Ambitious Science Teaching

Developing and using models

Modeling is a scientific practice during which scientists and engineers create, test, and revise representations over time using evidence. Developing and revising models provides opportunities for students to express their current understanding and to explicitly recognize how and why their thinking is changing over time. It also allows students to build their understanding of key science concepts and stimulate their peers’ thinking by comparing and discussing their representations with each other. To read more about models and modeling, visit http://goo.gl/Qm48yr

Modeling allows students to:

- Use drawing, text, and symbols (with a key or labels) to communicate ideas
- Represent observable and unobservable features in order to explain how or why a process or event unfolds as it does
- Represent their own understanding and ideas (not copied or reproduced.) No two models will be identical even if students are reasoning about the same ideas.
- Explain and/or predict an event or process (not a thing) in a specific context.

Why model?

- It makes students’ thinking visible to you and to their peers
- Allows students to show more of what they currently know in variety of ways
- Makes students’ reasoning available to their peers
- Helps students change their thinking in response to new evidence and ideas

What can I try?

☐ Add a modeling task to an existing lab or investigation in the unit. Have students develop a model to explain what caused the results from a student-collected or second hand data. Ask students to include zoom-ins to show what’s happening they can’t see or directly observe that would account for the patterns and relationships they found in the data.

In this 4th grade example, students identified a pattern in their data that bulb brightness increased as the number of batteries increased. Then students created a model to explain what caused this increase in brightness. Each student had a different representation which provided an opportunity to compare models during a class discussion of voltage, brightness, and energy transfer.
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- **Develop your own teacher-level explanatory model for a phenomenon.** Before you try any modeling with students, create a model for yourself to explain a phenomenon by mapping out your thinking on a blank sheet of paper or whiteboard. This can help you design spaces on a model scaffold template. Some questions to ask of your model is: What basic information about the phenomenon do I need? What’s happening here that I can’t see that’s causing X or Y or happen? How or why does X or Y happen? Am unpacking/explaining the science terms I use? Use zoom-ins and symbols to represent unobservable mechanisms.

- **Create a model scaffold template to use with students for a phenomenon related to your unit.** One place to start is to create a model scaffold for a real-world phenomenon. A model scaffold should ask students to explain how/why a contextualized phenomenon occurs. Before using a model scaffold template with students, try it out for yourself or give it to a colleague to try out to get feedback before trying it with students. For more about selecting phenomena, start here: [https://goo.gl/m36eWQ](https://goo.gl/m36eWQ)

A model scaffold should have:

- A guiding question at the top relate to the observable phenomenon
- Areas for drawing and lines for writing. Sentence starters or prompts are helpful.
- A comparison between two conditions or a change over time (before/after), so students explain how/why a process happens or how it would be different under different conditions

Once you have a model scaffold for the anchoring phenomenon for your unit, students should have the opportunity to develop and revise their models:

- Bookending a unit: *Use the model scaffold at the start and near the end of a unit to give students a chance to revise their thinking based on what they have done and learned and the evidence collected from class experiences.*
- Beginning, middle, and near the end: *Use a model scaffold at the start of a unit to elicit students’ ideas. Revise the models at a midpoint in the unit with evidence collected so far. Then near the end of the unit make final revisions or work from a blank model template to create a new model based on information from the unit.*
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Supporting students in revising models

Once you decide to have students develop their own scientific models, the next step is providing opportunities for students to revise models over the course of the unit as they gain more and more evidence from activities and in-class experiences. There are several tasks that can support students in doing this. Here are some examples.

- **Revising their initial model with color-coded sticky notes** Students use color-coded sticky notes to elaborate on what they would change and why. This task helps students identify where their thinking has changed and what new learning they have done. In the 6th grade example below from a sound energy unit, a pair of students revised their initial partner model using a colored pen and 3 colors of sticky notes (add/new, change, questions). Then students paired up with another pair to discuss their changes.

- **Using supporting evidence to revise models.** Students may easily add or change their claims but often need support in using evidence to support how or why they changed their thinking. Students place evidence sticky notes directly onto the model scaffold to identify activities from the unit and what they learned from those activities that the student used to make new claims or revise prior claims.
Peer feedback to support revising student-developed models. Once students have revised their own model, they should have an opportunity to look at their peers’ models and provide critical feedback. By critical, we mean helpful feedback that highlights an idea on the model and offers a direction to go next to improve or clarify that idea. This can be done as a gallery walk or a model swap/rotation with other students’ work. Students leave a sticky note with a suggestion of something they would add, change, or revise about the model and possible resources the student could refer to help them do this. Finally, students need time to read and address their peers’ comments on their models, justifying whether or not they will address it in their model. For a video of this, visit https://goo.gl/HyCHXH