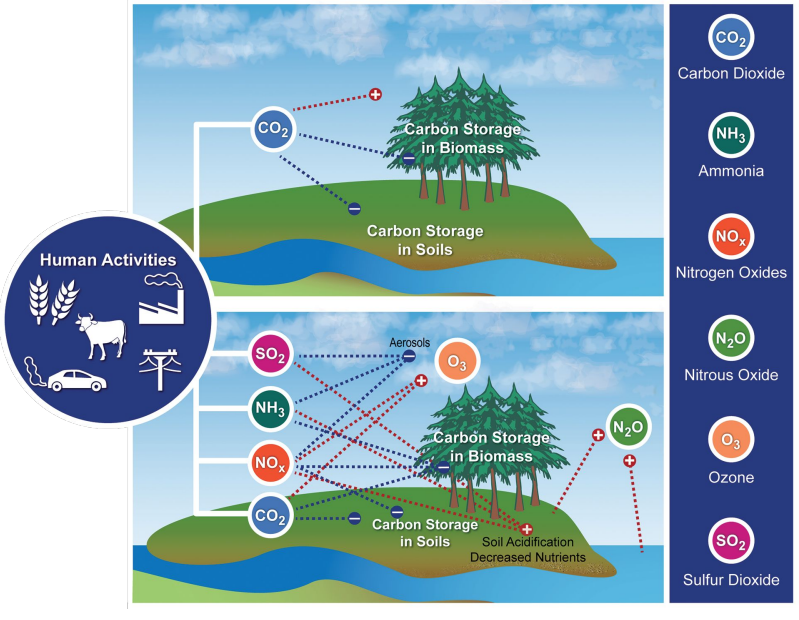
Crosscutting Concepts with MEL Activities

- Cause and Effect
- Stability and Change



Stability and Change

Focus: Stability & Change



Changes in one part of a system can cause large changes in another part

- Systems in dynamic equilibrium are stable
- Stability can be disturbed by sudden events or gradual changes
- Some changes are irreversible

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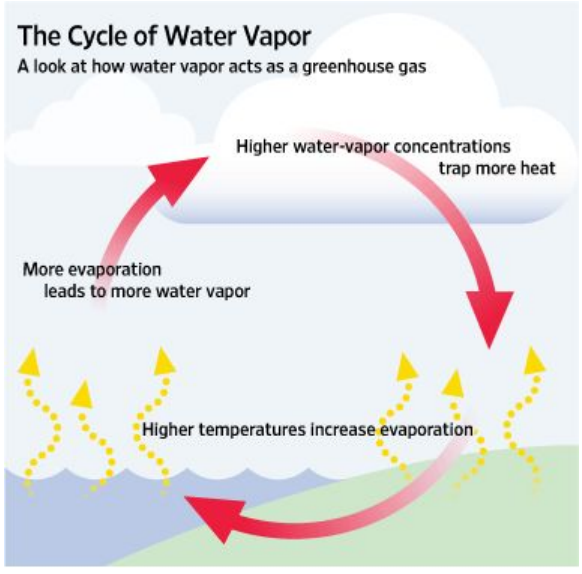
Focus: Stability & Change



Changes over time occur at different scales

- Negative feedback can stabilize a system - inputs and outputs are in opposite directions
- Positive feedback can destabilize a system - inputs and outputs are in same direction

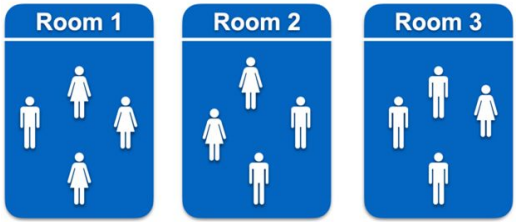
Crosscutting Concepts with MEL Activities

In your Breakout Room, discuss the following:

Unlike the DCIs and SEPs, the Crosscutting Concepts are often implied in the standards.

