

Think you know it? Well, think again: Reappraising plausibility judgments to facilitate knowledge reconstruction in science

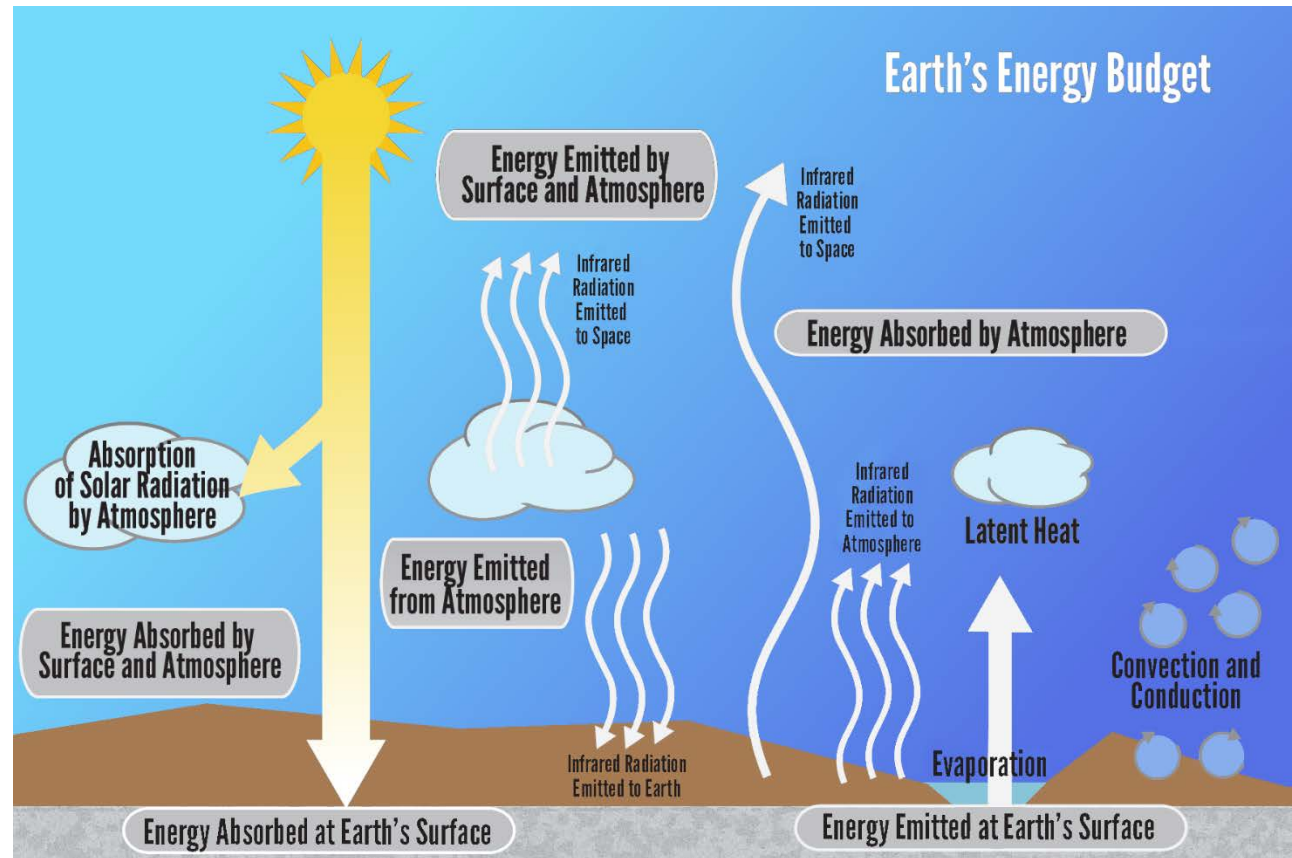
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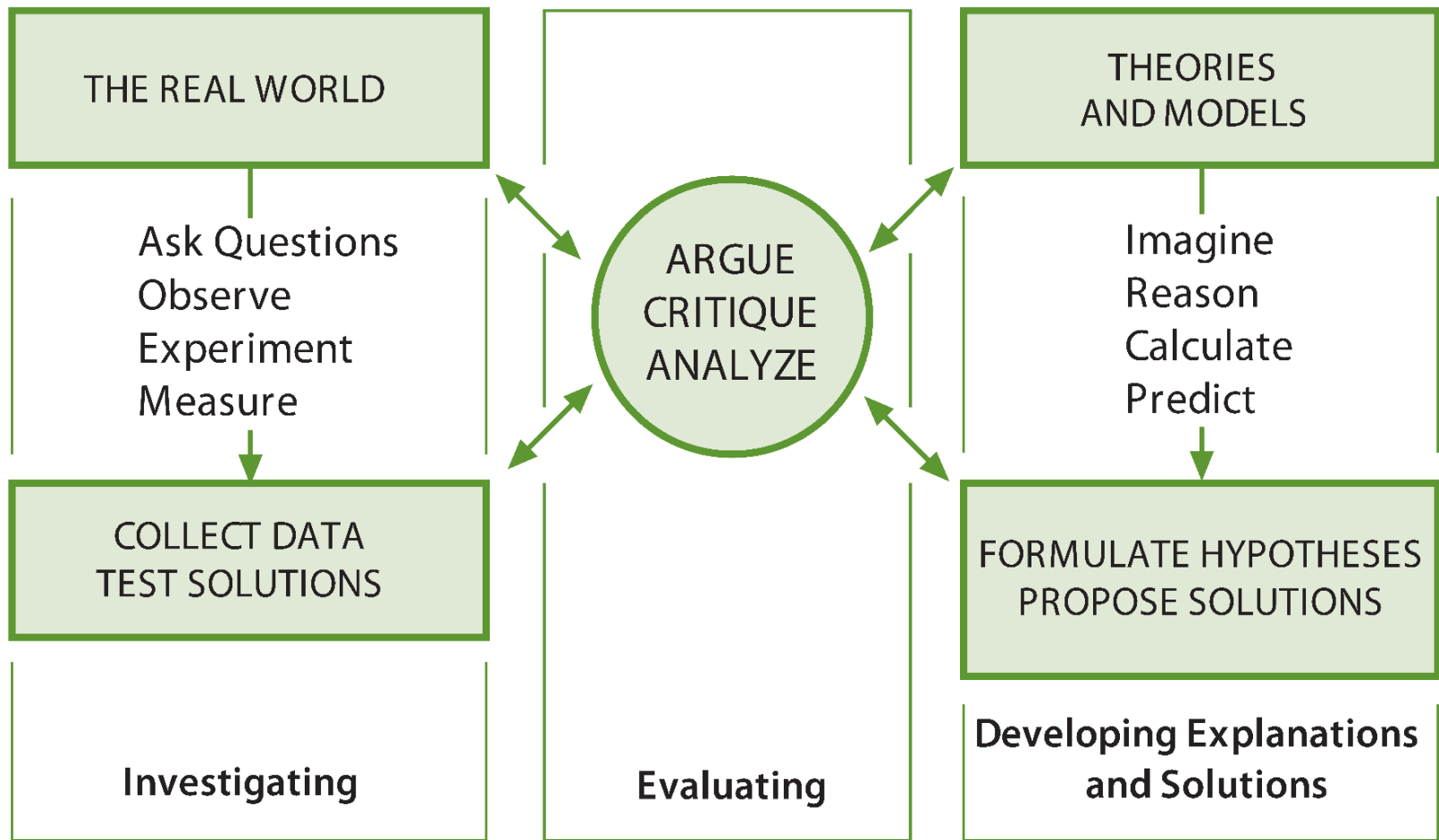


