Thinking Like A Kid

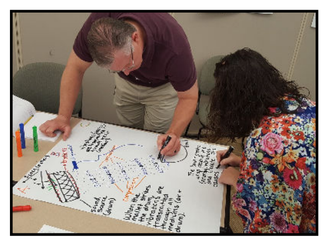
In some activities, we ask you to participate in "student hat" — engaging in the activities by thinking as your students would think. This can feel strange, and you may be wondering why we don't just describe how students do these activities and then examine classroom video and student work. Here's why.

A focus on the students' perspective: A key shift in NGSS storylines is that science work should be *coherent from the students' perspective*. Students should always see the work they are doing as a way to make progress on the questions and problems that their class has identified. Too often in science classrooms, the curriculum authors and teacher know why the next activity is coming, but students are left to figure it out after the fact, if they ever figure it out at all.

In storylines, teachers work with students to figure out *together* what the class needs to work on, and how to go about it. *Together* they reflect on progress and figure out where to go next. Of course the teacher has a guiding idea of where to go — the storyline is a planned trajectory. But by involving students as partners in reflection and planning, students see how today's data collection, analysis, or modeling will help the class make progress on the goals they have established.

How will thinking like a kid help? To do this joint navigation work, you need to work with students' ideas. Anticipating your students' ideas and questions will help you figure out what makes sense to them and how you can work with their ideas to help them develop the target science ideas. To plan your discussions, you need to put yourself in the mindset of your students.

- When your students experience a phenomenon, what ideas will they draw on to explain it? What will they wonder about?
- What kinds of experiences might they bring up to connect to the phenomena they are investigating?
- What kinds of prompts could you give to push them to dig deeper into the parts you want them to notice?
- What will they be able to figure out from investigating the phenomena in the unit so far? How would they model this?

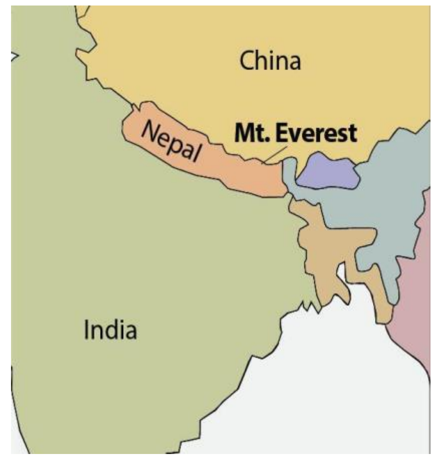


If we jump ahead to our knowledge as adults, we might overlook steps that will be important to our students. What is a logical next step to us, since we *know* the end game already, may not seem logical to students. Put yourself in the heads of your students so you can anticipate what they will see as puzzling and what ideas they might have. Then you can orchestrate the conversations to help students develop questions and ideas that will be productive for the storyline goals.

So in these activities, we will ask you to channel your inner student. Don't worry about getting the science right at first — your group will build these ideas over time as they engage with phenomena. Resist the urge to use your college-level knowledge to explain to others. Let the group struggle with the ideas as your students might. Resist the urge to label the phenomenon with the right science words — we are trying to develop step by step explanations, not just know that the process is called photosynthesis, sublimation, or endothermic reaction. Storylines require taking the learning step by step — let's practice doing that.

Name: ____ Date: ____________________

Reading: What is happening on Mount Everest?



Mount Everest is the tallest recorded mountain in the world. It is located on the border of two countries, China and Nepal. In the past, these two countries have collected earthquake, elevation, and location data separately on their own sides of the mountain, but had not compared the data with each other to check for accuracy. Since each country was collecting separate data and not using the other country's data to check their work, this led to a disagreement on the exact height of Mt. Everest. In 2015, a massive 7.8 magnitude earthquake occurred near Mt. Everest. Areas surrounding Mt. Everest and in both countries felt the earthquake. Scientists believed that the earthquake may have impacted the height, or elevation, of the mountain. The two countries decided to share their GPS data to figure out if there were any changes to Mt. Everest due to the earthquake.

In the years that followed, Chinese and Nepalese scientists set up Global Positional System (GPS) receivers at different places on the mountain. GPS provides the signals that our cell phones use to determine where we are located on Earth and can provide us directions to get to a new location. The GPS sensors that were used on Mt. Everest are even more sensitive than those in our phones, which enable them to detect a change in position as small as 1 millimeter.