- How do you decide WHICH CCCs apply in your instruction?
- How do you address it/them in your lesson with ***intention****?*

(10 min - Return to your previous Breakout Room & select a person to report out!)



Webinar Outline

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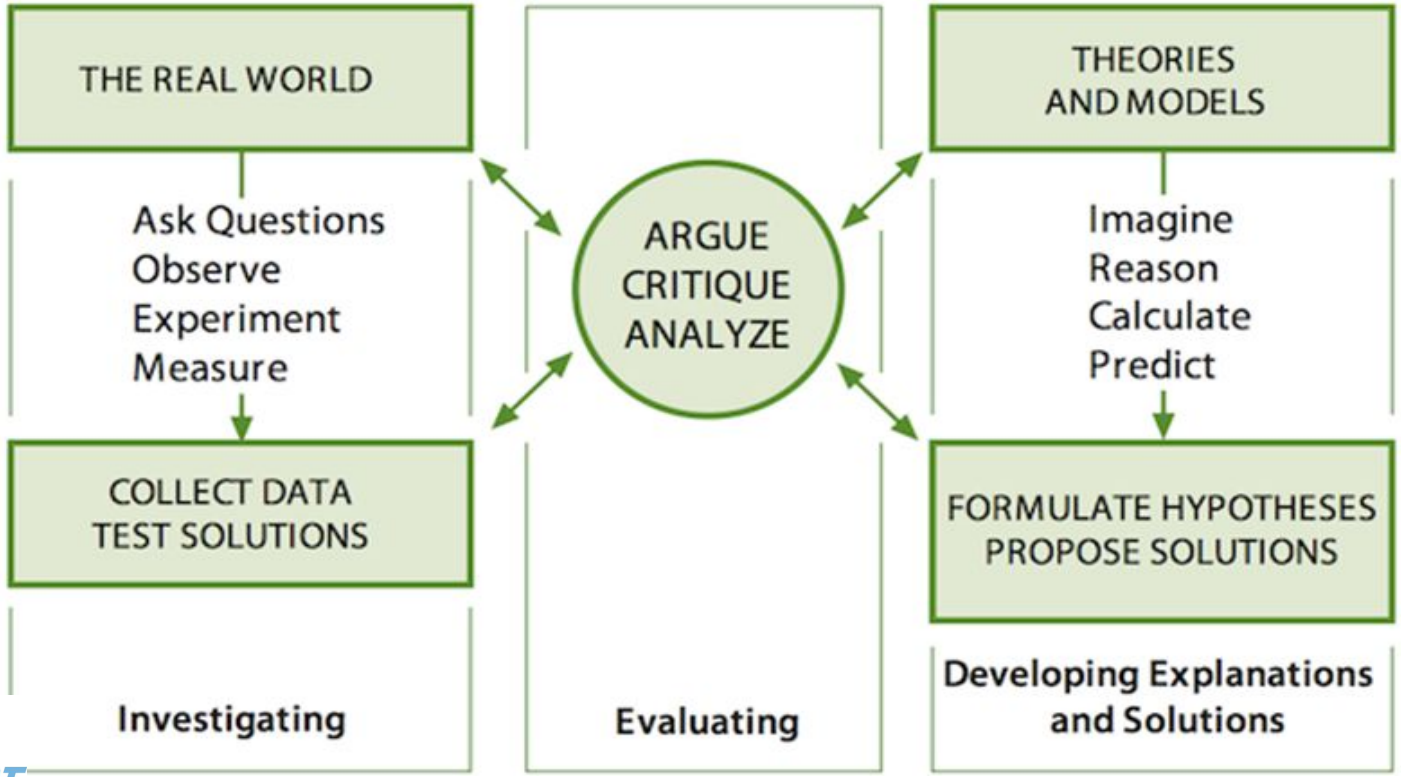
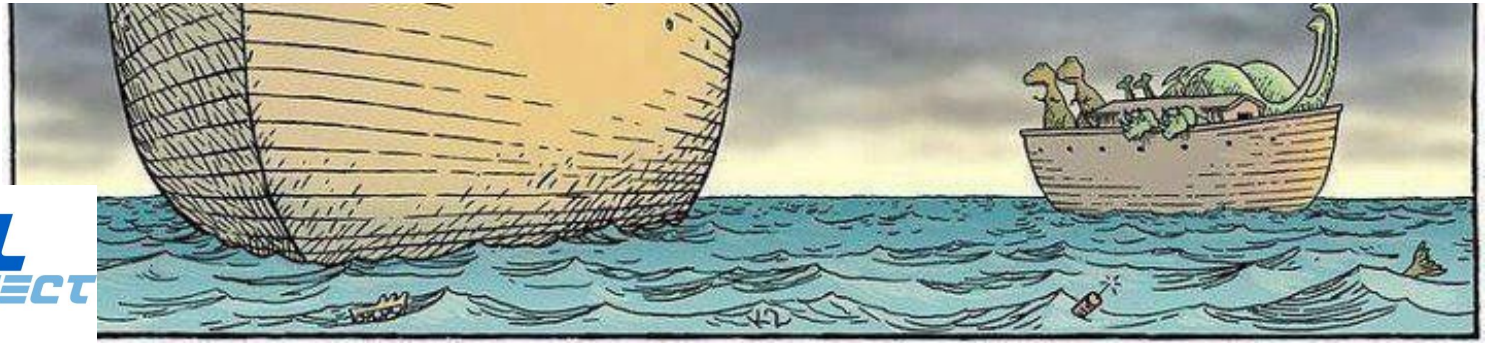
Evaluative reasoning is foundational to many—if not all—scientific practices (Ford, 2015)