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RESEARCH GROUP



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Scientific literacy involves knowing both (1) *what* scientists know & (2) *how* scientists know



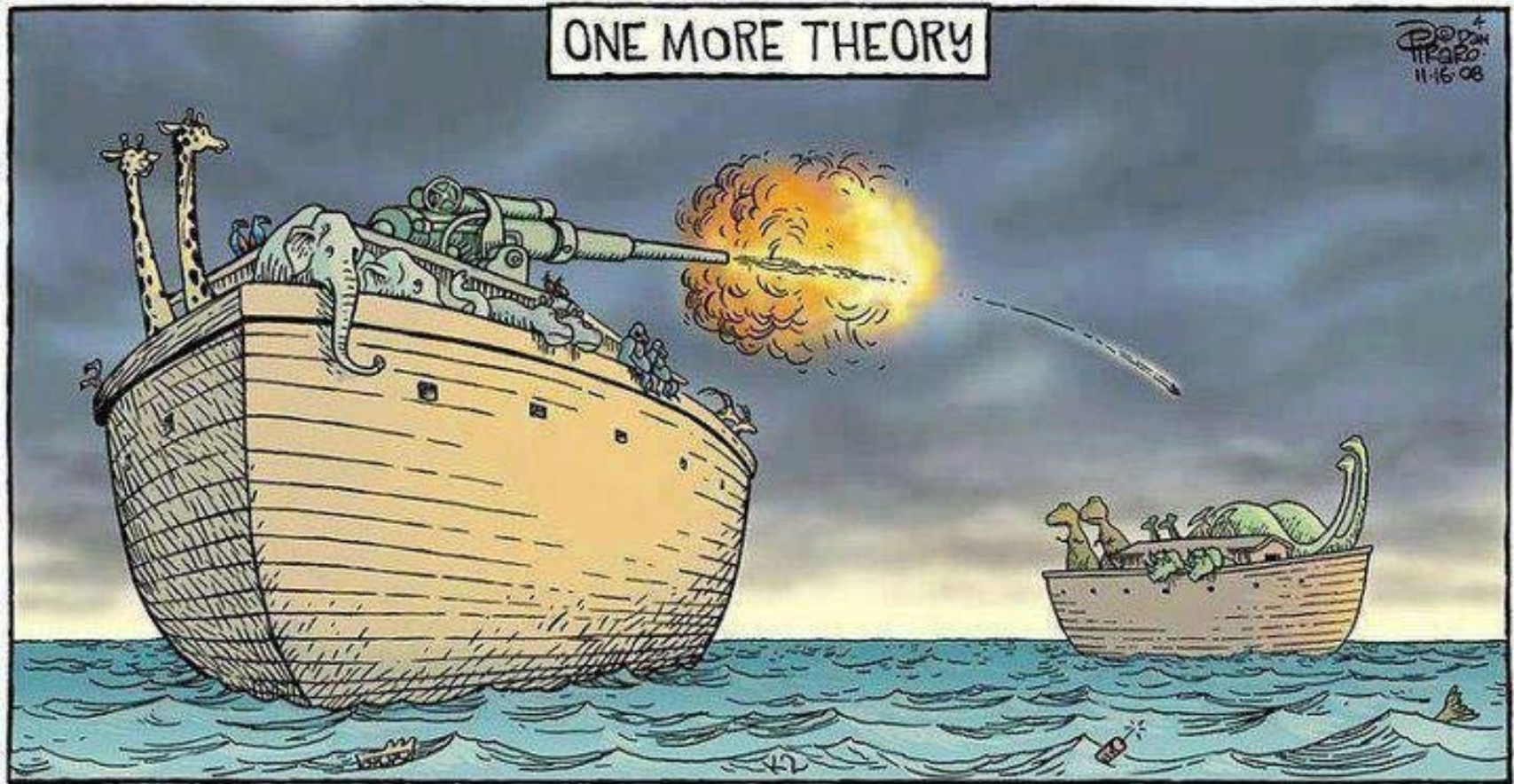
Evaluation as argument, critique, and analysis is central to scientific thinking and knowledge construction (NRC, 2012)

