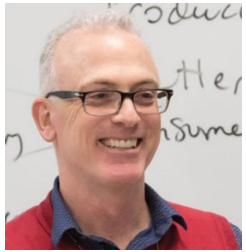
Teaching Students to Evaluate Sources and Claims

Pre-Workshop Webinar #2

LR-MEL Project Investigators



Doug Lombardi
U Maryland

Sarah McGrew
U Maryland

Donna Governor
U North Georgia

Carla McAuliffe
Institute for Global Environmental Strategies

Lorraine Ramirez Villarin
U North Georgia

Janelle Bailey
Temple U

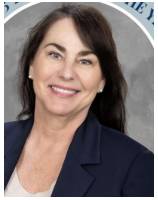
Missy Holzer
Science Curriculum Design Consultant

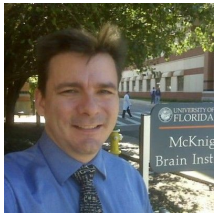
Gale Sinatra
U Southern California

Chantelle Renaud-Grant
U North Georgia

Sanlyn Buxner
Planetary Science Institute

LR-MEL Master Teachers





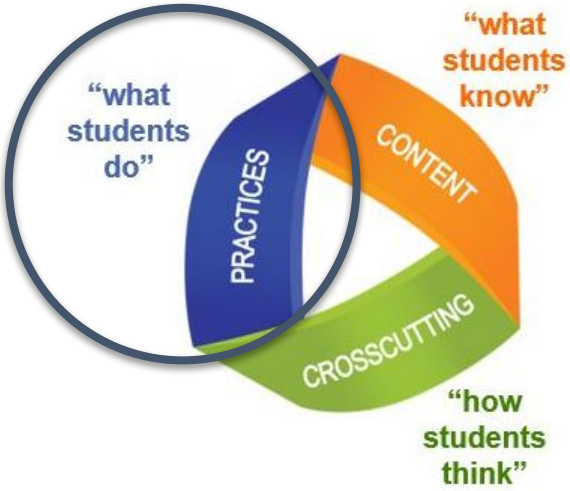
Penny Kline and Derek Piper
Vickery Creek Middle School (GA)

Andrea Johnson and Mike Magnotta
Philadelphia Performing Arts: A String Theory Charter School (PA)

Webinar Outline

- 3-D Teaching and Learning
- Science and Engineering Practices
- MEL Architecture
- Website Overview
- Next Steps

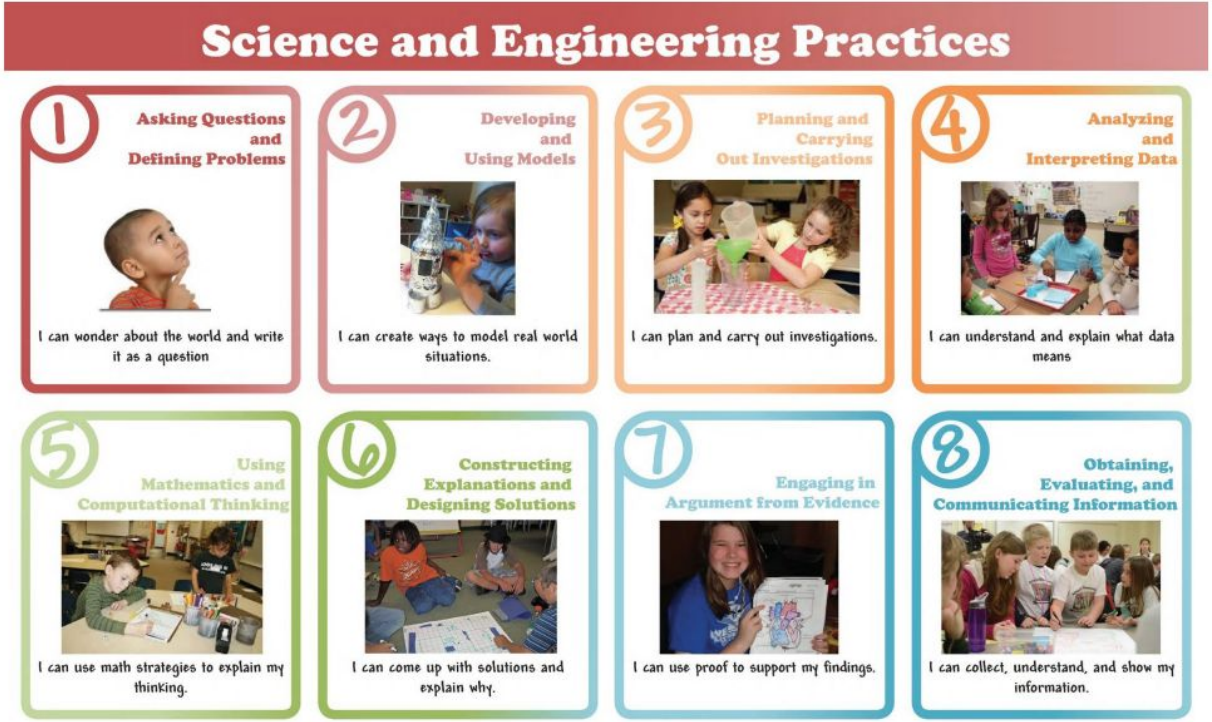
Shift in Science Education: 3-Dimensional Science Learning

