Research on Student Learning

Students in lower elementary grades have some understanding that models can be used to show how something works, but they believe that perceptual similarity between the model and what it is used to represent is very important when developing or evaluating models. [1] With repeated cycles of modeling and reflection, lower elementary students can focus more on similarities in function and less on perceptual similarities, and upper elementary students can understand the need for symbolic conventions (rather than only physical resemblance) when developing maps, diagrams, and other related display notations. [2]

Prior to instruction, or after traditional instruction, many middle- and high-school students continue to focus on perceptual rather than functional similarities between models and their referents, and think of models predominantly as small copies of real objects. [3] Consequently, students often interpret models they encounter in school science too literally and unshared attributes between models and their referents are a cause of misunderstanding. [4] Some middle- and high-school students view visual representations such as maps or diagrams as models, but only a few students view representations of ideas or abstract entities as models. [5]

Many middle- and high-school students think that models are useful for visualizing ideas and for communication purposes. [6] Only a few students think that models are useful in developing and testing ideas and that the usefulness of a model can be tested by comparing its implications to actual observations. [7]

Middle-school and high-school students accept the idea that scientists can have more than one model for the same thing. [8] However, having multiple models may mean for them that one could have literally a different view of the same entity, or that one could emphasize different aspects of the same entity -- omitting or highlighting certain things to provide greater clarity. Students are rarely aware that there could be different models to explain something or to evaluate alternative hypotheses. They find multiple model use in school science confusing are rarely use multiple models to think about phenomena; even if they do, the idea that one model is "right" and "real" persists. [9] Students may know that models can be changed, but changing a model for them means (typical of high-school students) adding new information or (typical of middle-school students) replacing a part that was made wrong. [10]

Developing and evaluating models *combined* with explicit instruction and reflection about the nature of models and modeling for an extended period of time can be effective in helping middle-school students make progress toward the following ideas: Models are not necessarily physical objects but could be conceptual representations that help scientists to predict and explain; there can be multiple models for the same phenomenon; and models are useful in visualization, predicting phenomena, and conducting investigations that are not otherwise possible. [11] The ideas that scientists revise their models in light of new insights or new data and that not all models are of equal value may be harder to develop. [12]

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