Design Pattern for Model Elaboration in Model-Based Reasoning | Design Pattern 2219

Title

Design Pattern for Model Elaboration in Model-Based Reasoning

Overview

This design pattern supports developing tasks in which students elaborate given scientific models by combining, extending, adding detail to a model, and/or establishing correspondences across overlapping models.
This design pattern can considered a special case of model formation in that the aim is to develop a modeled conception of a situation. But the emphasis is what is happening in the model layer with respect to extensions of models or connections between models. Model elaboration is also similar to model revision, in that a given model or a set of unconnected models does not account properly for the target situation and reformulation is required.

Use

U1. Like scientists, students of science should be familiar with the processes that lead to the development of scientific theories and the situated use of scientific models. Model elaboration, in which existing models are combined or extended to incorporate new data or to increase theoretical parsimony, is one such aspect of scientific inquiry: The user extends adapts, and connects models as prompted by the target situation.

Focal knowledge, skills, and abilities

Fk1. Ability to identify links between similar models (that share objects, processes, or states)

Fk2. Ability to link models at different levels or focusing on different aspects of phenomena to create a larger, more encompassing model.

Additional knowledge, skills, and abilities

Ak1. Familiarity with real-world situation

Ak2. Knowledge of model at issue

Ak3. Domain area knowledge (declarative, conceptual, and procedural)

Ak4. Familiarity with required modeling tool(s) (e.g., STELLA, Marshall's arithmetic schema interface)

Ak5. Familiarity with required symbolic representations associated procedures (e.g., Marshall's schema forms, mathematical notation)

Ak6. Familiarity with task type (e.g., materials, protocols, expectations)

Potential observations

Po1. Extent to which student catenates models appropriately across levels; that is, common entities and processes match up appropriately (e.g., individual-level and species-level models in transmission genetics)

Po2. Quality of student explanation of modifications, in terms of features of data/purpose that require reasoning across levels/submodels

Po3. Accuracy and completeness of mappings between a real-world situation and elaborated model.

Potential work products

Pw1. Correspondence mapping between elements or relationships of model and real-world situation

Pw2. Final elaborated model (Physical, symbolic, verbal, etc., as appropriate)

Pw3. Trace of steps and provisional models

Pw4. Written/oral explanation of reasoning behind elaboration

Potential rubrics

Characteristic features

Cf1. Real-world situation and one or more models appropriate to the situation, for which details of correspondence need to be fleshed out. Addresses correspondence between situation and models, and models with one another.

Cf2. Problem solution involves combining or making additions to existing models by, for example, embedding a model in a larger system, adding more parts to the model, or incorporating additional information about a real-world situation into the schema the model represents.

Variable features

Vf1. Is problem context familiar (i.e., degree of transfer required)?

Vf2. Model given to student(s), vs. model to elaborate produced by student(s) themselves

Vf3. Complexity of elaboration required <u>details</u>

Vf4. Is model use isolated, or in the context of a larger investigation? <u>details</u>

Vf5. Single model to elaborate vs. establishing correspondence among models at different levels or with different foci?

Vf6. Degree of scaffolding provided <u>details</u>

Vf7. Group or individual work?

Narrative structure

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

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

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

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

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

<u>Topic with Examples</u>. A given topic is presented using various examples to highlight the topic.

National educational standards

State standards

State benchmarks

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: 7.1.1.1.1. 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: 7.1.1.2.2. 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: 7.1.1.2.3. Generate a scientific conclusion from an investigation, clearly distinguishing between results (evidence) and conclusions (explanation).

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: 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: 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: 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.

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Templates

Exemplar tasks

Online resources

References

R1. Marshall (1993, 1995).

R2. Stewart & Hafner (1994).

R3. White & Frederiksen (1998).

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

Tags [Add Tag]

(No tags entered.)

List of Examples:

Activity Add'l KSAs: Affective Add'l KSAs: Cognitive Add'l KSAs: Executive Add'l KSAs: Language and Symbols Add'l KSAs: Perceptual Add'l KSAs: Skill and Fluency Continuous Zone Design Pattern Educational Standard Evaluation Phase Evaluation Procedure (rubric) Materials and Presentation Measurement Model Narrative Structure Observable Variable State Benchmark State Standards Student Model Student Model Variable Task Exemplar Task Model Variable Task Specification Template Variable Features: Affective Variable Features: Cognitive Variable Features: Executive Variable Features: Language and Symbols Variable Features: Perceptual Variable Features: Skill and Fluency Work Product

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