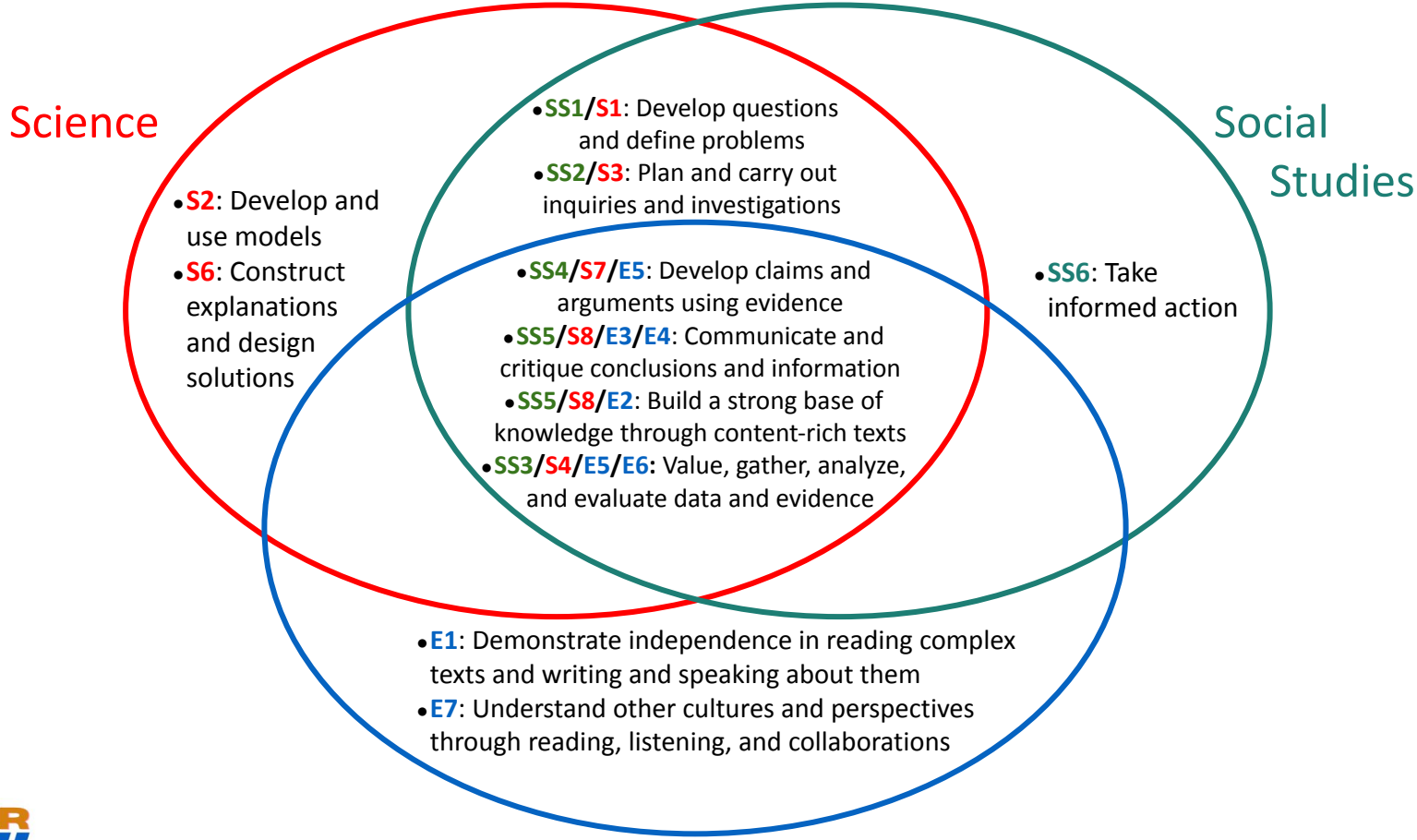


What does 3-D Teaching and Learning look like?

