Scientific Models

Critical teaching ideas - Science Continuum F to 10
Level: Moving towards level 6

Student everyday experiences

Many younger students think of models as either toys or simple copies of reality. This is broadly consistent with the everyday meaning of ‘model’ (e.g. ‘model cars’, ‘model airplanes’, ‘model railways’). Students often think of models as useful because they are copies (or even scale reproductions) of actual objects or actions. In such cases, students rarely look beyond the surface similarities between the model and the object or idea being represented by the model (that is, the question, 'Does it look like X?' will be the way the value of a model of X is judged).

As with many areas of science, the science meaning for the term ‘model’ differs from the everyday usage of the word. This is important in understanding student everyday experiences with models.

For more information on introducing scientific terms, see the focus idea Introducing scientific language – Level 3

Some students have the more developed view that ‘models’ can be more than just physical representations of objects. They recognise that ‘models’ can also be used to test ideas and processes in ways that may be impossible to do in the real world. This notion might be reinforced by the everyday use of such terms as ‘computer modelling’ and student experiences of computer game simulations.

A more advanced view, rarely encountered among upper primary/lower secondary students, is that testing ‘models’ (the act of testing for ‘fit’) can lead to their redesign to give improved predictions. Few students are aware of the importance science places on testing and refining models to build better understandings of the processes they seek to explain.


Scientific view

A scientific model is a physical and/or mathematical and/or conceptual representation of a system of ideas, events or processes. Scientists seek to identify and understand patterns in our world by drawing on their scientific knowledge to offer explanations that enable the patterns to be predicted. The models scientists create need to be consistent with our observations, inferences and current explanations. However, scientific models are not created to be factual statements about the world. It is helpful to categorise scientific models as:

- mental models (i.e. a representation of a complicated idea, e.g. how we think of an abstract idea like atoms)
• expressed models (i.e. a version of a mental model that is expressed by an individual through action, speech or writing such as in a diagram)
• consensus models (i.e. an expressed model that has been subjected to testing by scientists and consensus reached that the model has merit, e.g. The Big Bang Model).

The most useful scientific models will possess:

• explanatory power (a model that contributes nothing to explanations is of very little value)
• predictive power (the testing of predictions derived from the model is fundamental in establishing the robustness of the model)
• consistency across contexts (e.g. the model of an atom is the same when considering an atom of lead or an atom of gold)
• consistency with other scientific models (e.g. the model of an atom is the same for atoms in metal as it is for atoms found within a biological cell; the biological cell is another scientific model).


Critical teaching ideas

• Science is an attempt to explain our natural environment and make predictions about it (See the focus idea, Doing science authentically – Level 3)
• Science seeks to create simple descriptions of and explanations for our complex world. A scientific model is a very powerful and common way to represent these simplifications.
• When a scientific model enables us to make predictions it is more valued.
• As scientific models are representations of simplified explanations, they do not seek to explain every situation or every detail. This means that scientific models often are not identical with the ‘real world’ from which they are derived.

Students should appreciate that scientists create models and use them to make predictions. Since models are representations of scientific understandings, as these understandings change, so the models change as well.

The focus idea The work of science – Level 5 explores the development of scientific knowledge.

Explore the relationships between ideas in the Concept Development Maps – Models, Scientific World View.

Teaching activities

Open discussion via a shared experience.
Students will have encountered quite a number of models in their science learning to this point. In small groups, get students to consider the last, say, 12 months of their science learning and have them in small groups list all the scientific models they can identify. This list may also consider any scientific models they have encountered outside science classrooms (e.g. in the media).
When this list is completed, again in groups, have students generate criteria for deciding what a scientific model is. Have them summarize their findings on butcher’s paper for display. Each group can then consider the conclusions of other groups and a whole class discussion about the nature of scientific models can be undertaken.

**Promote reflection on and clarification of existing ideas.**

In groups, have students create their own model of, say, our solar system using diagrams or construction materials. On completion students can then compare their model with their understanding of the current scientific model by listing similarities and differences between the two models.

Have the class discuss these lists of similarities and differences. Consider how advances in technology may have assisted in our construction of improved models e.g. diagrams and drawings, static models, mechanical models and computer simulations. Discuss how these advances in technology may have also assisted in testing, refining and improving our understanding of the process/system being modelled and the redesigning of a better model.

An analysis of the orrery model pictured here is available at:

- [Lego Orrery – a site developed by George Moody of the Massachusetts Institute of Technology](#)

**Promote reflection on and clarification of existing ideas.**

Have students list the characteristics of ‘model’ cars (or planes or trains, etc), perhaps by considering the question, ‘What makes a particular model car a ‘good’ model car?’ An alternative approach could be to display two models of the same type of object where one is heavily stylised and the other shows much greater detail. Ask the students which one is a better model and encourage them to explain their selection.

Compare and contrast the characteristics the students identify for each model. Ask students to consider what the purpose of the model is and why the purposes may vary for different scientific models.

**Practice using and building the perceived usefulness of scientific models.**

Students can research the development over time of a current scientific model for some simple system, e.g. the circulatory or digestion system in the human body or a model of the Earth. Often the models for these simple systems have changed dramatically, reflecting our advances in technology and improved understanding. For example, the Earth was once considered to be a flat level disc and then was reconceptualised as a very large sphere. It is now known not to be spherical but a little more pear shaped.

After the students have outlined this development, have them consider:

- what changes the model has specifically undergone
- over what period of time have the changes occurred
• why the changes/developments in the model have occurred
• what new information or technology may have led to rethinking the design of the original model.