A Content Secondary Science Newsletter from the
Southern Nevada Regional Professional Development Program

Science Dissected

Model-Evidence Link (MEL) Diagrams

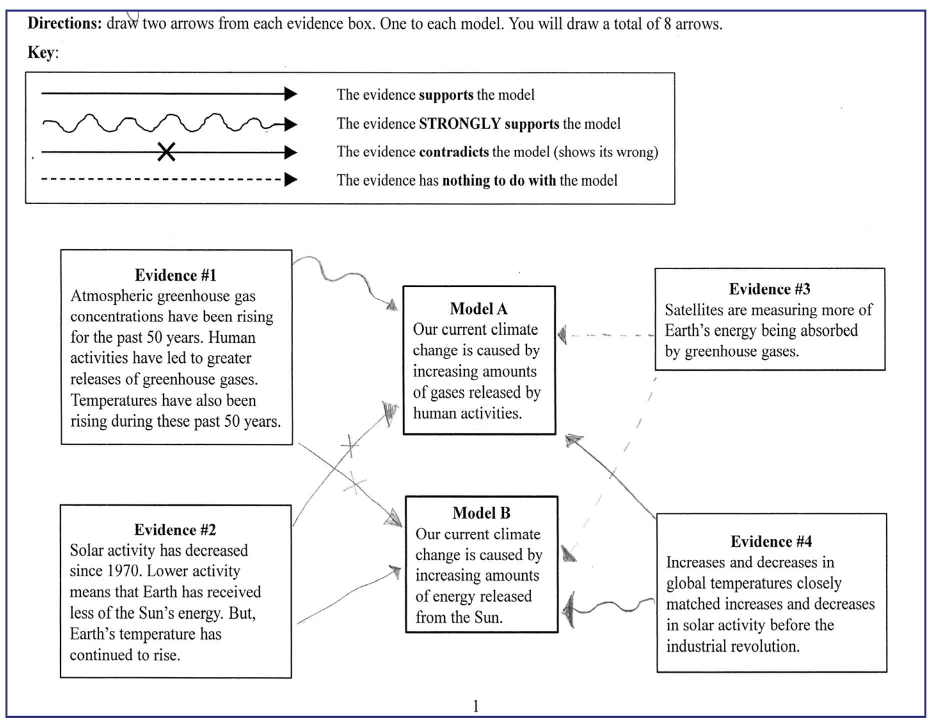
An Instructional Strategy Promoting Scientific Reasoning and Critical Evaluation

A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas was released by the National Research Council (NRC) in July 2011 with the purpose of guiding the development of the Next Generation Science Standards (NGSS), scheduled to be released in late 2012. Dimension 1 of the Framework: Scientific and Engineering Practices highlights the knowledge and skills students must learn to understand how scientific and engineering understanding develops through multiple approaches used to investigate, model, and explain the world.

A fundamental practice in which virtually all scientists and engineers engage is coordination between evidence, models, and theories. The new framework asserts that critical evaluation is essential when coordinating evidences and theories. In science education, ***critical evaluation is simply the analysis of how evidence supports not only a hypothesis, model, or theory, but also how evidence supports an alternative explanation***. The selected evidence may support more than one explanation in much the same way a large body of data can be narrowed and highlighted to support a particular position (same data used to support conflicting/opposing arguments—ex. CSI, or prosecutor and defense in courtroom).

The trick is getting our students to do this in a classroom setting. In other words, how do we get children and adolescents to critically evaluate connections between evidence and models?

As shown in the figure to the right, the model-evidence link diagram (MEL) is an instructional scaffold which facilitates students to evaluate the connections between evidences and alternative models. Using a MEL, students draw arrows in different shapes to indicate relative weight of the evidence between each evidence and each model. Straight arrows indicate that evidence *supports* the model; squiggly arrows indicate that evidence *strongly supports* the model; straight arrows with an "X" through the middle indicate the evidence *contradicts the model*; and dashed arrows indicate the evidence has *nothing to do* with the model.



Written by: Doug Lombardi & Bret Sibley

Model-Evidence Link (MEL) Diagrams continued...

Some critical questions you should be asking is how do students get more information about the evidences and how do they develop the skill to weight the connection between evidence and models?

The answer to the first question is that students use information from instructional materials that are readily available (e.g., textbooks or online resources). Students can also use any data that they may have gathered through experimentation or other activities.

The answer to the second question is through the use of a quick ranking task that helps students understand how scientist make *plausibility judgments*, which is the *potential truthfulness* in causal connection between evidences and models. The ranking task is shown to the right and in the task students make an initial rank of the importance of each arrow weight. Then they learn about the notion of falsifiability of scientific information and then re-rank the arrow weights. At the end, a class discussion with students will help them understand that contradictory evidence really has the most weight in determining the plausible model that explains a particular phenomena or event.

Students then use these MEL diagrams in collaborative argumentation and explanatory tasks to critically evaluate their links and construct understanding. Recently, science education research has shown that using MELs in tandem with argumentation and explanation provides an appreciable boost to their learning. Furthermore, students find MELs engaging and MELs are easy to insert into the hectic pacing of our curricular instruction.

How do scientists change their plausibility judgments?

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? Rate each evidence from 1 to 4. (1 = most important and 4 = least important)

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

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.

With falsifiability in mind, re-rate each evidence from 1 to 4. (1 = most important and 4 = least important)

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

Model-Evidence Link (MEL) Diagrams ready for classroom use can be accessed at the SNRPDP Website within the Science Dissected Newsletter folder, http://www.rpdp.net/link.news.php?type=sciencedis

The Targeted Interventions for Proficiency in Science (TIPS) Website serves as an excellent resource for students to research more information about the evidences, http://www.rpdp.net/sciencetips_v2/