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

Science & Engineering Practices




Science
Social Studies
English/Language Arts
•S2: Develop and use models
•S6: Construct explanations and design solutions
•SS1/S1: Develop questions and define problems
•SS2/S3: Plan and carry out inquiries and investigations
•SS4/S7/E5: Develop claims and arguments using evidence
•SS5/S8/E3/E4: Communicate and critique conclusions and information
•SS5/S8/E2: Build a strong base of knowledge through content-rich texts
•SS3/S4/E5/E6: Value, gather, analyze, and evaluate data and evidence
•SS6: Take informed action
•E1: Demonstrate independence in reading complex texts and writing and speaking about them
•E7: Understand other cultures and perspectives through reading, listening, and collaborations

Engaging in Argument from Evidence

- Compare and evaluate competing arguments in light of currently accepted explanations, new evidence, limitations, constraints, and ethical issues
- Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations to determine the merits of arguments

Arguments Evaluate Claims and Evidence

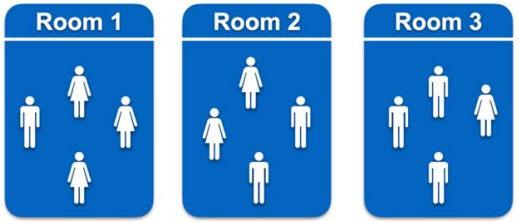
SS4/S7/E5: Develop claims and arguments using evidence

In Breakout Rooms:

- How does each content area support students to reach this goal?

Regroup:

- What did you discover?
- Where are the overlaps?



Familiar 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.

Scientists construct MODELS to explain evidence

Claims vs. Models

CLAIMS

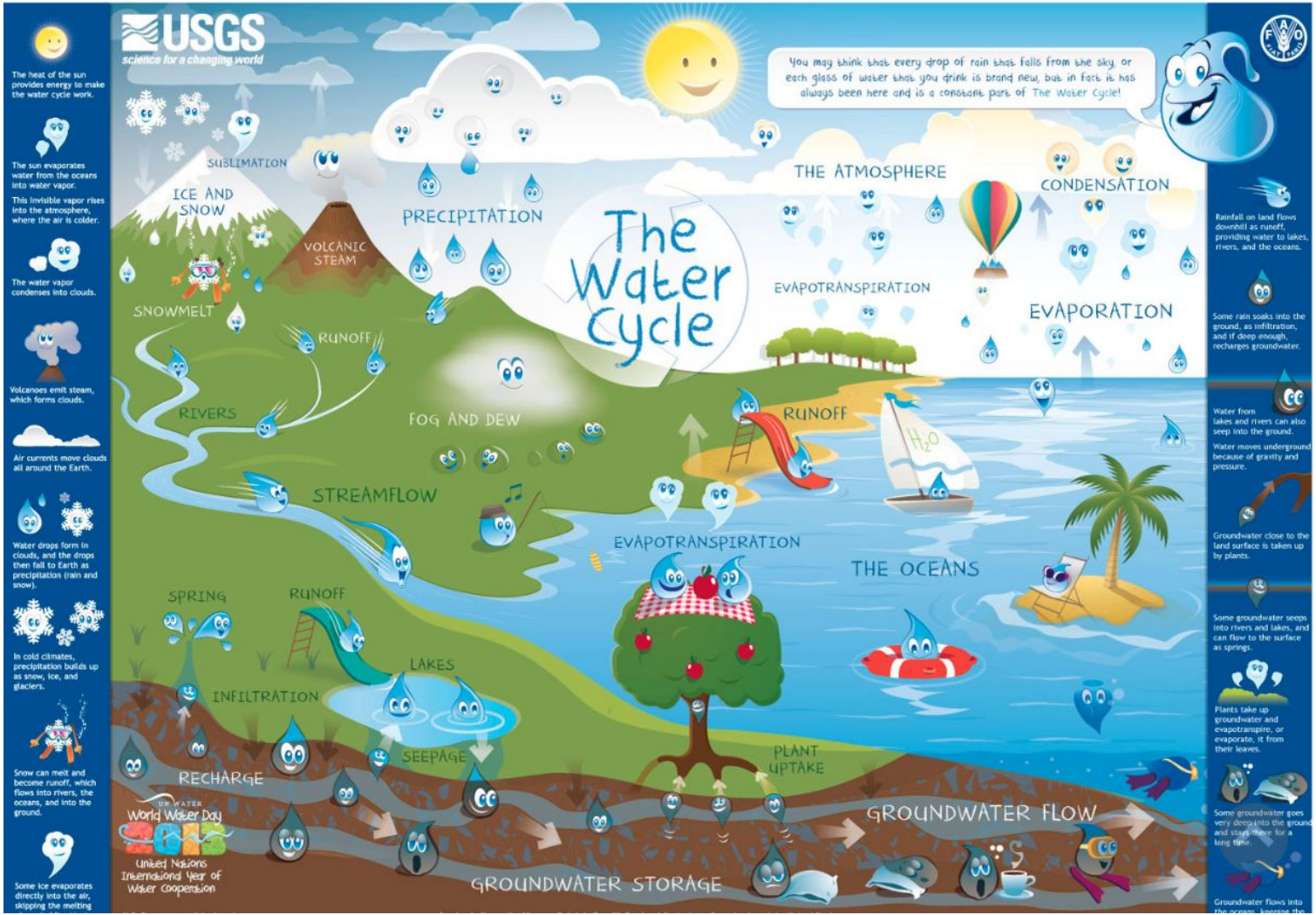
- An answer to a question
- An assertion based on results of an investigation
- Requires justification to support the claim

