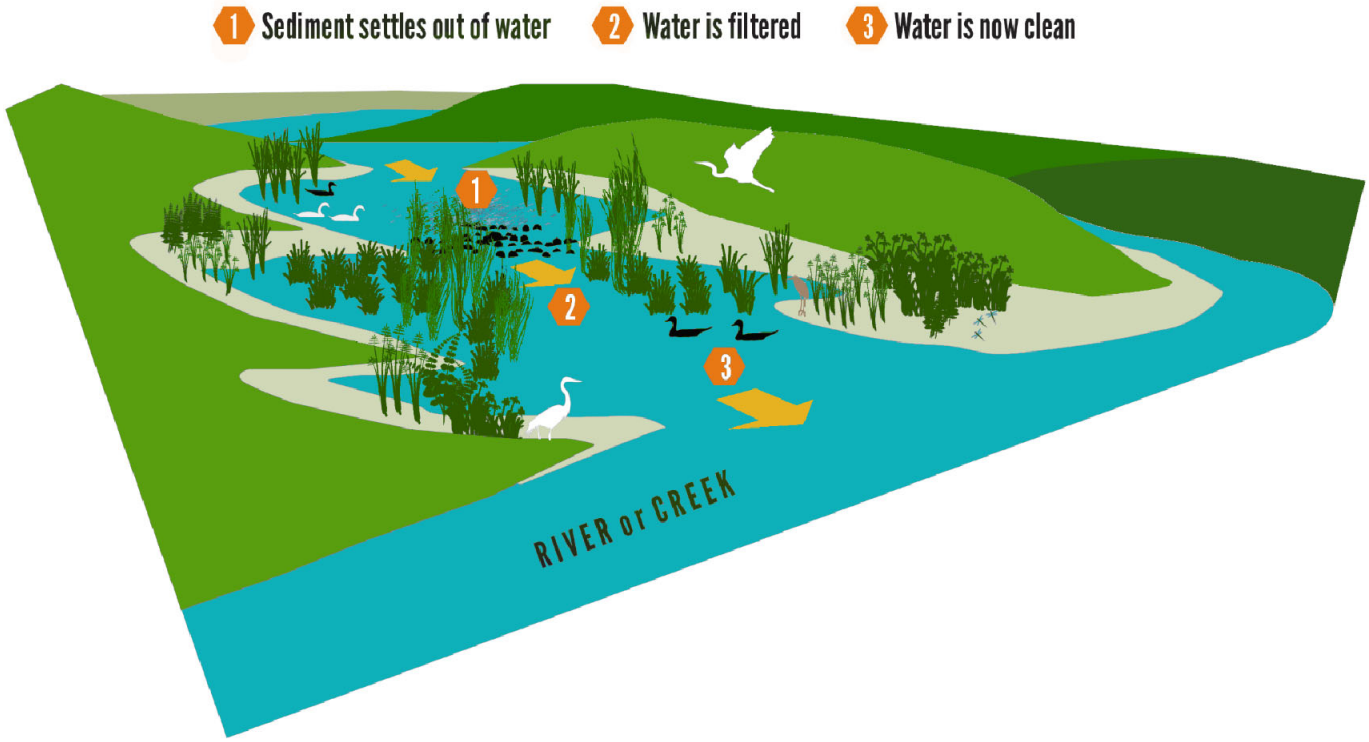
Evaluating Explanations about Water Resources: Scaffolds to Shift Students' Epistemic Judgments toward the Scientific

