

The MEL Project Teacher Guide

MEL and baMEL Directions and Hints



The MEL activities help students to be critically evaluative to support scientific thinking. Models must be coordinated with lines of evidence to help build an argument about the causes and effects of a particular phenomenon and its systematic relationships.

1. Complete the *Plausibility Ranking Task* (PRT)

This task normally takes about 20 minutes and is only done once, or twice at most. If you do multiple MELs/baMELs with a given set of students, keep that in mind. This task helps develop understanding about how scientists make judgments about the connection between evidence and models.

Name	Teacher	PeriodDate	Carefully read the following paragraph.
	How do scientists change their plau	isibility judgments?	Scientific ideas must be <i>falsifiable</i> . In other words, scientific ideas can never be proven. But, ideas can be disproven by opposing evidence. When this happens, scientistr smust revise the in or come un with another explanation. <i>Falsifiability</i> is a very immerational mixing when evaluate
Plausibility is a jud; another. The judgm decision.	gment we make about the potential tru ent may be tentative (not certain). Yo	athfulness of one model compared u do not have to be committed to t	o scientific knowledge.
Scientists may chan	ge their plausibility judgments about	scientific ideas.	As a reminder, scientists may change their plausionity judgments about scientific ideas and th do this by looking at the connections between evidence and the idea. Evidence may: 1. Support an idea
They do this by loo	king at the connections between evide	ence and the idea. Evidence may:	 Strongly support an idea Contradict (oppose) on idea
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Which may of or	idense de son skiele is most immert	and the second set of a low shellow	With <i>falsifiability</i> in mind, <i>re-rank</i> each evidence from 1 to 4. (1 = most important and
judgment? Use r	umbers 1 to 4 to rank each evidence	e. (1 = most important and 4 = le	least important). Use each number only once.
	Type of evidence	Your ranki	g Evidence supports the idea
Evidence support	s the idea		Evidence strongly supports the idea
Evidence strongly	supports the idea		Evidence contradicts (opposes) the idea
Evidence contrad	icts (opposes) the idea		Evidence has nothing to do with the idea
Evidence has not	ing to do with the idea		
	lip over to Page 2		
When instructed, i			
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- a. First, have students make an initial ranking of the importance of four categories of connections between evidence and models, where a line of evidence:
 - i. strongly supports a model,
 - ii. supports a model,
 - has nothing to do with a model, or iii.
 - contradicts a model. iv.

Guiding Questions:

- Workshop teachers: What do you think?
- b. Second, have the students read the short

passage about tentative nature of scientific information and falsifiability (the ability for a scientific idea to be proven false), as well as the relationship between contradictory evidence and falsifiability

- c. Third, conduct a short, whole class discussion with the students about the falsifiability passage.
- d. Fourth, then have the students re-rank the importance of the categories.

2. Rate the plausibility of the three baMEL models using *Model Plausibility Ratings* (MPR) sheet

Completing this sheet takes about 10 minutes and introduces students to the models they will be considering for the baMEL and re-introduces students to idea of plausibility judgements. This should be done as the first activity for each baMEL

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Please work on this individually and read the following information carefully. Humans create models to help explain things. Below are three models. These provide different explanations for increases in extreme weather events over the last 50 years. These events include intense hurricanes, heavier rainfall and flooding, dangerou wildfires, and heat waves. Model A: The number and strength of extreme weather events vary naturally. Human activities release carbon in the atmosphere. Yet, plants and oceans absorb any carbon increases. A person who supports this model makes the following argument: Although human activities have increased carbon in the atmosphere, plants and oceans eventually absor- this carbon. So, human activities are not causing changes in extreme weather events and current increa- mist be part of a natural cycle. Model B: Increases in extreme weather events are linked to climate change. Current climate change is mainly caused by human activities, such as fossil fuel use. A person who supports this model makes the following argument: Human activities are increasing the amount of carbon in the atmosphere and changing Earth's climate harcases in extreme weather events must then be linked to current climate change and human activities harcases this change. Model C: Over time, increases and decreases in extreme weather events are mainly caused by thanges in Earth's orbit around the Sun. A person who supports this model makes the following argument: In unwher and the externed weather events must then be linked to current climate change and human activities harcases in extreme weather events must then be linked to current climate change and human activities harcase this change.	Please work on this indiv Jumans create models to be below are three models. To ver the last 50 years. The rildfires, and heat waves. Todel A: The number a elease carbon in the atu , person who supports this lithough human activities is carbon. So, human ac- ust be part of a natural of Todel B: Increases in en- mainly caused by hum person who supports thi- human activities are incre- creases in extreme wead	vidually and rea help explain thin, These provide diffi- ese events include and strength of e nosphere. Yet, pl is model makes the thore increased of the increased of the increased of the increased of the increased of the increased of the increased of the increased of the increased of the incre	d the followin gs. ferent explana e intense hurri xtreme weath lants and occe- ne following a carbon in the o nusing changes events are lim	ng informa ng informa ng ang ang ang ang ang ang ang ang ang a	tion careful creases in ex- rier rainfall a vary natura any carbon , plants and e weather ev	ly. streme w nd flood lly. Hun a increas oceans e ents and	eather evo ing, dang nan activ ses. wentually	ents erous ities
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- e. Students individually read about the three models and plausibility
- f. Hold a class discussion to answer questions about the model and plausibility
- g. Have the students rate the plausibility of each model...make sure the draw a circle around one number for each model (there should be three circles)