The first official measurement of Mt. Everest was reported in 1856. At that time, it's peak was recognized to be about 29,002 feet above sea level. But since then, GPS data sharing between the two countries has allowed scientists to determine that Mt. Everest has increased in elevation by an average of 0.79 inches (2 cm) each year. In 2021, its peak was at 29,032 feet above sea level.

In addition to these changes in height, this GPS data has also provided evidence that the peak of Mt. Everest is moving at an average of 1.6 inches (or 4 cm) a year to the northeast.

Sources:

- Camero, K. (2020). The highest point on Earth just got higher. What we know about Mount Everest's growth. *Miami Herald*. Retrieved: https://www.miamiherald.com/news/nation-world/world/article247692110.html
- Wilkinson, F. (2021). How do you MEASURE Everest? It's complicated by frostbite and politics. *Science News by National Geographic*. Retrieved: www.nationalgeographic.com/science/article/remeasuring-mount-everest-the-worlds-tallest-mountain

Name: ___________________________________ Date: ___________________

Explain How Mt. Everest Moves and Grows

In the box below, draw an initial model to try to explain the following:

- What might cause Mt. Everest to increase in height 2 cm each year?
- What might cause Mt. Everest to move to the northeast 4 cm each year?

Use words, pictures, and anything else to help capture your thinking.

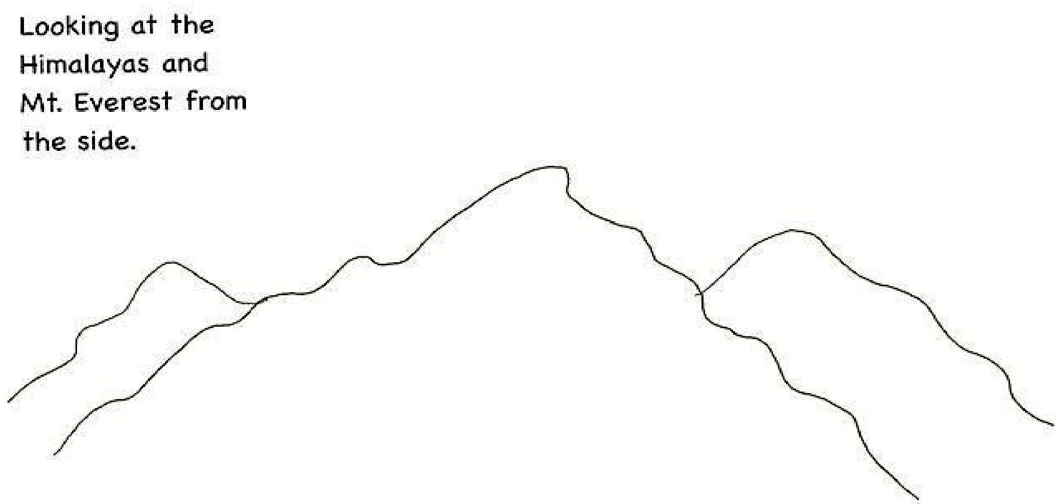
Use your model to explain:

How Mt. Everest moves 4 cm to the NE each year	How Mt. Everest grows taller by 2 cm each year

Name: ____________________________________ Date: ___________________

Unit 6.4, Lesson 1 - Alternate Initial Model

Based on what you have figured out about how Mt. Everest is changing over time, use the image below to represent the changes happening to Mt. Everest.



Name: ____________________________________ Date: ___________________

Patterns of Change for Mountains

Data for Causing Growth	Data for Causing Decrease in Height

Patterns between Mountains

Name: ___________________________________ Date: ____________________

Explaining Other Mountains That Shrink

In the spaces below, draw an initial model to explain what might be occurring with other mountains.

Explaining a shrinking mountain
• Choose a location where the data show that the mountain has been decreasing in elevation. • Develop a model to represent what you think is causing this to happen to the mountain.

Use your model to explain:

How a mountain shrinks over time

By Cindy Workosky
Posted on 2018-08-14

Recently, my colleagues and I had an exchange with some teachers in one of our professional development programs. One teacher said, "I think I do a lot of modeling in my class. I have my kids draw pictures of the science ideas they are learning all the time."