Doug Lombardi,

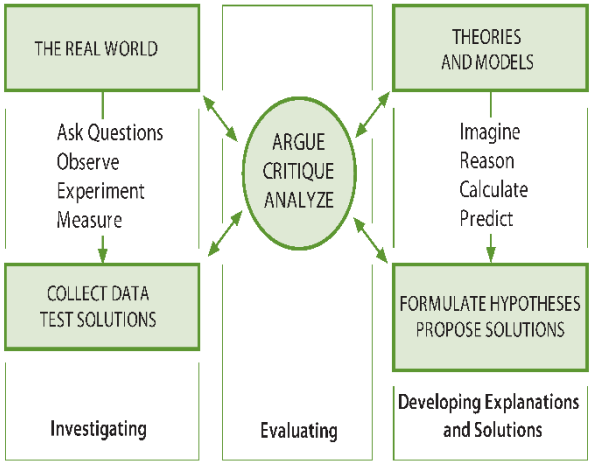
doug.lombardi@temple.edu

Timothy G. Klavon, Margaret A. Holzer, & Reed Kendall

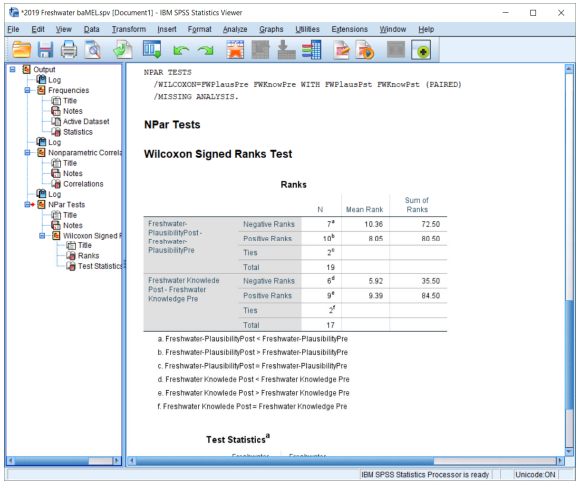


My research is supported, in part, by the US National Science Foundation (NSF) under Grant Nos. DRL-1316057 and DRL-1721041. Any opinions, findings, conclusions, or recommendations expressed are those of the author and do not necessarily reflect the NSF's views.

This presentation will overview our recent research about students' understanding of water resources



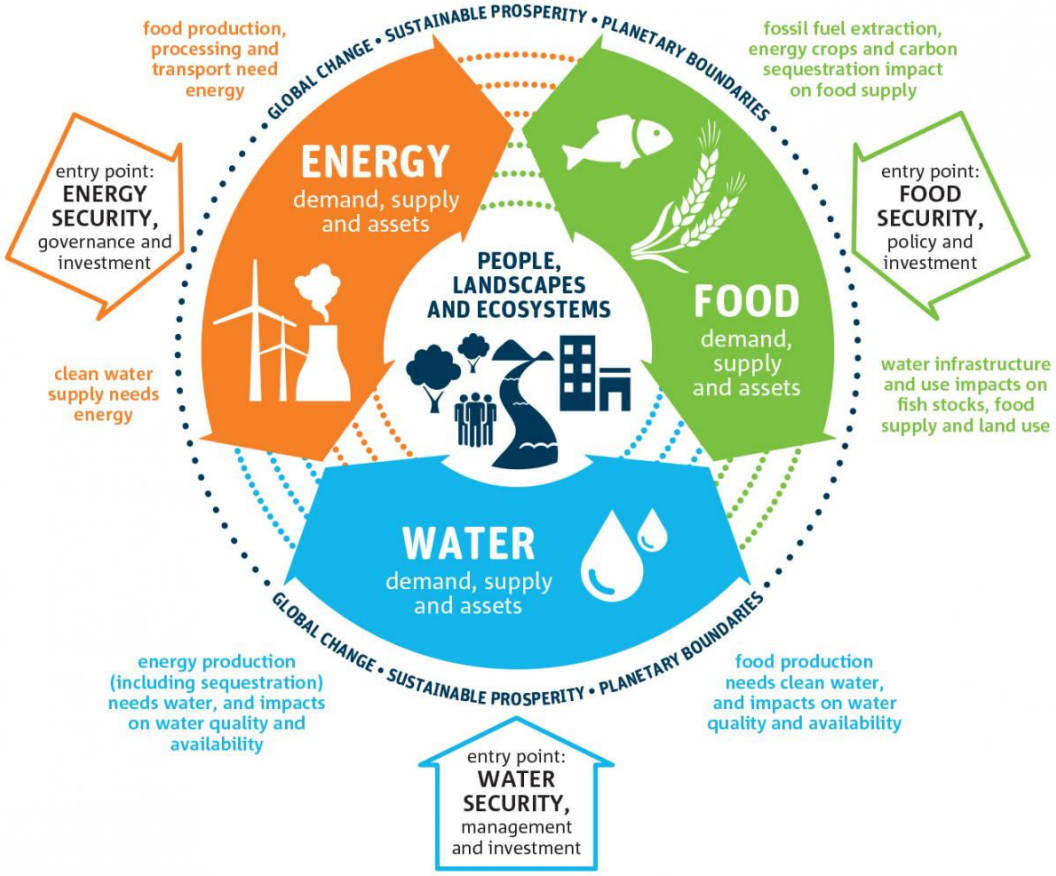
Theoretical and empirical foundations



Our present study

Implications and the road ahead

The Food Energy Water (FEW)-Nexus is a framework to address issues with human-natural systems



There is rapidly growing worldwide interest in research about education and discourse around the FEW-Nexus (Forbes et al., 2018)

Pressing and complex local and global FEW challenges requires increased scientific literacy…

