

Developing & Using Models

Science

Science often involves the construction and use of a wide variety of models and simulations to help develop explanations about natural phenomena. Models make it possible to go beyond observables and imagine a world not yet seen. Models enable predictions of the form “if . . . then . . . therefore” to be made in order to test hypothetical explanations.

Engineering

Engineering makes use of models and simulations to analyze existing systems so as to see where flaws might occur or to test possible solutions to a new problem. Engineers also call on models of various sorts to test proposed systems and to recognize the strengths and limitations of their designs. ([Framework, p. 50](#))

See [A Framework for K-12 Science Education, 2012, p. 56](#) for the [entire text](#) for Practice 2: Developing and using models.

In the video below from [BozemanScience.com](#), Paul Andersen explains the importance of modeling in science and engineering. Models are used by scientists to explain phenomenon. Unlike mental models, conceptual models can be shared by all scientists to improve our understanding of the Universe. Engineers use models study systems and test designs.

Developing & Using Models Progression through Gradebands:

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
<p>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</p> <ul style="list-style-type: none"> • Distinguish between a model and the actual object, process, and/or events the model represents. • Compare models to identify common features and differences. • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). • Develop a simple model based on evidence to represent a proposed object or tool. 	<p>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</p> <ul style="list-style-type: none"> • Identify limitations of models. • Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. • Develop and/or use models to describe and/or predict phenomena. • Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. • Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. 	<p>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> • Evaluate limitations of a model for a proposed object or tool. • Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. • Use and/or develop a model of simple systems with uncertain and less predictable factors. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms. • Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. 	<p>Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</p> <ul style="list-style-type: none"> • Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria. • Design a test of a model to ascertain its reliability. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Progression from [NGSS Appendix F p. 6](#).

Activities

Five Conceptual Change Activities are included to help teachers and students Confront Beliefs:

- [Developing & Using Models Activity #1: Syringe and Plunger](#)
- [Developing & Using Models Activity #2: Create Your Own Water Cycle](#)
- [Developing & Using Models Activity #3: Build-a-Bug](#)
- [Developing & Using Models Activity #4: The Goldilocks Principle: A Model of Atmospheric Gases](#)
- [Developing & Using Models Activity #5: Measuring Albedo and Climate Modeling](#)

Also refer to [Student Work in the Practice](#) for real-life examples of how MPRES teachers have applied this Practice.

The purpose of the activities is to engage teachers in the Practice of developing and using models. The emphasis is NOT on the activity itself, but rather the conceptual change related to the Practice. Consumers of this Toolkit are reminded not to get wrapped up in the activity, but rather continually reflect on the conceptual nature of the Practice to gain deeper understanding.

Since the following activities are NOT lesson plans, in some cases only a brief explanation of the activity has been provided. Professional development facilitators should encourage learners to direct their own investigations and intervene only as needed to redirect.

To facilitate conceptual change throughout each activity, you should consider the following questions. These questions are also repeated at key points in each activity to assist you.

Awareness Questions:

1. From the background information, what new awareness do you have about developing and using models?
2. In a 3-Dimensional classroom, what would this Practice look like?
3. What questions did the background raise for you?

Expose Belief Questions:

1. What are your current beliefs about this practice?
2. In what ways do you think you are using this practice?
3. What challenges do you see to using this practice?

Debrief activities by focusing on the conceptual understanding of the practice using the following prompts.

Resolve Belief Questions:

1. In what ways did this activity change your beliefs about developing and using models?
2. How difficult do you find it to develop and use models?

3. Discuss your level of confidence along the process of developing and using models.

Extend the Concept Questions:

1. How do you currently help students develop and use models of science phenomenon in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in developing and using models.
3. What is the relationship between this practice and others?

Go Beyond Questions:

1. Ask a colleague to observe one of your lessons OR video yourself teaching and tally the number of questions YOU ask and the number of questions STUDENTS ask.
2. Use the [EQuIP Rubric for Lessons & Units: Science](#) (PDF format) to evaluate a recent science lesson you taught.