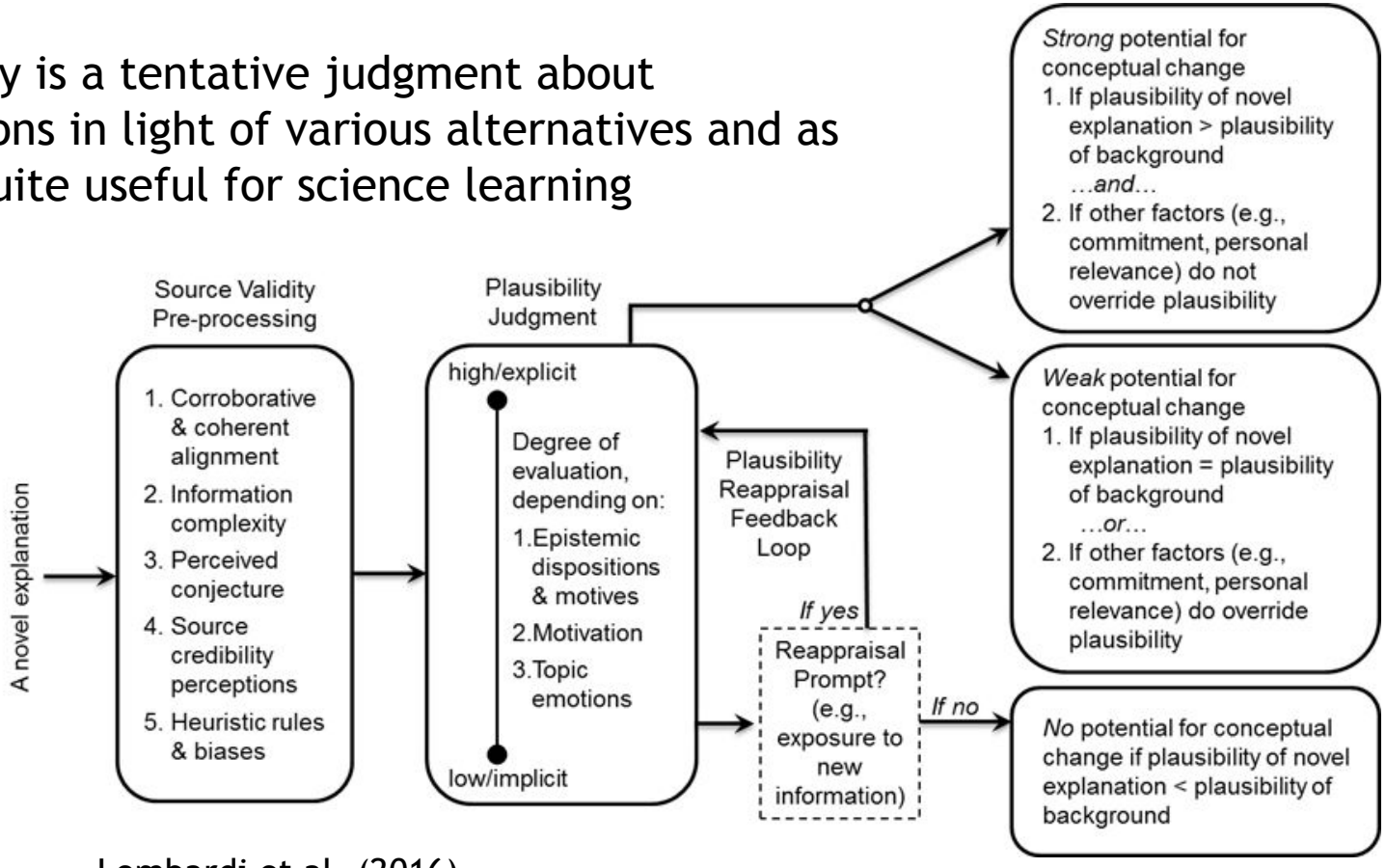
The three “spheres” of activity for scientists (NRC, 2012, p. 45)