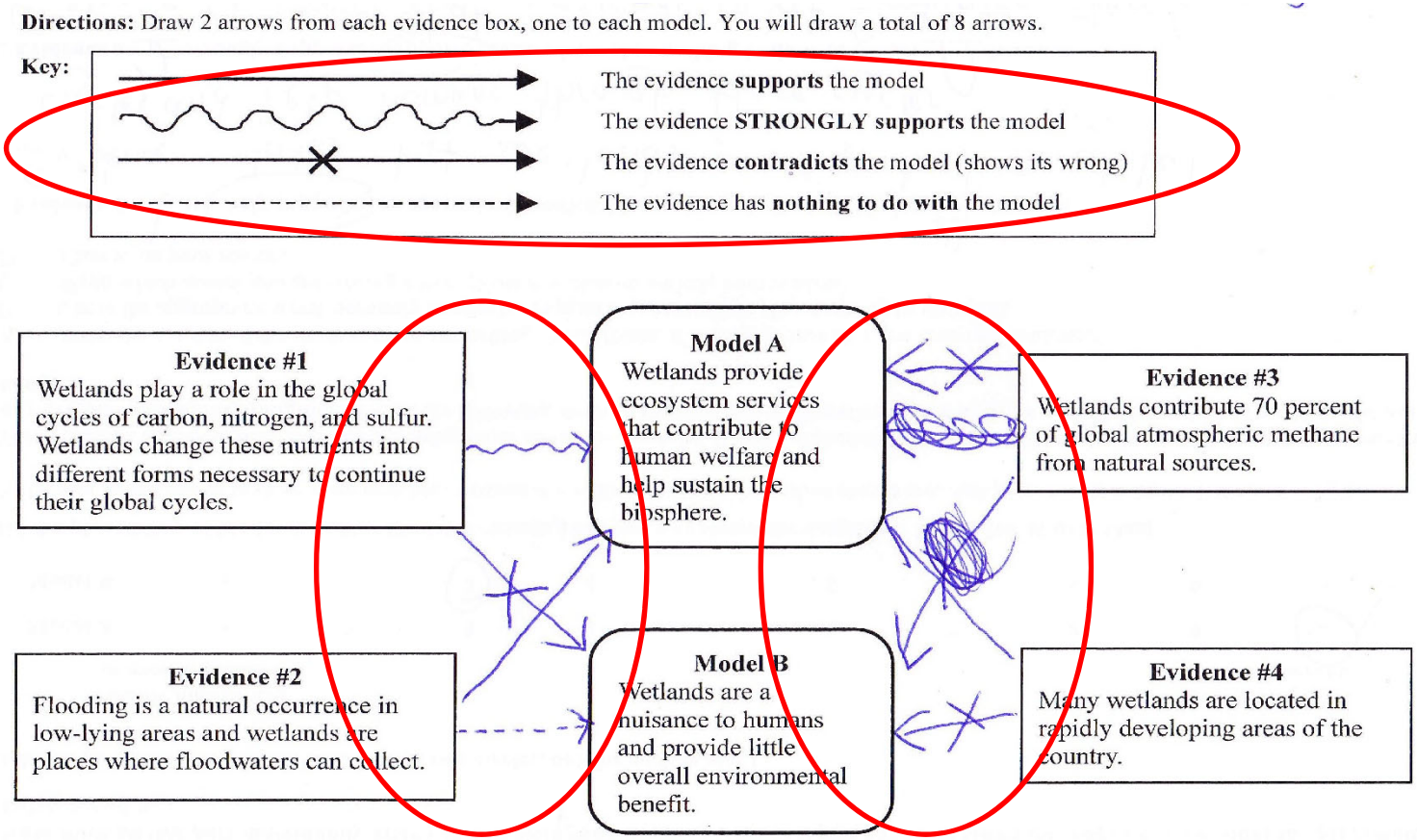
…and to deepen scientific literacy, students' must understanding both (a) what scientists know and (b) how scientists come to know what they know

However, students may find scientific explanations to be implausible

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

Classroom instructional scaffolds can help make students' evaluations explicit, thoughtful, & scientific

Chinn & colleagues (2012, 2014)