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!

Model of the Water Cycle



MEL Architecture: Evaluating Models

When using the Model-Evidence Link (MEL) activities, explanatory models are introduced and students evaluate models using plausibility judgments

What is Plausibility?

Chat Box!!!!

Plausibility of Models Explaining Climate Change

Name: _____ **Date:** _____ **Teacher:** _____ **Period:** ____

Please work on this individually.

Read the following information carefully.

Humans create *models* to help explain things.

Below are two models. These provide different explanations for why global temperatures have increased over the past 100 years and average sea levels have increased over the past 50 years.

Model A: Climate change is caused by humans who are releasing gases into the atmosphere.

A person who supports this model makes the following argument:

A few gases in Earth's atmosphere prevent some of Earth's energy from escaping out into space. Human activities are increasing the amount of these gases in the atmosphere. Therefore, humans are causing climate change.

Model B: Climate change is caused by increasing amounts of energy released from the Sun.

A person who supports this model makes the following argument:

The Sun is the main source of energy for planet Earth. Scientists have shown that for thousands of years Earth's average temperature increases when the Sun releases more energy. Therefore, the Sun is causing climate change.

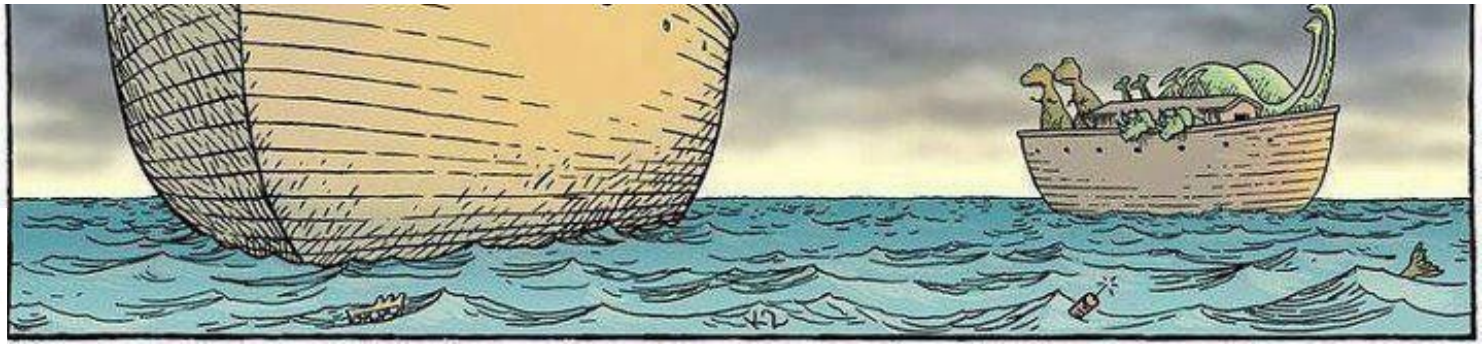
Plausibility is a judgment we make about the potential truthfulness of one model compared to another. The judgment may be tentative (not certain). You do not have to be committed to that decision.

