



## Design Pattern for Model Revision in Model-Based Reasoning | Design Pattern 2222

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<b>Title</b>	Design Pattern for Model Revision in Model-Based Reasoning
<b>Overview</b>	<p>This design pattern supports developing tasks in which students revise a model in situations where a given model does not adequately fit the situation or is not sufficient to solve the problems at hand. Because of its very centrality, model revision is difficult to assess in isolation from other aspects of model-based reasoning. Model revision is prompted only by model evaluation, and then model formation must be used to propose alternatives or modifications.</p>
<b>Use</b>	<ul style="list-style-type: none"> <li> <span style="font-size: 1.2em;">i</span> U1. Model-based reasoning concerns making inferences about real-world situations through the entities and structures of a model. When the model is not appropriate for the job at hand, either because it does not fit or it does not adequately capture the salient aspects of the situation, it is necessary to be able to revise the model.         </li> </ul>
<b>Focal knowledge, skills, and abilities</b>	<ul style="list-style-type: none"> <li> <span style="font-size: 1.2em;">i</span> Fk1. Ability, in a given situation, to modify a given model so that its features better match the features of that situation for the purpose at hand.         </li> <li> <span style="font-size: 1.2em;">F</span> Fk2. More specifically: Recognizing the need to revise a provisional model.         </li> <li> <span style="font-size: 1.2em;">F</span> Fk3. Modifying the provisional model appropriately and efficiently.         </li> <li> <span style="font-size: 1.2em;">F</span> Fk4. Justifying the revisions in terms of the inadequacies of the provisional model.         </li> </ul>
<b>Additional knowledge, skills, and abilities</b>	<ul style="list-style-type: none"> <li> <span style="font-size: 1.2em;">i</span> Ak1. Ability to detect anomalies not explained by existing model (i.e., model evaluation)         </li> <li> <span style="font-size: 1.2em;">F</span> Ak2. Familiarity with real-world situation         </li> <li> <span style="font-size: 1.2em;">F</span> Ak3. Domain area knowledge (declarative, conceptual, and procedural)         </li> <li> <span style="font-size: 1.2em;">F</span> Ak4. Familiarity with required modeling tool(s)         </li> <li> <span style="font-size: 1.2em;">F</span> Ak5. Familiarity with required symbolic representations associated procedures (especially statistical methods)         </li> <li> <span style="font-size: 1.2em;">F</span> Ak6. Familiarity with task type (e.g., materials, protocols, expectations)         </li> <li> <span style="font-size: 1.2em;">F</span> Ak7. Ability to engage in model use         </li> <li> <span style="font-size: 1.2em;">F</span> Ak8. Knowledge of model at issue         </li> </ul>
<b>Potential</b>	<ul style="list-style-type: none"> <li> <span style="font-size: 1.2em;">i</span> Po1. Quality and appropriateness of model revisions in order to address inadequacies of provisional model.         </li> </ul>

## observations

- ☞Po2. Degree of and appropriateness of general and/or domain-specific heuristics students use to revise their models.
- ☞Po3. Quality of the basis on which students decide that a revised model is adequate
- ☞Po4. Quality of explanation of the basis on which students decide that a revised model is adequate
- ☞Po5. Efficiency of the process by which students evaluate existing models as deficient and revised models as adequate ,including use of optimal strategies, sequence, monitoring... This observable can be applied when model revision is part of a larger investigation.
- ☞Po6. Extent to which students extract true results from a set of false models and recognize them as independent of the specific assumptions that vary across the (false) models.

## Potential work products

- ☞Pw1. Identification of reasons why the provisional model needs revision.
- ☞Pw2. Select new elements (via drag-and-drop) to add to provisional model to be consistent with logic of needed model revision
- ☞Pw3. Choice or production of revised model
- ☞Pw4. Explanation of reasoning for revised model
- ☞Pw5. Trace of models as constructed/revised (e.g., sequence of Genetics Construction Kit (GCK) models)
- ☞Pw6. Recordings or transcripts of what students said as they "thought aloud" while revising model
- ☞Pw7. Computer-kept records of inquiry steps in which model revision steps are embedded
- ☞Pw8. Notes written by students during model revision