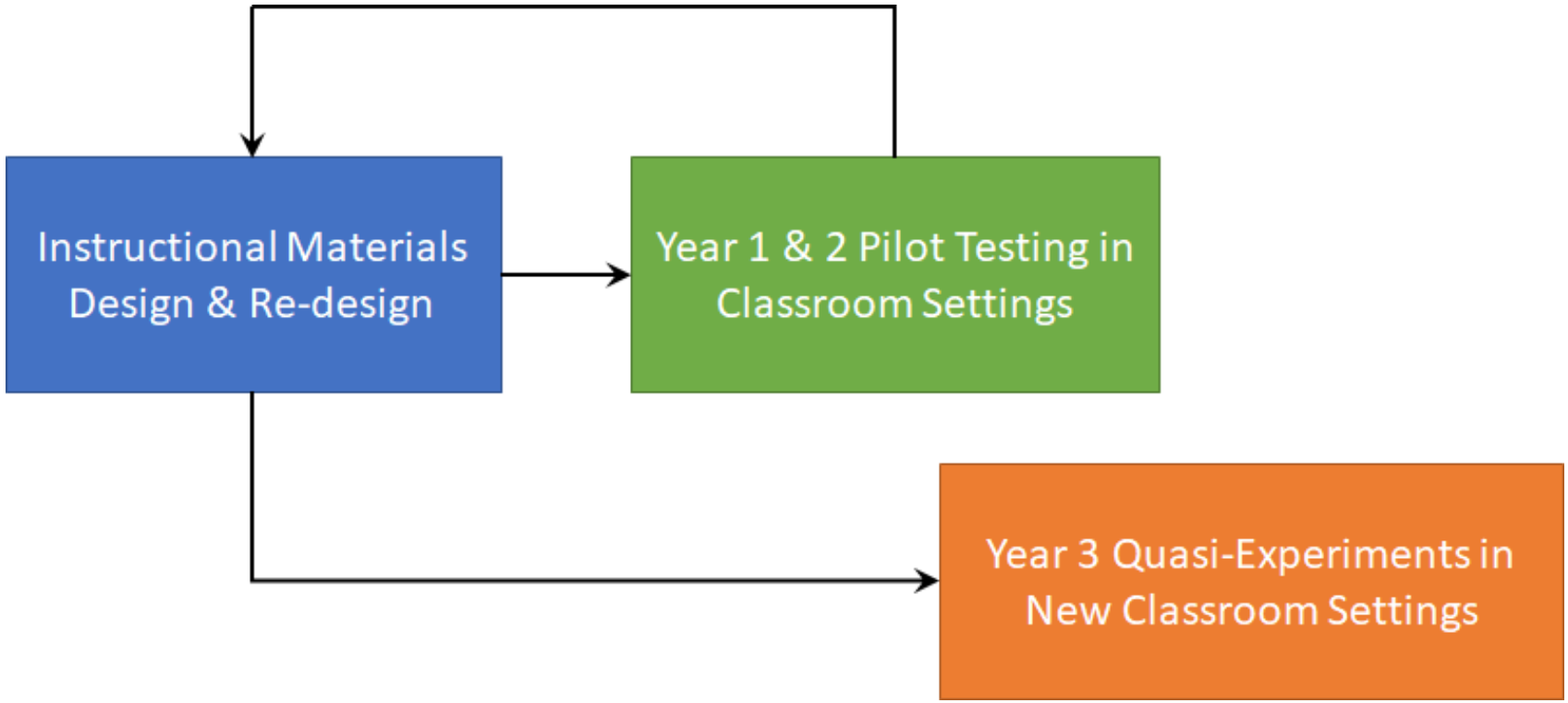


Example of student completed Model-Evidence Link (MEL) diagram

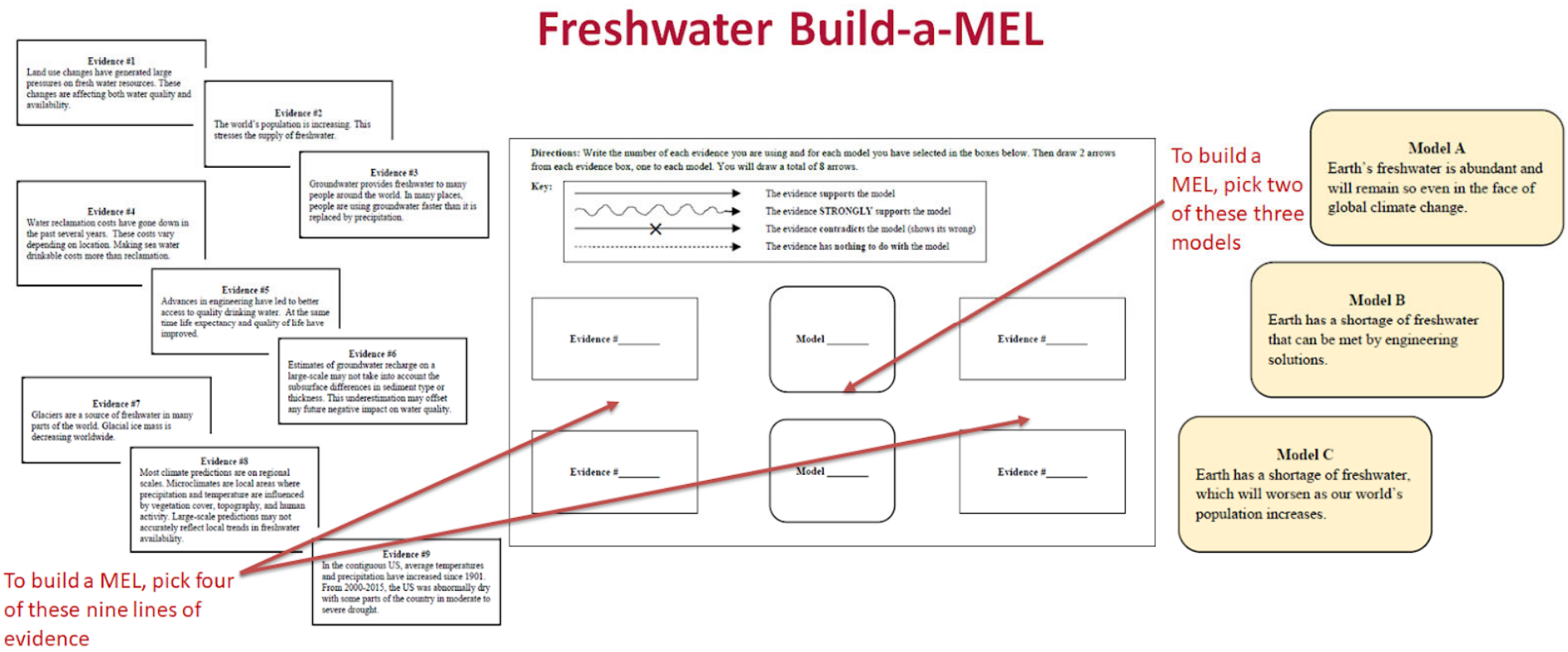
More critical evaluations may also promote students' reappraisal of their initial plausibility judgments & knowledge reconstruction (Lombardi et al., 2016)