Circle the plausibility of each model. [Make two circles, one for each model.]

	Greatly implausible (or even impossible)									Highly plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

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



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 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

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….

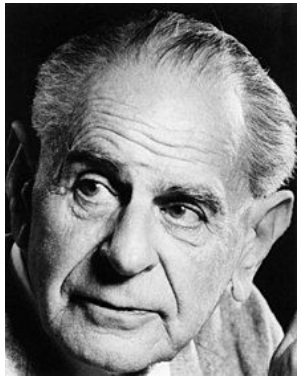
The Plausibility Ranking Task

	1	2	3	4	TOTAL
Evidence supports the idea	4.17% 1	29.17% 7	50.00% 12	16.67% 4	24
Evidence strongly supports the idea	45.83% 11	16.67% 4	20.83% 5	16.67% 4	24
Evidence contradicts (opposes) the idea	29.17% 7	50.00% 12	20.83% 5	0.00% 0	24
Evidence has nothing to do with the idea	20.83% 5	4.17% 1	8.33% 2	66.67% 16	24

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

THE LR MEL PROJECT

What About Contradictory Evidence?



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

"Theories can never be proven, only disproven"

Falsifiability

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/2025PRT2

Carefully read the following paragraph.

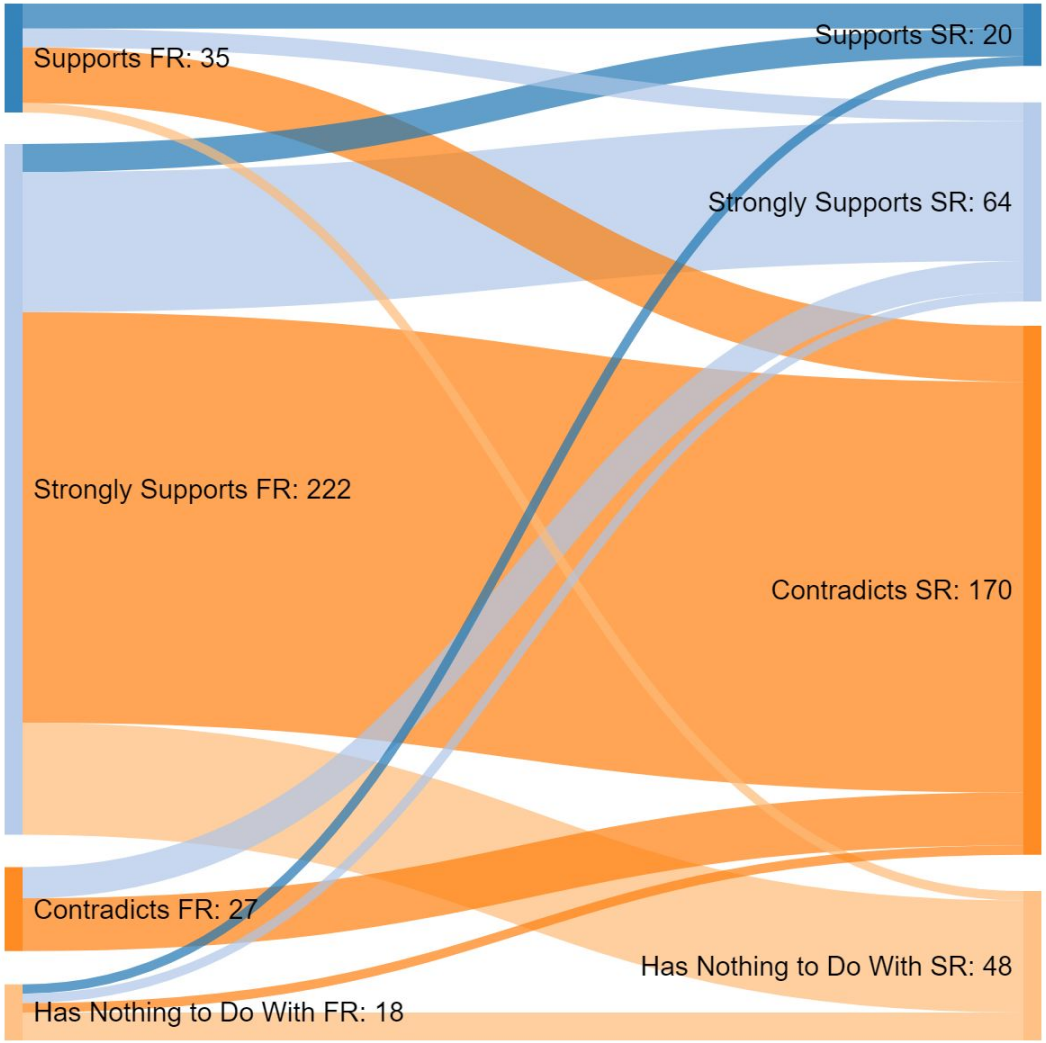
Scientific ideas must be *falsifiable*. In other words, scientific ideas can never be proven. But, ideas can be disproven by opposing evidence. When this happens, scientists must revise the idea or come up with another explanation. *Falsifiability* is a very important principle when evaluating scientific 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
Evidence supports the idea	2.86% 1	28.57% 10	65.71% 23	2.86% 1	35
Evidence strongly supports the idea	11.43% 4	48.57% 17	17.14% 6	22.86% 8	35
Evidence contradicts (opposes) the idea	77.14% 27	8.57% 3	8.57% 3	5.71% 2	35
Evidence has nothing to do with the idea	8.57% 3	14.29% 5	8.57% 3	68.57% 24	35