## Potential rubrics



## Characteristic features



- Cf1. A situation to be modeled, a provisional model that is inadequate in some way, and the opportunity to revise the model in a way that improves the fit

## Variable features



- ☞Vf1. Is the model-to-be-revised given, or was it developed by the student in the course of an investigation?
- ☞Vf2. In what way is the model unsatisfactory: Lack of fit to observations, inappropriateness to project goal, wrong grain size or aspects of phenomenon? Are the unsatisfactory aspects provided to the student, or to be discovered through model evaluation?
- ☞Vf3. Is model revision iterative, with feedback?
- ☞Vf4. To what degree is the model revision prompted?
- ☞Vf5. Is problem context familiar (i.e., degree of transfer required)?
- ☞Vf6. Complexity of problem situation
- ☞Vf7. Complexity of the model; i.e., number of variables, complexity of variable relations, number of representations required, whether the model is runnable)

Vf8. Group or individual work?

Vf9. Is extraneous information provided?

Vf10. Degree of scaffolding provided

## **Narrative structure**



Cause and effect. An event, phenomenon, or system is altered by internal or external factors.

Change over time. A sequence of events is presented to highlight sequential or cyclical change in a system.

General to Specific or Whole to Parts. A general topic is initially presented followed by the presentation of specific aspects of the general topic.

Investigation. A student or scientist completes an investigation in which one or more variables may be observed or manipulated and data are collected

Specific to general and Parts to whole. Specific characteristics of a phenomenon are presented, culminating in a description of the system or phenomenon as a whole.

Topic with Examples. A given topic is presented using various examples to highlight the topic.

## **National educational standards**



## **State standards**



## **State benchmarks**



MCA III: 7.1.1.1.1. Understand that prior expectations can create bias when conducting scientific investigations. For example: Students often continue to think that air is not matter, even though they have contrary evidence from investigations.

MCA III: 7.1.1.2.1. Generate and refine a variety of scientific questions and match them with appropriate methods of investigation, such as field studies, controlled experiments, reviews of existing work and development of models.

MCA III: 7.1.1.2.3. Generate a scientific conclusion from an investigation, clearly distinguishing between results (evidence) and conclusions (explanation).

MCA III: 8.1.1.2.1. Use logical reasoning and imagination to develop descriptions, explanations, predictions and models based on evidence.

MCA III: 8.1.3.4.1. Use maps, satellite images and other data sets to describe patterns and make predictions about local and global systems in Earth science contexts. For example: Use data or satellite images to identify locations of earthquakes and volcanoes, ages of sea floor, ocean surface temperatures and ozone concentration in the stratosphere.

MCA III: 7.1.1.2.2. Plan and conduct a controlled experiment to test a hypothesis about a relationship between two variables, ensuring that one variable is systematically manipulated, the other is measured and recorded, and any other variables are kept the same (controlled). For example: The effect of various factors on the production of carbon dioxide by plants.

MCA III: 7.1.3.4.2. Determine and use appropriate safety procedures, tools, measurements, graphs and mathematical analyses to describe and investigate natural and designed systems in a life science context.

MCA III: 6.1.3.4.1. Determine and use appropriate safe procedures, tools, measurements, graphs and mathematical analyses to describe and investigate natural and designed systems in a physical science context.

MCA III: 7.1.3.4.1. Use maps, satellite images and other data sets to describe patterns and make predictions about natural systems in a life science context. For example: Use online data sets to compare wildlife populations or water quality in regions of Minnesota.

MCA III: 8.1.3.4.2. Determine and use appropriate safety procedures, tools, measurements, graphs and mathematical analyses to describe and investigate natural and designed systems in Earth and physical science contexts.

**I am a kind of** ⓘ

**These are kinds of me** ⓘ

**These are parts of me** ⓘ

**Templates** ⓘ

**Exemplar tasks** ⓘ

**Online resources** ⓘ

**References** ⓘ

- R1. Mosteller & Tukey (1977)
- R2. Rumelhart & Norman (1977)
- R3. Stewart & Hafner (1991, 1994).
- R4. Stewart, Hafner, Johnson, & Finkel (1992)

**I am a part of** ⓘ

[Design Pattern for Model-Based Inquiry in Model-Based Reasoning.](#) (Design Pattern #2223)

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