Our projects investigate students' evaluations, plausibility, & knowledge about water resources & other science topics

Schematic of our first research project (2013-2017)

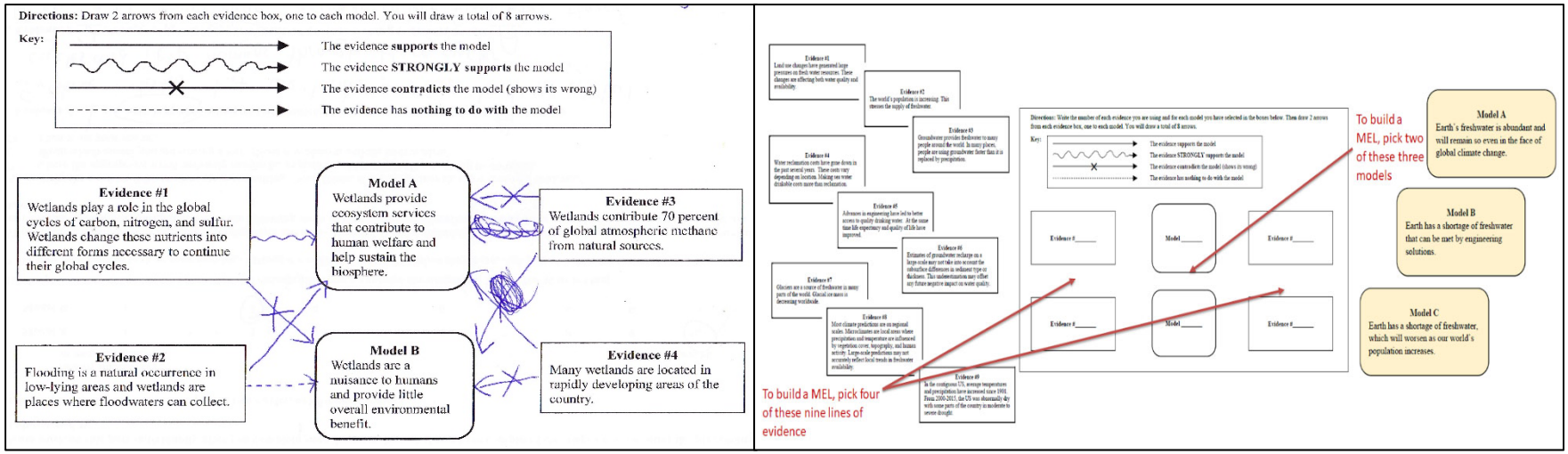


Our current project examines scaffolds that may increase students' epistemic agency



Students who exercise epistemic 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; Pickering, 1995)

The present pilot study compared students' learning between the two types of MEL activities



H: the build-a-MEL would result in greater levels of evaluation, scientific shifts in plausibility, & increased knowledge about water resources than the preconstructed-MEL

N **= 64 grade 9-12 students at two different schools, 1 in Georgia & 1 in New Jersey**

All students completed a written explanation task after completing their diagram or table

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

A. Write the number of the evidence you are writing about.
B. Circle the appropriate word (**strongly supports | supports | contradicts | has nothing to do with**).
C. Write which model you are writing about.
D. Then write your reason.

1. Evidence # 1 **strongly supports | supports | contradicts | has nothing to do with Model** A **because:**
Evidence 1 says that human activities have lead to greater releases of greenhouse gases, which have been rising for the past 50 years. This strongly supports Model A because it is explaining that our climate change is being caused by human activities.

2. Evidence # 1 **strongly supports | supports | contradicts | has nothing to do with Model** B **because:**
Evidence 1 contradict Model B, because evidence one says that human activities have lead to greater releases of greenhouse gases, while model B says that increasing amounts of energy from the sun is what is causing climate change.