A more scientific way to think about claims, evidence, and reasoning

Simultaneously evaluating how well scientific evidence supports competing claims and rendering a plausibility judgment on each claim



Plausibility is a tentative judgment about explanations in light of various alternatives and as such, is quite useful for science learning



Lombardi et al. (2016)

The Plausibility Ranking Task

How do scientists change their plausibility judgments?

Plausibility is a judgment we make about the potential truthfulness of one model compared to another. The judgment may be tentative (not certain). You do not have to be committed to that decision.

Scientists may change their plausibility judgments about scientific ideas.

They do this by looking at the connections between evi

1. *Support* an idea
2. *Strongly* support an idea
3. *Contradict* (oppose) an idea
4. Have *nothing to do* with the idea

Which type of evidence do you think is most important to a scientist's plausibility judgment? Use numbers 1 to 4 to *rank* each evidence. (1 = most important and 4 = least important). Use each number only once.

Type of evidence	Your ranking
Evidence supports the idea	
Evidence strongly supports the idea	
Evidence contradicts (opposes) the idea	
Evidence has nothing to do with the idea	

When instructed, flip over to Page 2

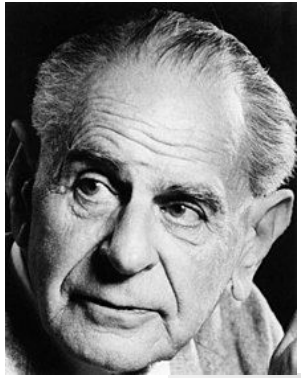
Prior to this webinar we asked you to take a survey….

The Plausibility Ranking Task

	1	2	3	4	TOTAL	SCORE
Evidence supports the idea	22.58% 7	32.26% 10	32.26% 10	12.90% 4	31	2.65
Evidence strongly supports the idea	45.16% 14	25.81% 8	12.90% 4	16.13% 5	31	3.00
Evidence contradicts (opposes) the idea	12.90% 4	38.71% 12	38.71% 12	9.68% 3	31	2.55
Evidence has nothing to do with the idea	19.35% 6	3.23% 1	16.13% 5	61.29% 19	31	1.81

Here are the results of the survey as of today at 6:00 pm….