However, students may find scientific explanations to be implausible



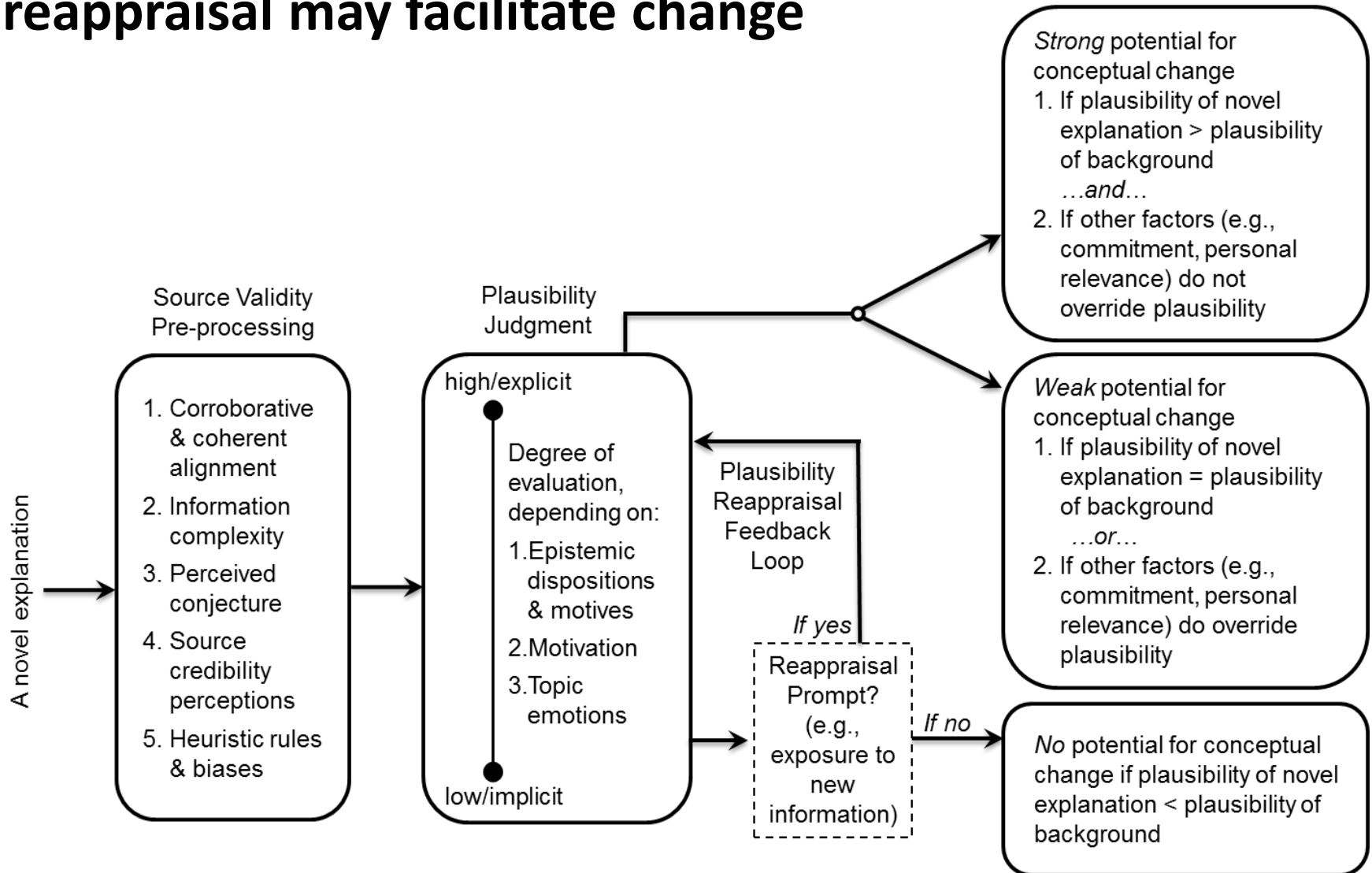
Epistemic judgments (e.g., plausibility) are often formed through automatic cognitive evaluations with little purposeful thinking (Lombardi et al., 2016a)

Plausibility is specifically an epistemic judgment associated with explanations



Other types of epistemic judgments are associated with evidence (e.g., credibility, reliability, & believability; Lombardi et al., 2016a)

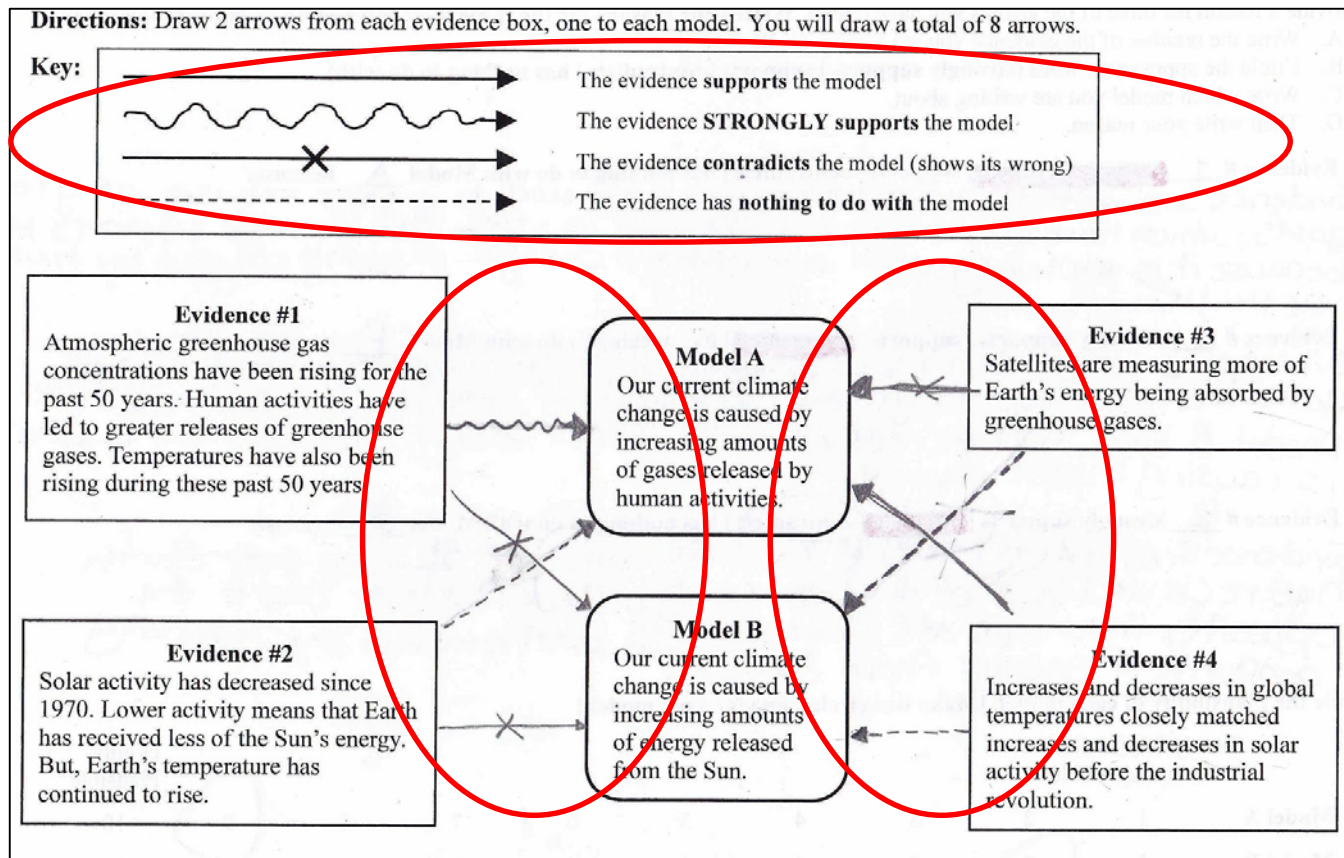
Plausibility is a tentative epistemic judgment, and with reappraisal may facilitate change



Model of plausibility judgments in conceptual change (PJCC; Lombardi et al., 2016a)

Instructional scaffolds can help make students' evaluations more explicit, thoughtful, & scientific...

