Design Pattern for Model Articulation in Model-Based Reasoning | Design Pattern 2220

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Title	Design Pattern for Model Articulation in Model-Based Reasoning
Overview	Tasks supported by this design pattern assess student's ability to articulate the meaning of physical or abstract systems across multiple representations. Representations may take qualitative or quantitative forms. This DP is relevant in models with quantitative and symbolic components (e.g., connections between conceptual and mathematical aspects of physics models) Model articulation is often be pertinent in multiple-step tasks, after the model formation step.
Use	U1. Scientists reason through problems both as qualitative or physical relationships and as symbolic systems. This ability to articulate across multiple qualitative and/or quantitative representations or physical realities is crucial to students' development of scientific knowledge and ability.
Focal knowledge, skills, and abilities	Fk1. Ability to articulate meanings between qualitative and/or quantitative systems associated with scientific phenomenon. Fk2. Ability to transform information between qualitative and/or quantitative systems associated with scientific phenomenon.
Additional knowledge, skills, and abilities	Ak1. Knowledge of and ability to reason within qualitative and quantitative systems implied in the task. That is, this DP isolates the ability to move between systems, and therefore it presupposes students' ability to operate within the symbolic etc. systems involved. 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 operations applied across systems Po2. Extent to which student accurately maps one system into another, rather than back onto itself Po3. Accuracy of predictions in system y based on expressions in system x

- Po4. Accuracy and completeness of creation of system y based on expressions in system x
- Po5. Quality/appropriateness of description of meaning of information across systems
- Po6. Accuracy of selection of system (given example, i.e., instruction would have made the various systems explicit to students).

Potential work products

- Pw1. Re-expression of information in one or more systems in terms of another system
- Pw2. Cross-system problem solutions with mappings (e.g., force diagrams and equations). Can be prompted with "show your work."
- Pw3. Verbal descriptions and explanations of meanings across representational systems
- Pw4. Predictions for one system given information about an associated system
- Pw5. Selection of system for scenario presented in terms of other systems

Potential rubrics

Characteristic features

- Cf1. Multiple inter-related representation systems
- Cf2. Task addresses relationship in expressions from one system to another

Variable features

- Vf1. Articulation between semantic and symbolic systems, among different symbolic systems, or across multiple systems?
- Vf2. Is problem context familiar (i.e., degree of transfer required)?
- Vf3. Number of systems used (model, symbolic, physical, abstract)
- Vf4. Complexity of systems
- Vf5. Complexity of mappings (conditions, # issues to simultaneously consider)
- Vf6. Prior exposure to representations and mapping conventions
- Vf7. Is articulation the focus of a task, or is it part of a larger task? If part of a larger task, is the articulation problem presented to the student or is the need for, and carrying out of, articulation to be sought in the trace of a free-form solution trace?
- Vf8. Degree of scaffolding provided (e.g., is need for elaboration prompted? Are hints or checklist provided to guide elaboration?)
- 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. Greeno (1989)

R2. diSessa (1983, 1993)

R3. Marshall (1993)

I am a part of Design Pattern for Model-Based Inquiry in Model-Based Reasoning. (Design Pattern #2223)

Tags [Add Tag]

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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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