Design Pattern for Model Formation in Model-Based Reasoning | Design Pattern 2175

Title

Design Pattern for Model Formation in Model-Based Reasoning

Overview

This design pattern supports developing tasks in which students create a model of some real-world phenomenon or abstracted structure, in terms of entities, structures, relationships, processes, and behaviors. The Model Formation design pattern can be viewed as a subpart of the Model-Based Inquiry design pattern, and many tasks combine Model Formation with Model Use. The Model Formation design pattern also overlaps with those for Model Elaboration and Model Revision. details

Use

U1. Ability to build a model is a fundamental component of inquiry-based science. During the construction of a model, students make design decisions regarding the question(s) they are interested in answering, what variables they need to include, how "precise" their model needs to be, and how it corresponds to the elements of the situation.

Focal knowledge, skills, and abilities

Fk1. Ability to pose relevant questions about system to construct model

Fk2. Ability to relate elements of model to features of situation and vice versa.

Fk3. Ability to describe (i.e., narrate) the situation through the entities and relationships of the model

Fk4. Ability to identify which aspects of the situation to address and which to omit.

Fk5. Decision-making regarding scope and grain-size of model, as appropriate to the intended use of 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)

Ak7. Ability to communicate with other colleagues

Potential

Po1. Qualities of final model:

observations

Accuracy of determination of what variables are important to include in the model

Po2. Accuracy of representation of relations among variables

Po3. If runnable model, quality of model output

Po4. Appropriateness of degree of precision of model of phenomenon or system being modeled.

Po5. Modeling process:
Efficiency in terms of tools and representations

Po6. Quality (relevancy, accuracy) of questions asked about the system to inform the construction of a model. includes domain-specific heuristics and domain-specific explanatory schemas when these are targets of inference.

Po7. If talk-aloud, degree to which student talks about the meaning of the data

Po8. Quality of rationale student provides for steps in construction of model. Includes domain-specific heuristics and domain-specific explanatory schemas when these are targets of inference

Po9. Quality of rationale for what entities and relationships are expressed in the model, versus those which are omitted

Po10. Speed at which student forms model details

Potential work products

Pw1. Final version of model

Pw2. Explanation of model interpretation (as written or typed log or response, or audio transcript)

Pw3. Correspondence mapping between elements or relationships of model and real-world situation when there are gaps in one or the other to be filled

Pw4. Notes taken during model building process

Pw5. Trace of steps taken to build model

See Scalise and Gifford (2006) for a taxonomy and illustrations of work product formats that are amenable to automated scoring.

Potential rubrics

Characteristic features

Cf1. Specific situation or data (either provided or previously generated by student), to be modeled, for some purpose.

Cf2. Correspondence must be established between elements of the model and elements of the situation.

Variable features

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

Vf2. To what degree is the model prompted?

Vf3. Is model formation isolated, or in the context of a larger investigation?

Vf4. Complexity of problem situation details

- Vf5. Complexity of the model; i.e., number of variables, complexity of variable relations, number of representations required, whether the model is runnable)
- Vf6. Well-defined problem vs. ill-defined problem (or gradations thereof)
- Vf7. Is extraneous information provided (makes tasks more difficult)?
- Vf8. Kind of model needed for problem goal: simple & quick versus more exact and complex
- Vf9. Role/depth of approximation required
- Vf10. Degree of scaffolding provided
- Vf11. 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: 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.

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These are kinds of me

These are parts of me

Templates

Exemplar tasks

Online resources

References

R1. diSessa (1993).

R2. Hunt & Minstrell (1994)

R3. Kintsch & Greeno (1985)

R4. Kintsch (1994)

R5. Kindfield (1999)

R6. Redish (2003)

I am a part of

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

[Add Tag]

Tags

(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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