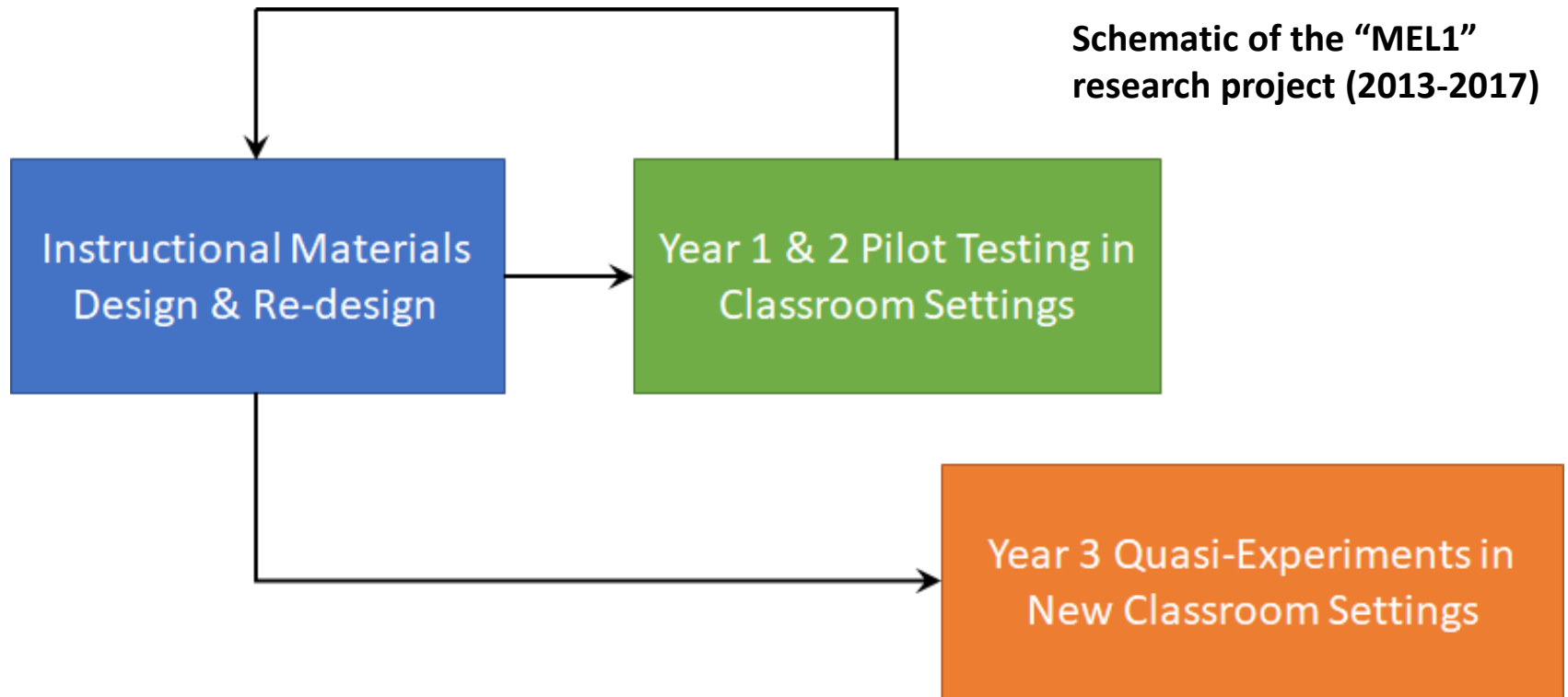
...Chinn & colleagues (2012, 2014)



Scientific evaluations may also promote students' reappraisal of their initial plausibility judgments & knowledge reconstruction (Lombardi et al., 2016a)

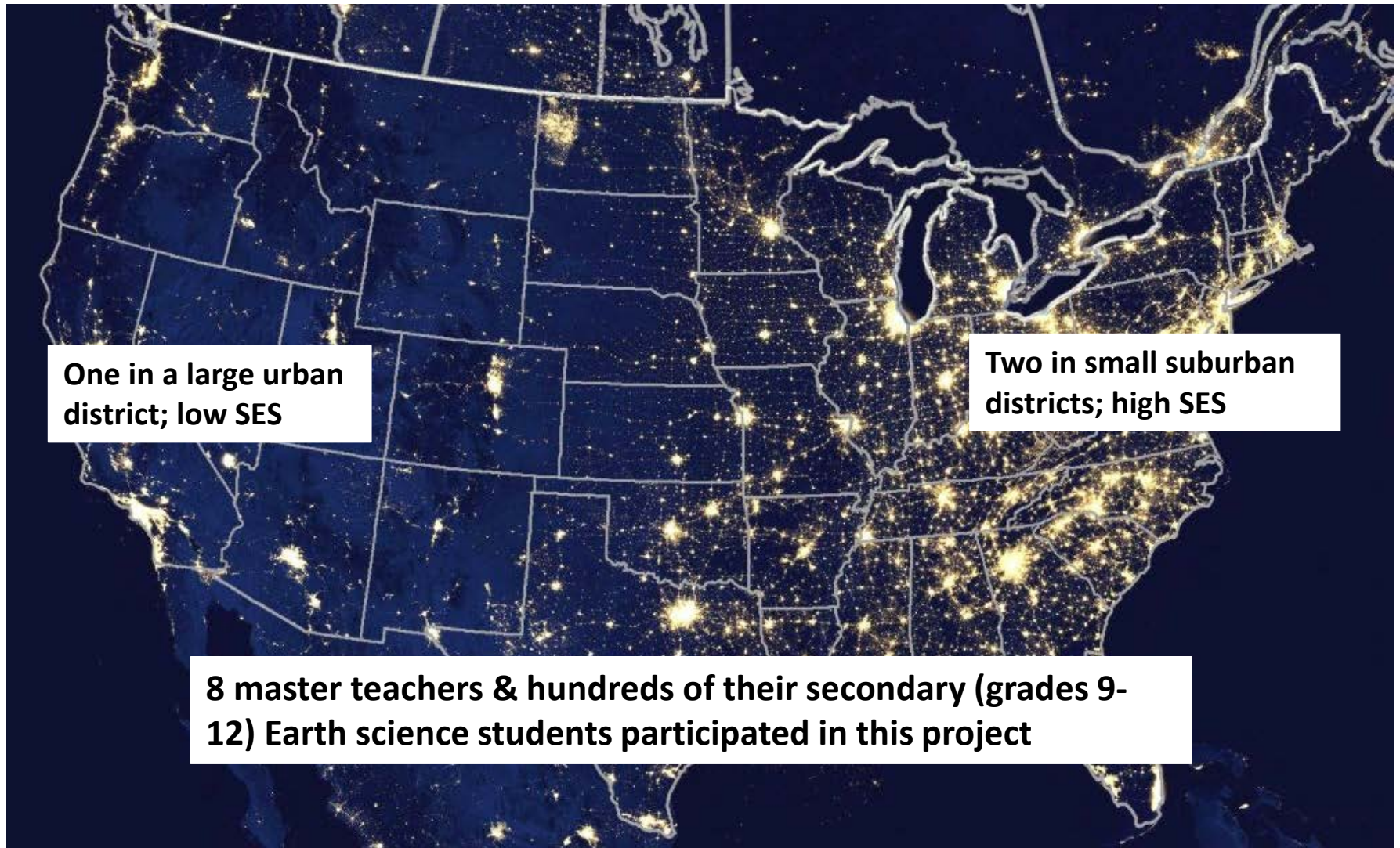
Our projects investigate students' evaluations, plausibility, & knowledge about Earth science topics

