Design Pattern for Model Use in Model-Based Reasoning | Design Pattern 2218

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Title

Design Pattern for Model Use in Model-Based Reasoning

Overview

This design pattern supports developing tasks that require students to reason through the structures, relationships, and processes of a given model.
Model use is often combined with model formation in the same tasks, and most tasks that address model evaluation and model revision also involve model use.

Use

U1. Scientific models are abstracted schemas involving entities and relationships, meant to be useful across a range of particular circumstances. Procedures within the model space can be carried out to support inferences about the situation beyond what is immediately observable.

Focal knowledge, skills, and abilities

Fk1. Ability to reason through the concepts and relationships of a given model to make explanations, predictions and conjectures: Qualitative reasoning through the model; Quantitative reasoning through the symbolic representations associated with the 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. Quality of students' explanations, predictions, or retrodictions as reasoned through the model ; e.g., correctness, appropriateness (i.e., quality of the product of model us).

Po2. Qualities of solution procedure, such as appropriateness, efficiency, systematicity, quality of strategy, and effectiveness of procedures (i.e., qualities of the student's process).

Po3. Quality of student's explanation of her own solution through a model (i.e., quality of the student's explanation of their process of model use, as distinct from the quality of the product of their reasoning).

Potential work products		Pw1. Selection of hypotheses, predictions, retrodictions, explanations, and/or missing elements of real world situation Pw2. Constructed hypotheses, predictions, retrodictions, explanations, and/or missing elements of real world situation, via: Creation of one or more representational forms; Filling in given, possibly partially filled in, representational forms. Pw3. Intermediate products developed in selection/construction of hypotheses, predictions, explanations, and/or missing elements Pw4. Written/oral explanation of the hypotheses, predictions, explanations, and/or missing elements. Pw5. Trace of actions taken in solution Pw6. Talk- aloud of solution. Pw7. Critique of a given solution
Potential rubrics		
Characteristic features		Cf1. Real-world situation and one or more models appropriate to the situation. Focus is on reasoning through the schema and relationships embedded in the model. Reasoning is as if the model is appropriate to the situation is the focus.
Variable features		Vf1. Is problem context familiar (i.e., degree of transfer required)? Vf2. Is model use isolated, or in the context of a larger investigation? Vf3. Complexity of model Vf4. Complexity of situation Vf5. Complexity of reasoning required details Vf6. Model provided or generated by student? Vf7. Data provided or generated by student? Vf8. Degree of scaffolding provided (especially if model use involves strategies, alternate approaches, and multiple steps) Vf9. Group or individual work?
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: 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.

I am a kind of

These are kinds of me

These are parts of me

Templates

Exemplar tasks

Online resources

References

R1. Stewart, J., & Hafner, R. (1994).
R2. Johnson-Laird (1983)
R3. Gentner & Stevens (1983)
R4. Hestenes, Wells, & Swackhamer (1992)

I am a part of

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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