MEL Architecture
Step 1: Evaluating Models

Students are asked to evaluate competing scientific models

Plausibility of Models Explaining Climate Change

Name: _____ **Date:** _____ **Teacher:** _____ **Period:** ____

Please work on this individually.

Read the following information carefully.

Humans create *models* to help explain things.

Below are two models. These provide different explanations for why global temperatures have increased over the past 100 years and average sea levels have increased over the past 50 years.

Model A: Climate change is caused by humans who are releasing gases into the atmosphere.

A person who supports this model makes the following argument:

A few gases in Earth's atmosphere prevent some of Earth's energy from escaping out into space. Human activities are increasing the amount of these gases in the atmosphere. Therefore, humans are causing climate change.

Model B: Climate change is caused by increasing amounts of energy released from the Sun.

A person who supports this model makes the following argument:

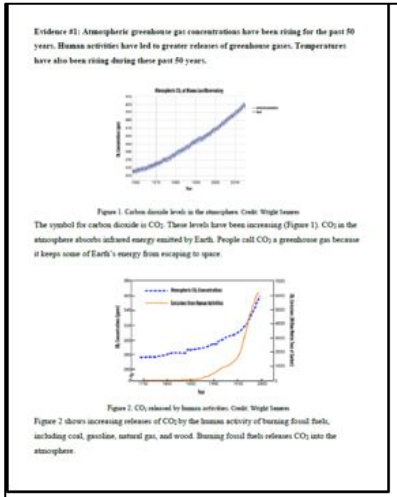
The Sun is the main source of energy for planet Earth. Scientists have shown that for thousands of years Earth's average temperature increases when the Sun releases more energy. Therefore, the Sun is causing climate change.

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.

Circle the plausibility of each model. [Make two circles, one for each model.]

	Greatly implausible (or even impossible)									Highly plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

MEL Step 2: Examining the Evidence



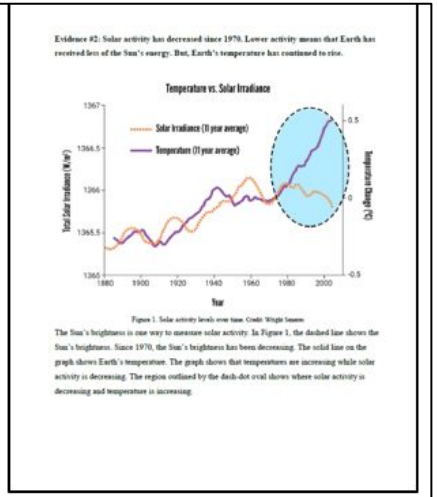
Evidence #1: Atmospheric greenhouse gas concentrations have been rising for the past 50 years. Human activities have led to greater releases of greenhouse gases. Temperatures have also been rising during these past 50 years.