Schematic of the "MEL1" research project (2013-2017)



Our research question: How does sustained instruction promoting evaluation result in plausibility reappraisal and knowledge changes about Earth science topics?

This first project involved three school districts from very different parts of the US



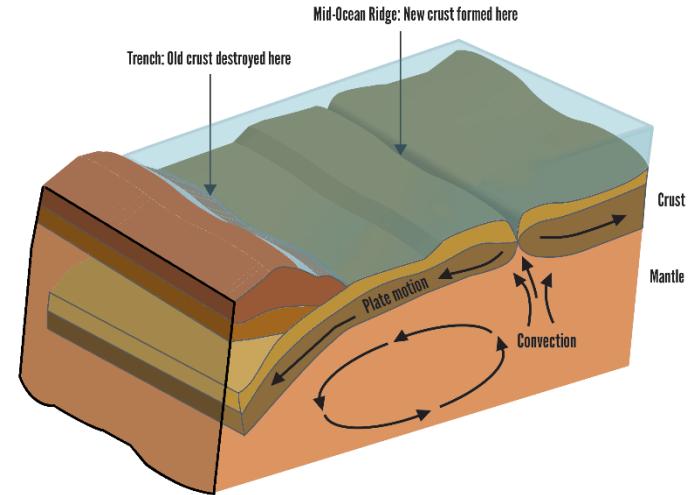
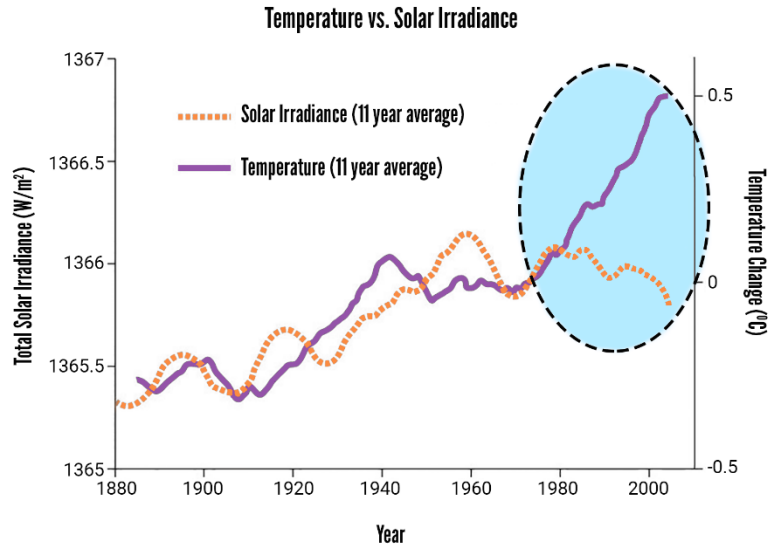
One in a large urban district; low SES

Two in small suburban districts; high SES

8 master teachers & hundreds of their secondary (grades 9-12) Earth science students participated in this project

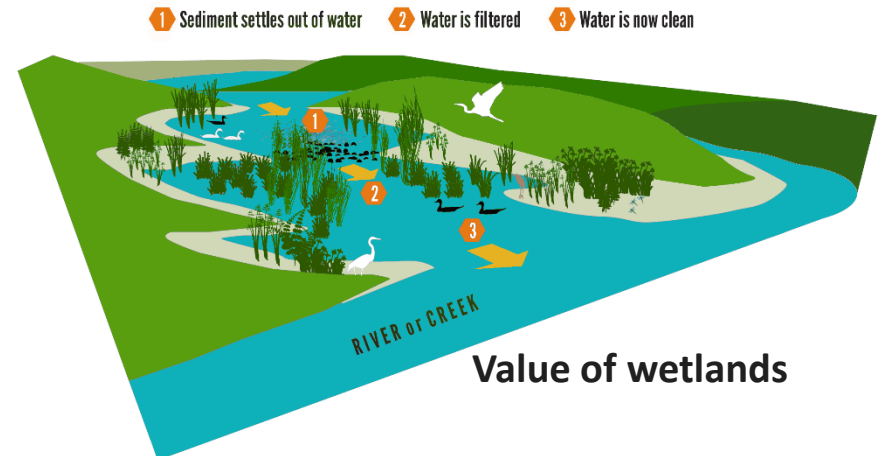
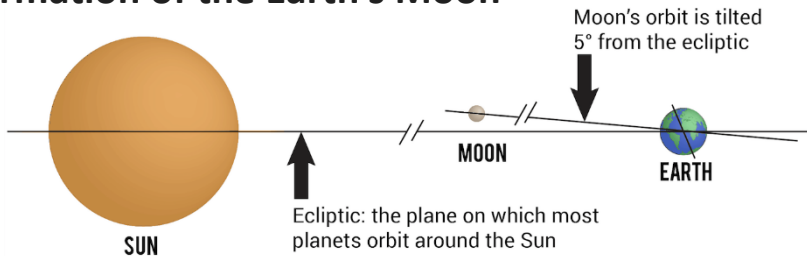
Secondary students experienced instruction about 4 topics during the course of a school year

