Britannica Expedition:LEARN!

Teacher Toolkit

Constructing and Interpreting Models: Grades 3–5

OVERVIEW:

People use models every day. From maps, to toy cars and airplanes, to globes or diagrams in instructions, models are all around us. A model is a representation of something else, acting as a substitute for the real thing. Models can be diagrams, physical replicas, mathematical equations, analogies, and computer simulations. Models represent systems or part of systems and are essential to science learning, understanding, and communication. They allow scientists to make predictions and construct explanations. In addition, they allow scientists to go beyond the visible world to show and describe objects that are too large, small, or fast for the human eye. Scientists also use models to represent things that don't exist anymore, things that have yet to be created, or things that are too hard to communicate with words.

Models are also essential to engineers, since they are used to visualize, design, and communicate design features to others. Engineers use models to evaluate systems, test prototypes for solutions, and analyze systems and designs for their strengths and limitations.

At the elementary level, students can use models to describe and predict phenomena, describe the interactions of specific parts of a system, and show the relationships among variables. In addition, students should be able to identify and evaluate the limitations of a model to explain the causes of a phenomenon. By the end of 5th grade, student models should move beyond simple renderings or maps and begin to incorporate interactions between parts of a system and cause-and-effect relationships within a system.

Mini-Lesson I

What Is a Model? (10 minutes)

Background: Before students can begin using models in science, it is important to build a shared vocabulary and understanding about what models are and how they are used. The following mini-lesson introduces students to the vocabulary of scientific modeling, providing them with examples that help them build a conceptual understanding of the vocabulary.

- Show students an image of a model car, airplane, train or another object that students would consider to be a toy. Ask students what the object is.
- Emphasize that while the object is a toy, it is also considered a model, or an object that represents something else.
- Share with students that models are essential to learning about and doing science as they help us observe and study objects that we might not otherwise be able to bring into the classroom.
- Build students' understanding of the vocabulary by displaying the **What Is a Model? anchor chart** and walking through the definition and examples.
- After introducing scientific models to students, invite them to work with a small group to brainstorm as many examples of scientific models as possible.
- Share with students they will now look at an example of a model and how it is used.
- Display the image "Model of a Cell" on page 5-Build in the *Expedition: Learn!* lesson "How Is the Human Body Organized?" Share that the model of a cell represents something that we can't observe easily and it can help us understand different parts of a cell.
- Invite students to work with a partner to explore the *Expedition: Learn!* lessons to find other examples of models and discuss how they are used.

Mini-Lesson II

Analyzing Models (20-30 minutes)

Background: Once students have a conceptual understanding of models and how and why they are used in science and engineering, students can begin using models to learn about scientific concepts. The following mini-lesson is based on the *Expedition: Learn!* lesson "Weathering and Erosion."

- Invite students to turn and talk to share the definition of a model and some examples. Share with students that they will work on analyzing models.
- Display the **Analyzing Models anchor chart**. Introduce and model each step, recording on a piece of chart paper for students to reference using the model "Investigating Soil Erosion" on page 5-Build of the *Expedition: Learn!* lesson "Weathering and Erosion." Sample responses below each step:
    - **Step 1: Describe what you observe in the model.**
        - *I see two slopes covered with soil. One slope has plants, and the other does not. Water is being poured onto both slopes. On the slope with the plants, the soil stays in place, but on the slope without plants, the soil is sliding down.*
    - **Step 2: What scientific phenomena or concept does the model represent?**
        - *This model demonstrates cause and effect, showing the difference between two variables—soil with plants and soil without plants—and how plants help reduce soil erosion.*
    - **Step 3: What conclusions can you draw from the model?**
        - *Plants play an important role in controlling soil erosion by holding the soil in place with their roots and preventing it from washing away.*

- **Step 4: What are the limitations of the model? What is missing?**
  - *This model does not account for other factors, like wind or the natural variation in the height and steepness of real mountain slopes. These missing elements limit the model's ability to predict erosion in more complex, real-world environments.*

- Release students to work with a partner and analyze a different model using the steps in the anchor chart. As time allows, invite pairs to share their analysis with another pair, discussing each component in the anchor chart.