Topic Hint: Origins of the Universe

The distinction between models A and C is subtle. Encourage students to look at the differences in vocabulary.

- 3. Use the *baMEL* lines of evidence and three models to construct a *MEL diagram*. This is a completely new activity and the essence of the new build-a-MEL (baMEL). We don't know how long this will take, but thinking that this, along with the MPR (see above) will take one traditional class period (~50 minutes). The students should have the opportunity to consider and discuss all the different models and lines of evidence when making their selections.
 - h. Give students the model cards and the evidence cards (these should be pre-cut prior to using). Have students lay these out. You may with to laminate the cards as they are intended for reuse.



- i. Students should select 4 lines of evidence and 2 models from the set from which they will construct a MEL diagram.
- j. To help them in their selection of lines of evidence, they should read the one-page evidence texts. An example of one of the evidence texts is below:

Teacher Hint

Have the students place unused evidence texts to the side, face down, to make collection easier at the end of the activity.

Topic Hint: Fossils

Accommodation Hint: Laminated cards can be annotated with dry erase markers by students with language

difficulties.

Evidence 5 refers to coral reefs. Students might be confused by the fact that reefs are on the Earth's surface even though they are under water.



- k. Students may need to manipulate the cards and try different combinations in making their decisions about which models and which lines of evidence they will use in their MEL diagrams.
- 1. It may work best if students work in groups of three or four in constructing a MEL.
- m. Once students decide their two models and four lines of evidence, they should complete the baMEL worksheet by writing in their selected model letters (A, B, or C) and lines of evidence numbers (1-8, or 1-9 for freshwater).

Teacher Hint

Have students place models in alphabetical order from top to bottom and the lines of evidence in numerical order from top to bottom/left to right. This will help everyone keep track of their work.

If you worked with other stu	dents, their name(s):		
Directions: Write the number	er of each evidence you are us	ng and for each model you have a	elected in the boxes below. Then draw 2 arrow
Hom each evidence box, on	e to each model. 1 ou will draw	a total of 8 arrows.	
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Evidence #		Model	Exidence #
Evidence #	_ (Model	Exidence #

4. Now students are ready to complete their own *MEL diagram*.

Along with completing the Explanation Task (see below for a student example from the Climate Change pre-constructed MEL), drawing arrows on the MEL diagram and discussing arrows in groups takes just under 1 traditional class period (~30-40 minutes).



To do so:

- a. Students draw arrows in different shapes to indicate their judgments (which correspond to the four categories in the ranking task) about the strength of the connection between each line of evidence and a model.
- b. 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.
- c. Have students work in teams to discuss the types of connections made between the evidence and models; however, students should be told that if their thoughts lie with an arrow type that's different from their teammates, that they should not change it.

5. Students next use completed MEL diagrams in an *Explanation Task* to critically evaluate their links and construct understanding. This task asks students to select and write about evidence-to-model links that they had made on their MEL diagram.



Provide a reason A. Write the B. Circle the C. Write whi D. Then writ	for three of number of th appropriate ch model you e your reasor	the arrows the evidence word (stror u are writing the strong the s	you have o you are wr igly suppo g about.	frawn. Writ riting about. orts suppor	e your reas rts contrae	ons for the licts has 1	three most	t interestin lo with).	g or import	tant arrows.
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- a. In their written explanations, students identify each end of the link, with an evidence statement (which are numbered) at one end and the model (either Model A or B) at the other.
- b. Students write their judgment about the strength of the link (i.e., the evidence strongly supports the model, the evidence supports the model, the evidence has nothing to do with the model, or the evidence contradicts the model).
- c. Students then provide a justification for their weighting of link strength.