Causes of current climate change



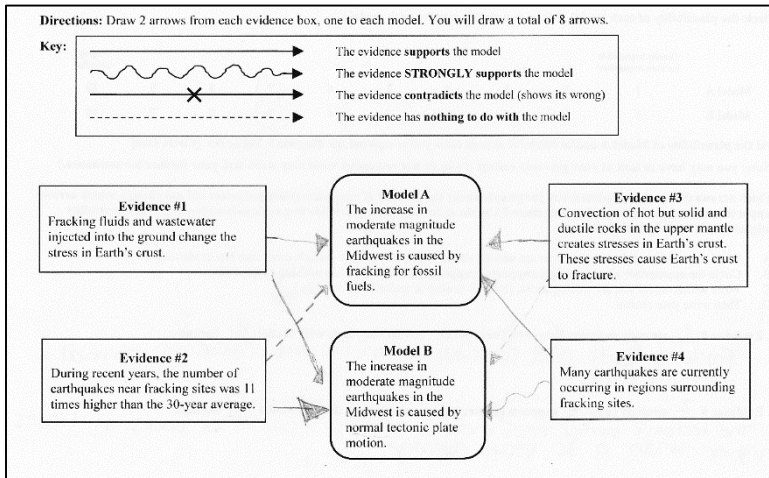
Hydraulic fracturing & earthquakes

Formation of the Earth's Moon

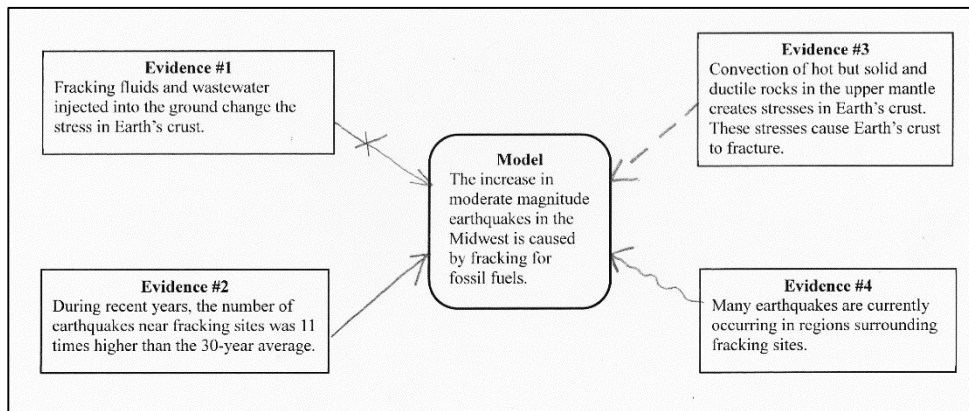


Value of wetlands

In Year 3, we conducted a quasi-experiment comparing three different tasks



**The Model-Evidence Link (MEL) diagram,
4 lines of evidence, 2 alternatives**



**The Mono-MEL diagram, 4 lines of
evidence, only 1 alternative**

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

Directions: Use the following codes to indicate how well each evidence supports each model. You should put a code into each blank table cell.

Key:

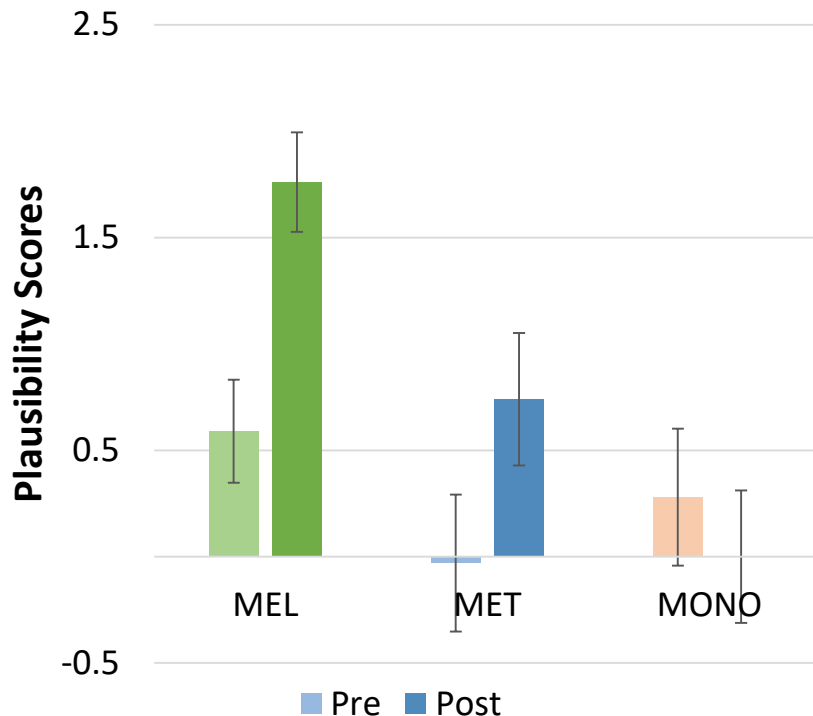
- S** = The evidence **supports** the model
- SS** = The evidence **STRONGLY supports** the model
- C** = The evidence **contradicts** the model (shows its wrong)
- N** = The evidence has **nothing to do with** the model

	Model A The increase in moderate magnitude earthquakes in the Midwest is caused by fracking for fossil fuels.	Model B The increase in moderate magnitude earthquakes in the Midwest is caused by normal tectonic plate motion.
Evidence #1 Fracking fluids and wastewater injected into the ground change the stress in Earth's crust.	C	N
Evidence #2 During recent years, the number of earthquakes near fracking sites was 11 times higher than the 30-year average.	S	N
Evidence #3 Convection of hot but solid and ductile rocks in the upper mantle creates stresses in Earth's crust. These stresses cause Earth's crust to fracture.	N	SS
Evidence #4 Many earthquakes are currently occurring in regions surrounding fracking sites.	S	C