Mini-Lesson III

Constructing Models (40 minutes)

Background: In elementary school, students are expected to use and construct models to represent ideas and explanations in both science and engineering. Once students have built a solid understanding of how scientists and engineers use models, they should engage in the process of constructing models. Not only does this help students solidify their understanding of the topics covered as they learn to communicate their findings through models but it also helps them understand the thought processes of scientists and engineers. The following mini-lesson scaffolds students' construction of a model based on the *Expedition: Learn!* lesson "What Is Friction?"

- Invite students to turn and talk to share the definition of a model and some examples. Share with students that they will work on constructing models.
- Invite students to either independently or collaboratively read the *Expedition: Learn!* lesson "What Is Friction?" Upon completion, distribute and display the **Constructing Models graphic organizer**. Introduce and model each step, calling on volunteers as appropriate. Share with students that you are going to make a model that shows how friction affects movement. Sample responses:
  - **Step 1: Identify the phenomena or concept.**
    - *The concept we are modeling is friction—how it slows or stops the motion of objects. For example, when you apply brakes to a bike, friction between the brake pads and the wheel slows it down.*
  - **Step 2: Create a focus question. What is the model trying to show?**
    - *Encourage students to think about how they can refine their questions. Ask them to think about what specific part of friction they are curious about. Ask them to consider if they want to focus on the surfaces, the speed of movement, or the force of friction. One focus question might be "How does friction affect the movement of objects?" or "What role does the type of surface play in friction?"*
  - **Step 3: Define the components of the model. What does it need to show? What needs to be included?**
    - *We need to show two main things: the object in motion (like a bike wheel or a ball) and the surface it moves on. We should also include friction, which acts in the opposite direction of the motion.*
  - **Step 4: Create a sketch of the model**
    - *Draw the object in motion and use arrows to show the direction of the movement and the direction of the friction. The size of the arrows can help us show the strength of the forces acting on the object.*
  - **Step 5: Review the model to consider the limitations and/or missing components.**
    - *Our model will not include all possible forces, like wind or the effects of gravity. It also may not show how heat is created from friction.*
  - **Step 6: Revise the model to elaborate on the initial ideas.**
    - *We can add more detail to the model, like showing the heat produced by friction or adding labels to make the different forces more clear.*
  - **Step 7: Present the model to the class.**
    - *Explain how your model shows the effect of friction on movement, and describe any limitations or improvements you made.*

Check for Understanding

If you observe ...	Then try ...
students struggling to describe what they see in a model	provide sentence stems to support their analysis and development of language. For example: • The model shows ___. • The ___ on the model represents ___. • The model represents ___.
students struggling to connect the model to a scientific concept.	brainstorm a list of key learnings related to the topic of study that students can draw from when connecting the model to a scientific concept.

What Is a Model?

Scientific Models

- Representations of objects, systems or events.
- They are used as tools for understanding the natural world.
- Models use familiar objects to represent unfamiliar things.

Scientists use models to represent:	
	objects that are too small to see, such as an atom or a cell.
	objects that are too big to see, such as the planets or solar system.
	objects that no longer exist, such as dinosaurs.
	objects that have yet to be invented, such as a robot.
	events that occur too slowly to see, such as the formation of landforms.
	events that occur too quickly to see, such as earthquakes.
	events that have yet to happen, such as hurricanes.

Analyzing Models

Step 1:

Describe what you observe in the model.

Step 2:

What scientific phenomena or concept does the model represent?

Step 3:

What conclusions can you draw from the model?

Step 4:

What are the limitations of the model? What is missing?

Constructing Models

Step 1: Identify the phenomena or concept.

Step 2: Create a focus question. What is the model trying to show?

Step 3: Define the components of the model. What does it need to show? What needs to be included?

Step 4: Create a sketch of the model.

Step 5: Review the model to consider the limitations and/or missing components.

Step 6: Revise the model to elaborate on the initial idea.

Step 7: Present the model to the class!