The only consistent characteristic across disciplines is that scientific explanations are open to revision in light of new evidence (NGSS, 2013, Vol 2, p. 96)

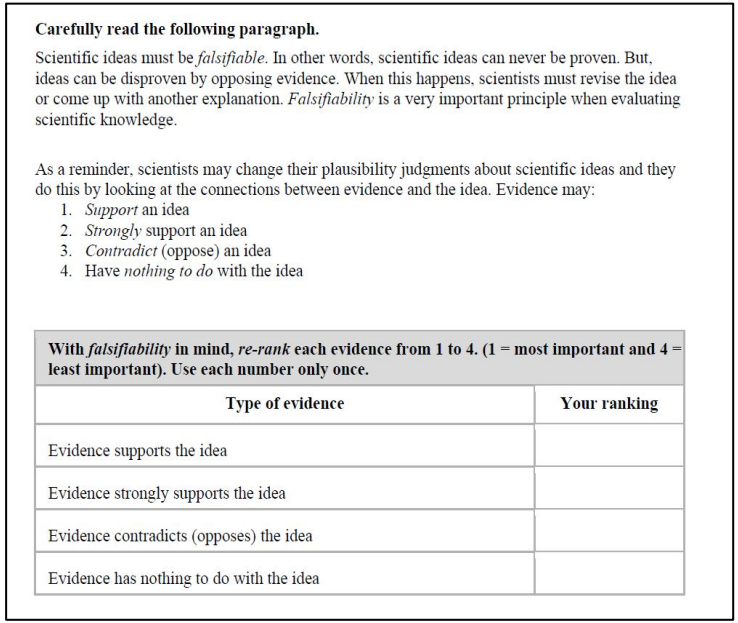


Falsifiability makes explanations scientific, that is, scientific explanations must be open be able to be proven wrong (i.e., false)
--Karl Popper

Falsifiability for a theory is **great**, but a theory can still be **respectable**...as long as it is verifiable
--Brian Green

The Plausibility Ranking Task

- Now that you've heard a bit more about plausibility and falsifiability, let's re-rank the four types of evidence.
- Go to https://www.surveymonkey.com/r/MEL_2021_PT2



Carefully read the following paragraph.

Scientific ideas must be *falsifiable*. In other words, scientific ideas can never be proven. But, ideas can be disproven by opposing evidence. When this happens, scientists must revise the idea or come up with another explanation. *Falsifiability* is a very important principle when evaluating scientific knowledge.

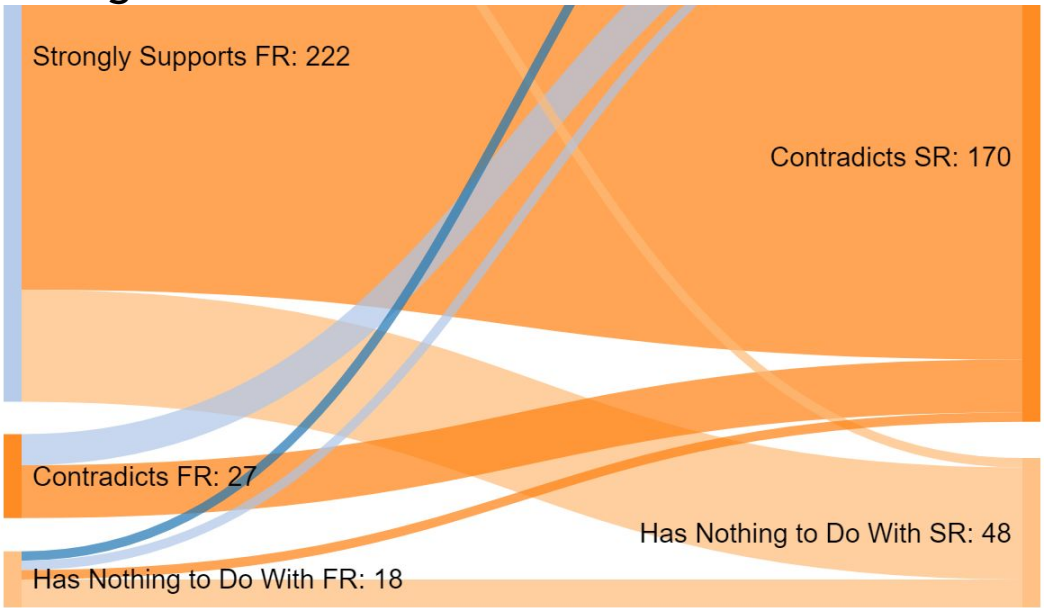
As a reminder, scientists may change their plausibility judgments about scientific ideas and they do this by looking at the connections between evidence and the idea. Evidence may:

1. *Support* an idea
2. *Strongly* support an idea
3. *Contradict* (oppose) an idea
4. Have *nothing to do* with the idea

With *falsifiability* in mind, *re-rank* each evidence from 1 to 4. (1 = most important and 4 = least important). Use each number only once.

Type of evidence	Your ranking
Evidence supports the idea	
Evidence strongly supports the idea	
Evidence contradicts (opposes) the idea	
Evidence has nothing to do with the idea	

Contradictory evidence promotes shifts in plausibility judgments about explanations, demonstrates the process of scientific evaluation, & deepens students' knowledge

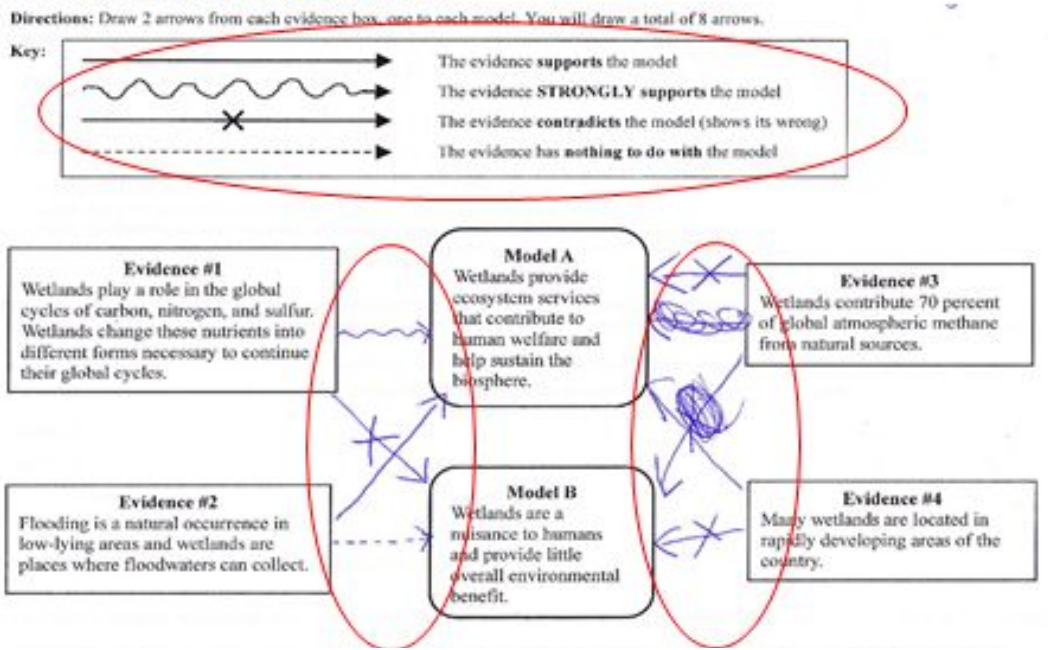


The Plausibility Ranking Task (p2)--*your new responses*

	1	2	3	4	TOTAL	SCORE
Evidence supports the idea	12.90% 4	25.81% 8	58.06% 18	3.23% 1	31	2.48
Evidence strongly supports the idea	38.71% 12	29.03% 9	19.35% 6	12.90% 4	31	2.94
Evidence contradicts (opposes) the idea	32.26% 10	45.16% 14	16.13% 5	6.45% 2	31	3.03
Evidence has nothing to do with the idea	16.13% 5	0.00% 0	6.45% 2	77.42% 24	31	1.55