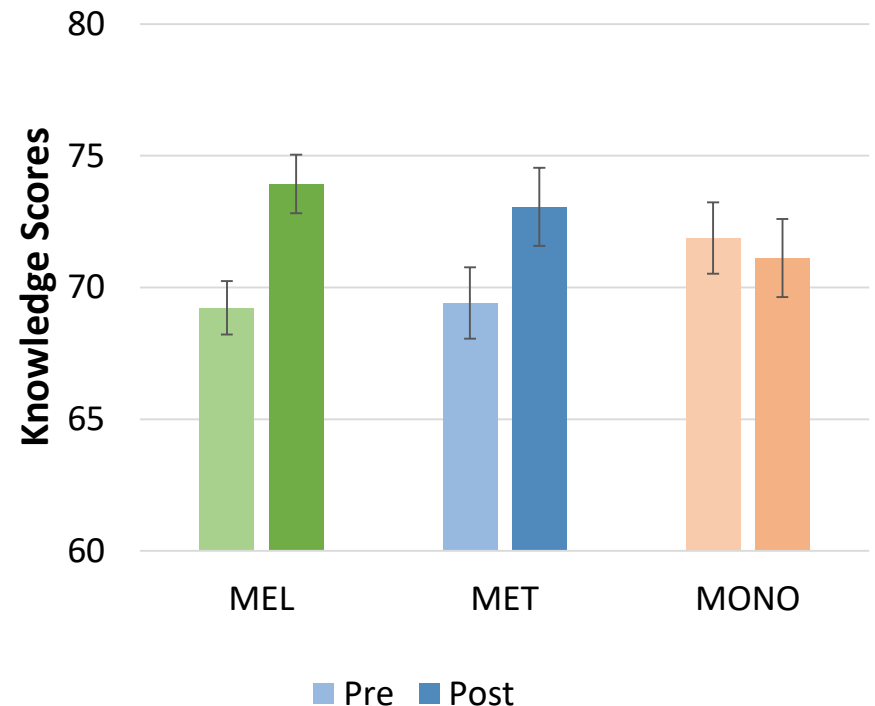
**The Model-Evidence Link Table (MET),
4 lines of evidence, 2 alternatives**

Participants scores showed meaningful plausibility shifts and knowledge increases toward the scientific...

...but only when students simultaneously evaluated lines of evidence and two alternative explanations (Lombardi et al., 2018a)

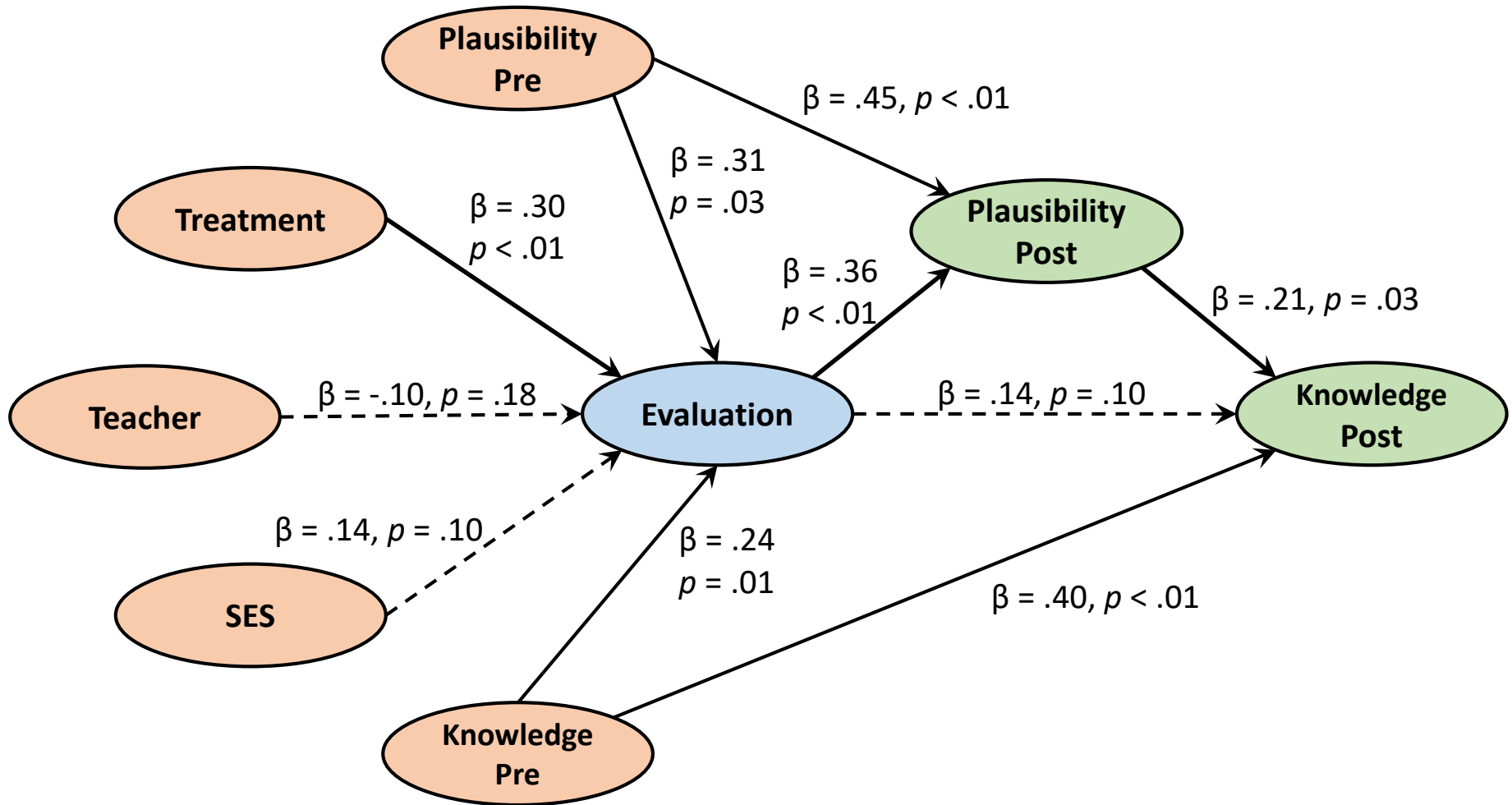


Wilks' $\lambda = .843$, $F(2,61) = 5.67$, $p = .006$,
medium effect size ($\eta^2 = .157$)



Wilks' $\lambda = .893$, $F(2,61) = 3.67$, $p = .03$,
medium effect size ($\eta^2 = .107$)

Deeper evaluations facilitated participants' plausibility reappraisals and greater knowledge



GoF = .437 (large explanatory power); APC = .265, $p < .001$; ARS = .330, $p < .001$; AVIF = 1.12; AFVIF = 1.46; and NLBCDR = 1.0; Lombardi et al. (2018a)

These results are aligned with and complementary to several empirical studies and recent theory...

...(e.g., Lombardi et al., 2013; Lombardi et al., 2016a,b,c; Lombardi et al., 2018b)



But we are unsatisfied, because unpublished results suggest that students are not transferring their evaluative thinking outside of the classroom context

Our current project examines scaffolds that increase students' "conceptual agency" (Pickering, 1995)

Freshwater Build-a-MEL

Evidence #1
Land use changes have generated large pressures on fresh water resources. These changes are affecting both water quality and availability.