This description of modeling is common. When we ask our colleagues, either informally or in professional development settings, about their current teaching and the practice of developing and using models, they often respond that they consider models as things like 3-D replicas or drawings. They say, "I have my kids make models of cells, the solar system, the water cycle, atoms, and so on."

This type of "modeling" activity might sound promising, but it often doesn't fully realize the potential of the modeling practice. It's not surprising, though, that this conception of modeling is so pervasive because much of the available information on modeling focuses on drawing as a way to bring kids into this practice. In our experience with modeling, we've found that a depiction—usually a drawing—focuses our attention on a surface feature of the practice and not on the deeper knowledge-building potential.
For example, teachers might typically ask students to draw a model of the pond ecosystem, or draw a model of the forces acting on a ball as it rolls down a ramp. But without a clear purpose, students might be confused about how they should interpret these tasks and can't properly judge their ideas, leaving them to appeal to the teacher or textbook as authority. "Is this right?" is what most students will inevitably ask.
In contrast, when a class can work together to examine a phenomenon or class of phenomena *and* specify questions they want to answer, the aim is clear, and students can decide if the model is effective by asking, "Does this help us answer our questions in ways that makes sense?"

We believe that viewing modeling as a means to an end is a useful way to think about the practice. Models are not the end products or learning targets in themselves, but they allow us to achieve our explanatory goals. Models help us make sense of a phenomenon in a systematic way and explain what is happening. They are used *for* an explanatory purpose.

Two of us wrote an academic paper about this idea (Gouvea & Passmore 2017). In it, we suggest a few touchpoints for educators as they consider how the modeling practice is positioned in the classroom. We ask:

- *Is there a clear phenomenon? Is there some puzzling or unknown aspect of that phenomenon to investigate? Do students understand their role as trying to understand this phenomenon better?*
- *Is there a clear question? Does the question help clarify what about the phenomenon is puzzling or unknown? Do students understand their role as attempting to answer that question?*

- *Is there a clear* _purpose_*? Are there clear criteria for what constitutes having made progress toward answering the question? Do students understand they are responsible for generating and evaluating that knowledge? (Gouvea & Passmore 2017, p. 58)*

We call this the *models of* versus *models for* distinction. By using this simple linguistic distinction, we have found it easier to see models as explanatory tools. When planning lessons, we try to avoid saying that "students will develop a model *of* photosynthesis." Instead, we say, "Our class will develop a model *for* where the matter comes from when a seed becomes a tree." We find this slight shift in language helps us keep the modeling practice connected to an explanatory purpose. Try it out!

The next time you want to incorporate a modeling experience in the classroom, we suggest you ask yourself what the model is *for*, without using the name of the science idea or a simple label of the thing in your answer. The word "*for"* should be followed by a phenomenon and matched to a question we have about that phenomenon, something that the science ideas we are developing as a class will help us explain.
Returning to our earlier example of asking students to "draw a model of the pond ecosystem," which is rather vague, a teacher might instead want to ask students to "develop a model for why there are more mayflies than frogs in the pond." This revision centers our modeling work on the phenomenon we are trying to explain. We have found that this simple shift in how we talk about (and hopefully, in how we think about) models in the science classroom can help us engage in this practice in more powerful ways. Please post your comments below and let us know how it this approach is working for you!

Reference: Gouvea, J. & Passmore, C. Sci & Educ (2017) 26: 49.
https://doi.org/10.1007/s11191-017-9884-4
As teachers and science educators we are passionate about the modeling practice and its potential to improve student learning in the science classroom. We are part of the team that developed the high school biology curriculum found at modelbasedbiology.com.
Cynthia Passmore is a professor of science education at the University of California, Davis.

Anchoring Phenomenon Routine Tracker

	<u>Element 1:</u> Explore the Phenomenon  *What do we notice?*	**<u>Element 2:</u>** Attempt to Make Sense of the Phenomenon  *How can we explain this? Do our explanations agree?*	**<u>Element 3:</u>** Identify Related Phenomena  *Where else does something similar happen?*	**<u>Element 4:</u>** Develop Questions and Next Steps  *What should we do to figure out how to explain this?*
Notes about what you or the students did.				
How does this support ***<u>figuring out</u>***?				
How does this support a ***<u>classroom culture where all students have access?</u>***				