Figure 1. Carbon dioxide levels in the atmosphere. Credit: Wright Senators

The symbol for carbon dioxide is CO_2. These levels have been increasing (Figure 1). CO_2 in the atmosphere absorbs infrared energy emitted by Earth. People call CO_2 a greenhouse gas because it keeps some of Earth's energy from escaping to space.

Figure 2. CO_2 released by human activities. Credit: Wright Senators

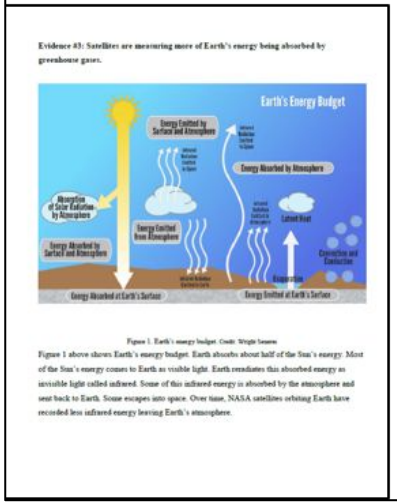
Figure 2 shows increasing releases of CO_2 by the human activity of burning fossil fuels, including coal, gasoline, natural gas, and wood. Burning fossil fuels releases CO_2 into the atmosphere.



Evidence #2: Solar activity has decreased since 1970. Lower activity means that Earth has received less of the Sun's energy. But, Earth's temperature has continued to rise.

Figure 1. Solar activity levels over time. Credit: Wright Senators

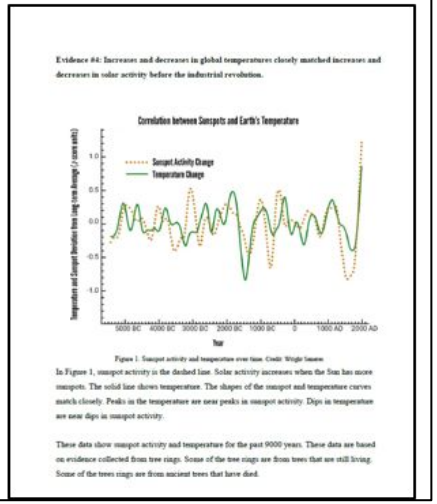
The Sun's brightness is one way to measure solar activity. In Figure 1, the dashed line shows the Sun's brightness. Since 1970, the Sun's brightness has been decreasing. The solid line on the graph shows Earth's temperature. The graph shows that temperatures are increasing while solar activity is decreasing. The region outlined by the dash-dot oval shows where solar activity is decreasing and temperature is increasing.



Evidence #3: Satellites are measuring more of Earth's energy being absorbed by greenhouse gases.

Figure 1. Earth's energy budget. Credit: Wright Senators

Figure 1 above shows Earth's energy budget. Earth absorbs about half of the Sun's energy. Most of the Sun's energy comes to Earth as visible light. Earth reradiates this absorbed energy as invisible light called infrared. Some of this infrared energy is absorbed by the atmosphere and sent back to Earth. Some escapes into space. Over time, NASA satellites orbiting Earth have recorded less infrared energy leaving Earth's atmosphere.



Evidence #4: Increases and decreases in global temperatures closely matched increases and decreases in solar activity before the industrial revolution.

Figure 1. Sunspot activity and temperature over time. Credit: Wright Senators

In Figure 1, sunspot activity is the dashed line. Solar activity increases when the Sun has more sunspots. The solid line shows temperature. The shapes of the sunspot and temperature curves match closely. Peaks in the temperature are near peaks in sunspot activity. Dips in temperature are near dips in sunspot activity.

These data show sunspot activity and temperature for the past 9000 years. These data are based on evidence collected from tree rings. Some of the tree rings are from trees that are still living. Some of the trees rings are from ancient trees that have died.