Evidence #2
The world's population is increasing. This stresses the supply of freshwater.

Evidence #3
Groundwater provides freshwater to many people around the world. In many places, people are using groundwater faster than it is replaced by precipitation.

Evidence #4
Water reclamation costs have gone down in the past several years. These costs vary depending on location. Making sea water drinkable costs more than reclamation.

Evidence #5
Advances in engineering have led to better access to quality drinking water. At the same time life expectancy and quality of life have improved.

Evidence #6
Estimates of groundwater recharge on a large-scale may not take into account the subsurface differences in sediment type or thickness. This underestimation may offset any future negative impact on water quality.

Evidence #7
Glaciers are a source of freshwater in many parts of the world. Glacial ice mass is decreasing worldwide.

Evidence #8
Most climate predictions are on regional scales. Microclimates are local areas where precipitation and temperature are influenced by vegetation cover, topography, and human activity. Large-scale predictions may not accurately reflect local trends in freshwater availability.

Evidence #9
In the contiguous US, average temperatures and precipitation have increased since 1901. From 2000-2015, the US was abnormally dry with some parts of the country in moderate to severe drought.

Directions: Write the number of each evidence you are using and for each model you have selected in the boxes below. Then draw 2 arrows from each evidence box, one to each model. You will draw a total of 8 arrows.

Key:

- The evidence supports the model
- The evidence **STRONGLY** supports the model
- X The evidence contradicts the model (shows its wrong)
- The evidence has nothing to do with the model

Evidence # _____	Model _____	Evidence # _____
Evidence # _____	Model _____	Evidence # _____

To build a MEL, pick two of these three models

Model A
Earth's freshwater is abundant and will remain so even in the face of global climate change.

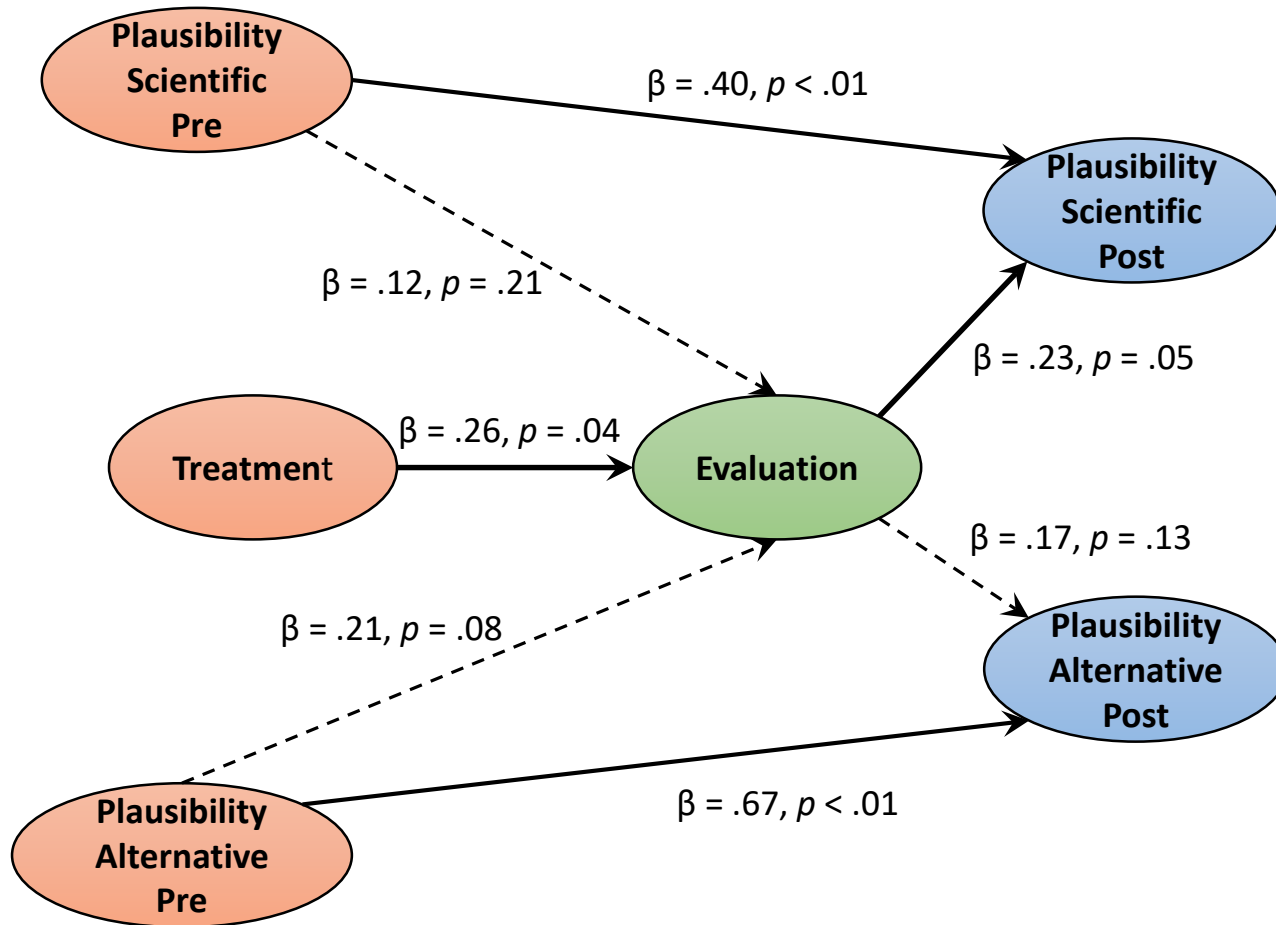
Model B
Earth has a shortage of freshwater that can be met by engineering solutions.

Model C
Earth has a shortage of freshwater, which will worsen as our world's population increases.

To build a MEL, pick four of these nine lines of evidence

Students who exercise conceptual agency are authors of their own contributions, accountable to the classroom learning community, and have the authority to think about and solve problems (Nussbaum & Asterhan, 2016)

Initial pilot testing reveals that the baMEL may increase evaluations above the pre-constructed MEL



GoF = .434 (large explanatory power), ARS = .248

Researchers & teachers need to help students scientifically evaluate & reappraise their epistemic judgments...

...and development of scientific thinking practices are essential for all so that we can equitably address current and future global challenges



Acknowledgements and thank you!

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