Model-Evidence Link Diagram

Instructional scaffolds can facilitate students' evaluations to be more explicit and scientific



Webinar Outline

- 3-D Teaching and Learning
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Project Website: https://serc.carleton.edu/mel/index.html

The Model-Evidence Link Diagrams Project

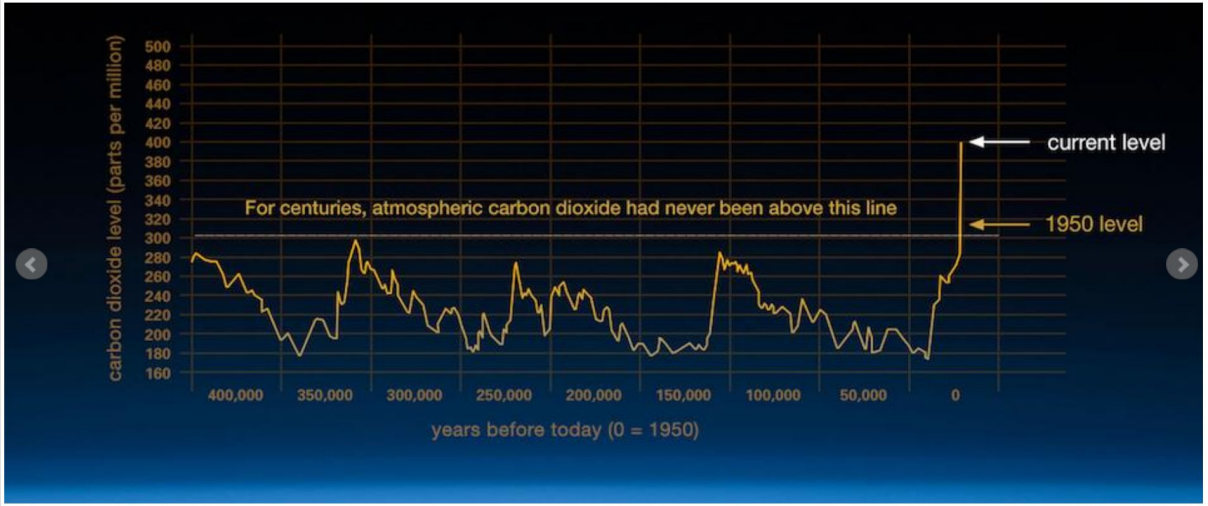
Model–Evidence Link Diagrams Project

Model–Evidence Link Diagrams Project

- About
- Teaching Resources
- Professional Development

Model–Evidence Link Diagrams Project

The purpose of our project is to promote students' scientific thinking when confronted with controversial and/or complex Earth and space science topics. We do this by using an instructional scaffold called the model–evidence link (MEL) diagram. We are currently adapting this scaffold to enable students to build their own MEL diagram, which we call the build–a–MEL (baMEL). Topics for MEL and baMEL activities include: climate change, earthquakes and fracking, wetlands use, formation of the moon, extreme weather, fossils and Earth's past, freshwater availability, and origins of the universe.



Webinar Evaluation Survey

Please fill out a Webinar Evaluation Survey at:

https://www.surveymonkey.com/r/MEL_2021_Pre

or linked to from this page:

https://serc.carleton.edu/mel/prof_dev/preinstitute_webinar.html

Please fill out this survey by Wednesday May 26, 9 pm EDT

Questions?

For general questions, use the Chat Box to ask them.

For specific questions, email us at MEL2institutes@gmail.com

Thank you - “See” you at the workshop!

ACKNOWLEDGEMENTS

The material in this Webinar is based upon work supported by the NSF under Grant Nos. 1721041 and 2027376. Any opinions, findings, conclusions, or recommendations expressed are those of the authors and do not necessarily reflect the NSF's views.