MEL Step 3: Connecting Evidence to Models

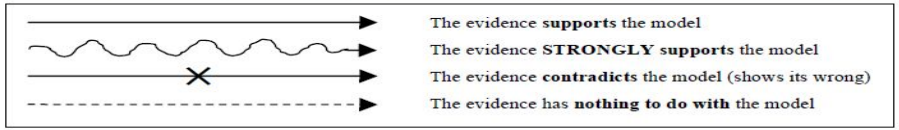
Complete the MEL diagram using the evidence texts as a resource

Name: _____ **Date:** _____ **Teacher:** _____ **Period:** _____

If you worked with other students, their name(s): _____

Directions: Draw 2 arrows from each evidence box, one to each model. You will draw a total of 8 arrows.

Key:



Evidence #1
Atmospheric greenhouse gas concentrations have been rising for the past 50 years. Human activities have led to greater releases of greenhouse gases. Temperatures have also been rising during these past 50 years.

Model A
Our current climate change is caused by increasing amounts of gases released by human activities.

Evidence #3
Satellites are measuring more of Earth's energy being absorbed by greenhouse gases.

Evidence #2
Solar activity has decreased since 1970. Lower activity means that Earth has received less of the Sun's energy. But, Earth's temperature has continued to rise.

Model B
Our current climate change is caused by increasing amounts of energy released from the Sun.

Evidence #4
Increases and decreases in global temperatures closely matched increases and decreases in solar activity before the industrial revolution.

Types of Arrows

Supports

Strongly Supports

Contradicts

Has nothing to do with

Evidence #1

Atmospheric greenhouse gas concentrations have been rising for the past 50 years. Human activities have led to greater releases of greenhouse gases. Temperatures have also been rising during these past 50 years.

Evidence #2

Solar activity has decreased since 1970. Lower activity means that Earth has received less of the Sun's energy. But, Earth's temperature has continued to rise.

Model A

Climate change is caused by humans who are releasing gases into the atmosphere.

Model B

Our current climate change is caused by increasing amounts of energy released from the Sun.

Evidence #3

Satellites are measuring more of Earth's energy being absorbed by greenhouse gases.

Evidence #4

Increases and decreases in global temperatures closely matched increases and decreases in solar activity before the industrial revolution.

Break Out Rooms!

Click here for evidence texts

MEL Step 4:
Model Re-Evaluation & Explanation

Explain your reasoning

Re-evaluate the Models using Evidence-based reasoning

Name_____ **Date**_____ **Teacher**_____ **Period**_____ **Topic**_____

Please work on this part <u>individually</u> after you complete your diagram.

1. Now that you have completed the diagram, reconsider the plausibility of Models A and B (and C, if there is one). Circle the plausibility of each model. [Make one circle for each model.]

	Greatly implausible (or even impossible)									Highly plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10
Model C (if there is one)	1	2	3	4	5	6	7	8	9	10

2. For the model you selected as most plausible, explain why you think so.

Evaluating the Explanation Task

3. Which arrows changed your plausibility judgments about the models? If your plausibility judgment did not change, which arrows supported your original plausibility judgments? Consider 2 lines of evidence. For each line, does it support, strongly support, or contradict one of the models? Why? When writing your explanation, consider the following:

- Use the specific information from the evidence text and figures to support your response. Ex: when looking at graphs or figures, be sure to describe the patterns in the data.
- Describe any cause and effect relationships found in the text.

Evidence #_____strongly supports | supports | contradicts | has nothing to do with Model_____*because*:

Evidence #_____strongly supports | supports | contradicts | has nothing to do with Model_____*because*:

Evaluate students claims using evidence-based reasoning

Project Website: https://serc.carleton.edu/mel/index.html

Webinar Evaluation Survey

Please fill out a Webinar Evaluation Survey at:

https://www.surveymonkey.com/r/37LMQPX

(this will also be emailed out)

Please fill out this survey by Friday May 23, 9pm EDT

Questions?

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

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

DON'T LEAVE!
We need you in our Institute groups for some last minute business items!

Thank you - We look forward to seeing you at the institutes!

ACKNOWLEDGEMENTS

This research project is supported by the US National Science Foundation (NSF) under Grant Nos. 2201012, 2201015, 2201016, 2201017, 2201018, and 2346657. Any opinions, findings, conclusions, or recommendations expressed are those of the authors and do not necessarily reflect the NSF's views.