3. Evidence # 2 **strongly supports | supports | contradicts | has nothing to do with Model** B **because:**
Evidence 2 contridicts Model B because evidence 2 says that Earth has recieved less of the suns energy, and mode B says the opposite, that climate change has been caused by increasing amounts of energy from the sun.

Students rated the plausibility (pre and post) of two or three alternative explanatory models for a phenomenon

Case 1: Probabilistic Reasoning

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

Case 2: Plausibilistic Reasoning (common)

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

Case 3: Plausibilistic Reasoning (uncommon)

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

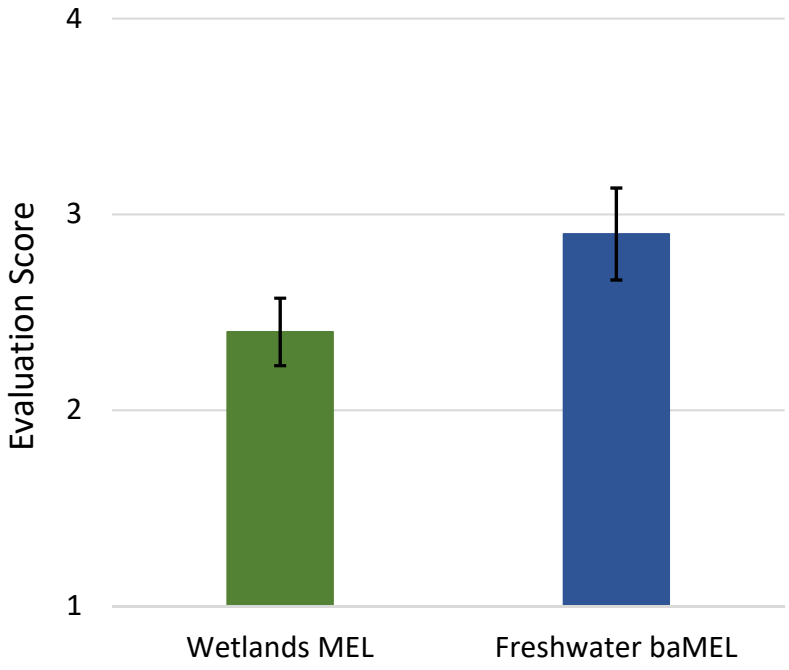
	Greatly implausible (or even impossible)									Highly Plausible
Model A	1	2	**3**	4	5	6	7	8	9	10
Model B	1	2	**3**	4	5	6	7	8	9	10

Short knowledge surveys probed students' understanding for each topic pre and post instruction

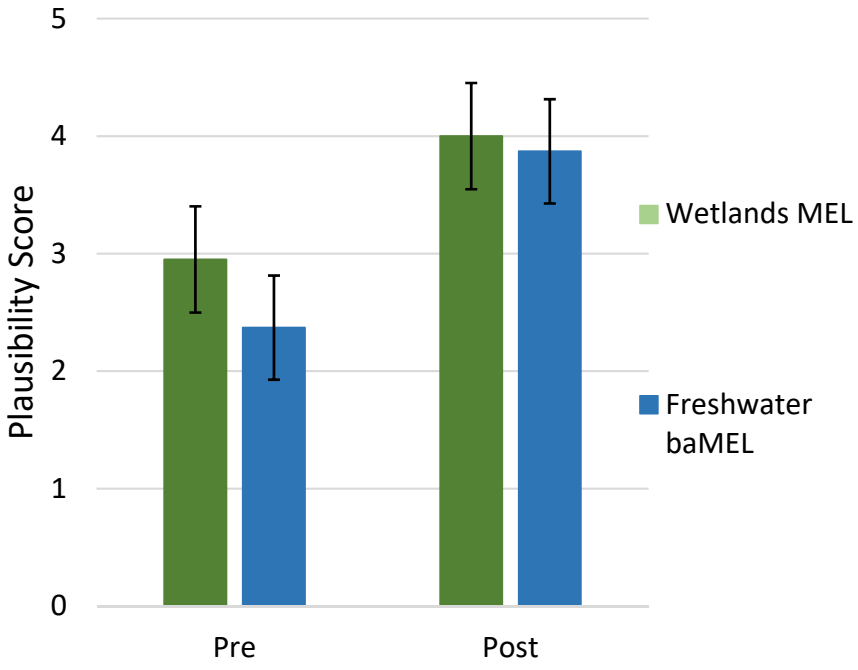
Below are statements about freshwater resources. Rate the degree to which you think that *hydrologists* agree with these statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. Water reclamation makes contaminated water safe for humans to use.	A	B	C	D	E
2. Engineers will solve current shortages of freshwater.	A	B	C	D	E
3. Freshwater is abundant and will remain so even in the face of global climate change.	A	B	C	D	E
4. Land use decisions affect Earth's surface, but have little impact on the water cycle.	A	B	C	D	E
5. Technology advances have made water safer for human use.	A	B	C	D	E
6. Groundwater recharge rates are similar from place to place because soils are generally uniform.	A	B	C	D	E
7. Global temperatures have increased. But, there has not been an overall decrease in global glacial ice.	A	B	C	D	E
8. Microclimates have various levels of precipitation. This affects how much water is available for human use.	A	B	C	D	E
9. Over the past 100 years, lower amounts of rainfall have occurred across the US. This means that greater amounts of land have been affected by drought in the last 20 years.	A	B	C	D	E
10. Current shortages of freshwater will get worse around the globe as world population increases.	A	B	C	D	E
11. Climate change and increasing populations will lead to more freshwater shortages.	A	B	C	D	E

The build-a-MEL resulted in greater levels of evaluation and slightly more pronounced shifts in plausibility

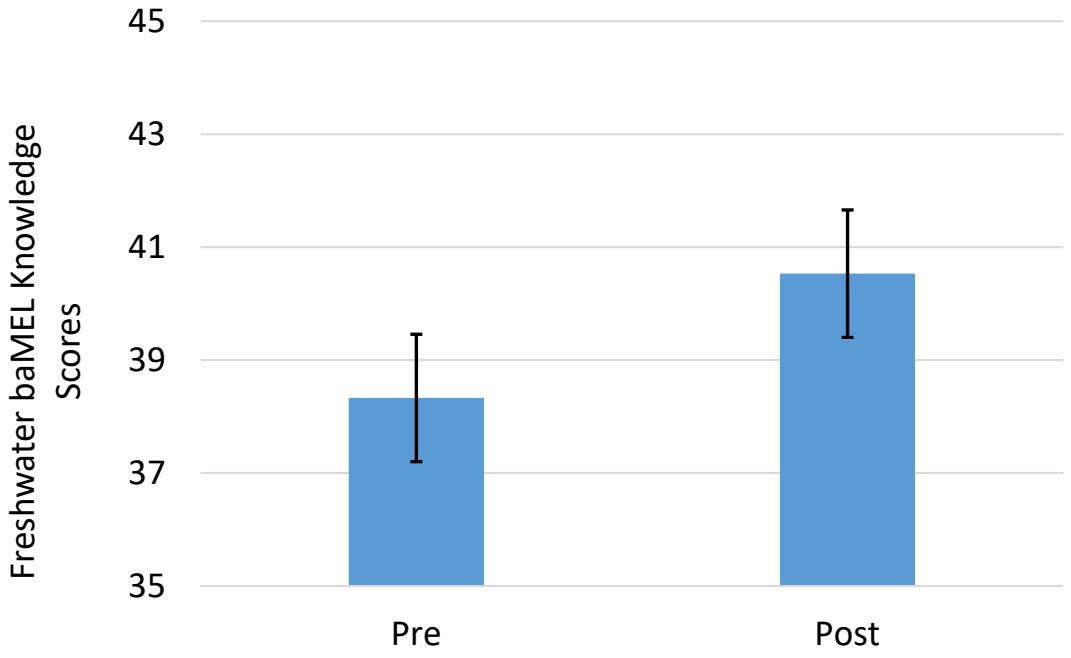


Wilcoxon Signed Ranked Test, $z = 1.17$



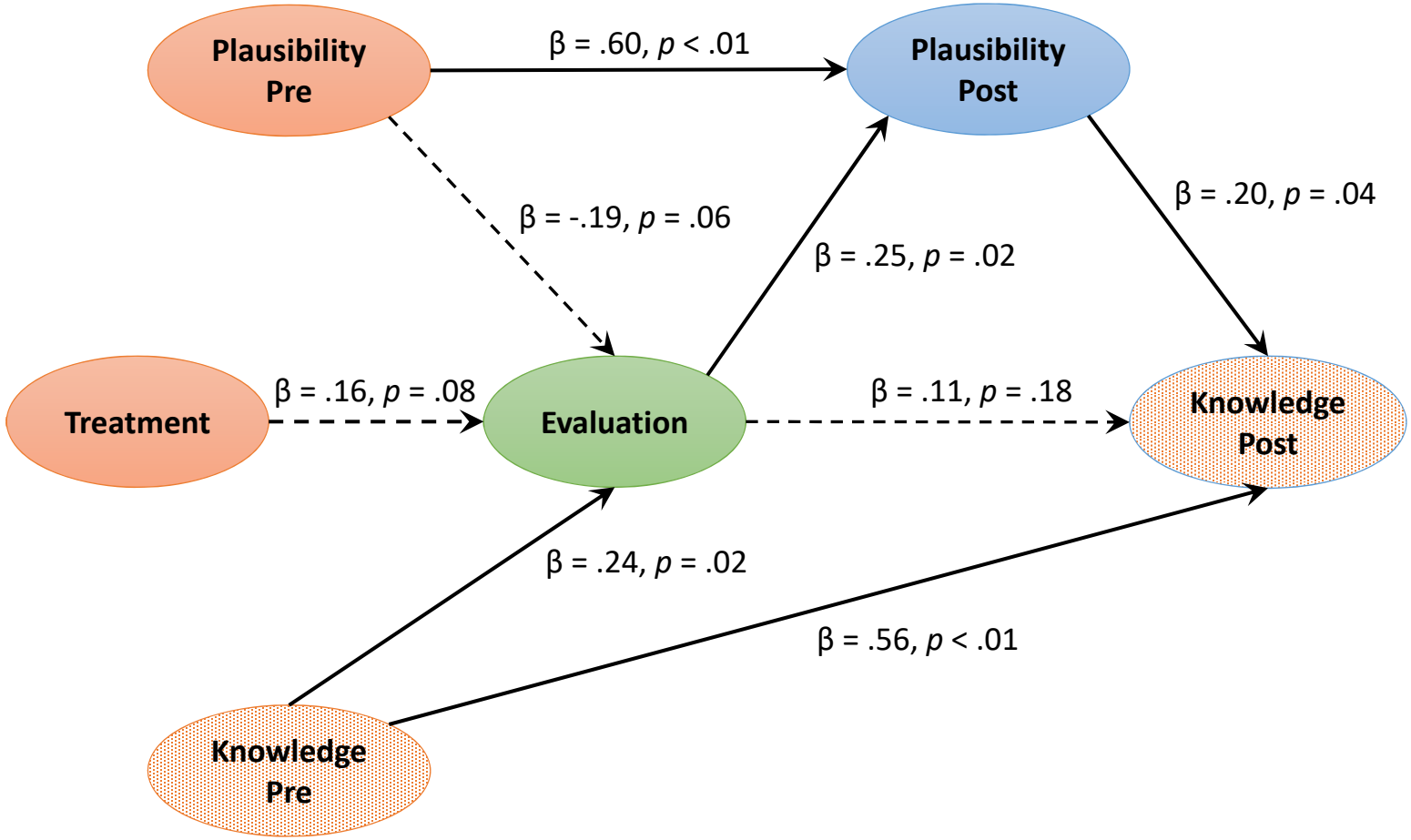
$z = 2.24$ (Freshwater build-a-MEL)
$z = 1.88$ (Wetlands pre-constructed MEL)

The build-a-MEL resulted in somewhat increased knowledge about water resources



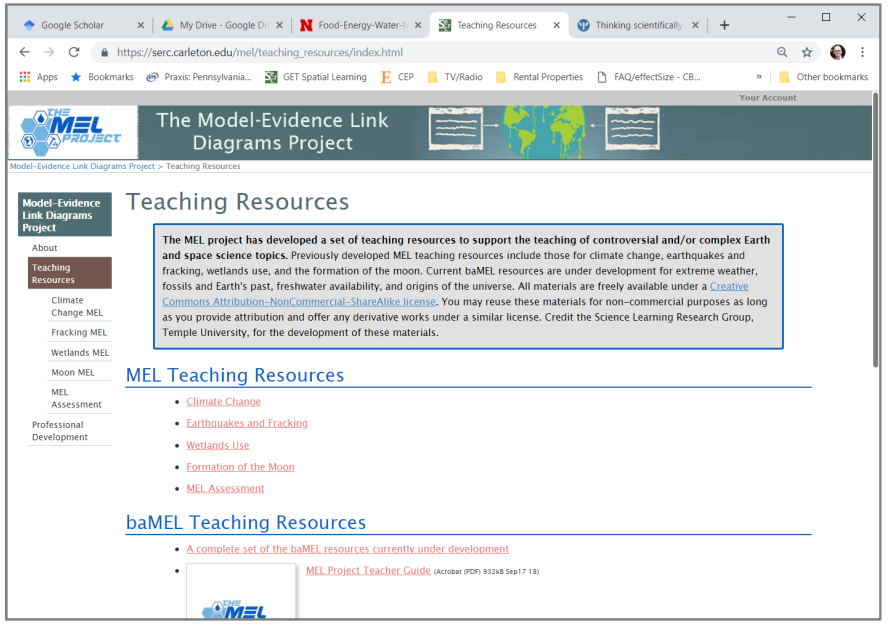
Wilcoxon Signed Ranked Test, $z = 1.62$

These pilot data weakly suggest the build-a-MEL may be more effective than the pre-constructed MEL



GoF = .562 (large explanatory power), ARS = .316

Currently we are in the midst of Year 2 of our current project



Our team is currently examining and analyzing incoming data

Please stay tuned and visit our websites early and often

http://serc.carleton.edu/mel/

http://sciencelearning.net

Please consider joining the growing group of educational researchers studying FEW security & sustainability…

..and thanks so much for attending!