Model Use in Interdependence Among Living Systems | Design Pattern 2225

Title

Model Use in Interdependence Among Living Systems

Overview

This design pattern supports developing tasks that require students to reason through the structures, relationships, and processes of ecological models.
Use of ecological models is often combined with the formation of ecological models in tasks. Many tasks that address evaluation and revision of ecological models also involve the use of these models.

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. Ecological models that, for example, show predator-prey relationships, the flow of energy, and the recycling of matter are instances of scientific models in life science. Students must be able to use these models to reason about processes and interdependencies in living systems.

Focal knowledge, skills, and abilities

Fk1. Ability to use an ecological model to explain the relationships among populations and communities details

Fk2. Ability to use an ecological model to explain similarities and differences among types of interdependent relationships (e.g., predator/prey vs. parasite/host vs. producer/consumer/decomposer) details

Fk3. Ability to use an ecological model to explain how populations in an ecosystem are dependent on biotic and abiotic resources details

Fk4. Ability to use an ecological model to explain how producers make, use, and store food details

Fk5. Ability to use an ecological model to explain how energy changes form in a food web details

Fk6. Ability to use an ecological model to explain how the amount of matter stays the same as it is transferred between organisms and their physical environment details

Additional knowledge, skills, and abilities

Ak1. Knowledge of entities (e.g., plants and animals) represented in the ecological model details

Ak2. Knowledge of different ecological models (e.g., food webs, water cycle) details

Ak3. Understanding that when two entities are related or interdependent, manipulating one will affect the other

Ak4. Knowledge of how to use and interpret required modeling tool(s) (e.g., online state assessment

interface, STELLA, ESIS) details

- Ak5. Knowledge of required symbolic representations associated procedures (e.g., chemical equations, mathematical notation)
- Ak6. Familiarity with task type (e.g., materials, protocols, expectations)
- Ak7. Knowledge of what a population is details
- Ak8. Knowledge of what a community is details
- Ak9. Knowledge of what an ecosystem is details
- Ak10. Ability to recognize whether an ecosystem is stable details
- Ak11. Ability to distinguish between biotic and abiotic resources in an ecological model details
- Ak12. Ability to recognize producers in a food web details
- Ak13. Ability to recognize consumers in a food web details
- Ak14. Ability to recognize decomposers in a food web details
- Ak15. Ability to determine interdependencies in a model by holding constant some entities while varying others details

Potential observations

- Po1. High quality explanation of how communities and populations represented in an ecological model interact. details
- Po2. High quality explanation of how one or more interdependent relationships represented in an ecological model are similar to or different from other interdependent relationships represented in the model. details
- Po3. High quality explanation of how populations represented in an ecological model are dependent on the biotic and abiotic resources shown in the model. details
- Po4. High quality explanation of how producers make, use, and store food in an ecological model. details
- Po5. High quality explanation of how energy represented in an ecological model, such as a food web, changes form. details
- Po6. High quality explanation of how the amount of matter stays the same as it is transferred between the organisms and components of the physical environment shown in an ecological model. details
- Po7. Accurate completion and description of a flow chart showing how energy flows in an ecological model
- Po8. Accurate completion and description of a flow chart showing how matter flows in an ecological model

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. details

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. details

Pw5. Trace of actions taken in solution

Pw6. Talk- aloud of solution.

Pw7. Critique of a given solution

Pw8. Completion and description of a flow chart showing how energy flows in an ecological model.

Pw9. Completion of a flow chart showing how matter flows in an ecological model.

Pw10. Description of how producers in an ecological system use the energy from sunlight to make sugars from carbon dioxide and water in a process called photosynthesis.

Potential rubrics

Characteristic features

Cf1. Ecological model represents a real-world situation

Cf2. Presentation of at least one ecological model appropriate to the situation

Cf3. Questions require students to reason through the schema and relationships in the model

Variable features

Vf1. Problem context/ Type of ecological model details

Vf2. Complexity of model details

Vf3. Relative stability of ecological model (should this be part of complexity? AHD) details

Vf4. Use of visual and linguistic supports in model details

Vf5. Model provided to or generated by student details

Vf6. Data provided to or generated by student details

Vf7. Degree of scaffolding provided details

Vf8. Complexity of situation NOT SURE WHAT THIS MEANS (AHD)

Vf9. Complexity of reasoning required details

Vf10. Presentation of background about the ecological model details

Vf11. Provision of definitions of terminology relevant to ecological model details

Vf12. Provision of descriptions of entities in an ecological model details

Vf13. Model use isolated vs. in the context of a larger investigation details

Vf14. Group work or individual work details

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.

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.

National educational standards

NSES 8ASI1.3. Use appropriate tools and techniques to gather, analyze, and interpret data. The use of tools and techniques, including mathematics, will be guided by the question asked and the investigations students design. The use of computers for the collection, summary, and display of evidence is part of this standard. Students should be able to access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes.

NSES 8ASI1.4. Develop descriptions, explanations, predictions, and models using evidence. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description, providing causes for effects and establishing relationships based on evidence and logical argument. This standards requires a subject knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.

NSES 8ASI1.5. Think critically and logically to make the relationships between evidence and explanations. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment. Students should begin to state some explanations in terms of the relationship between two or more variables.

Unifying Concepts 1.2 - Evidence, models, and explanation. Scientific explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements. As students develop and as they understand more science concepts and processes,their scientific explanations should more frequently include a rich scientific knowledge base, evidence of logic, higher levels of analysis, greater tolerance of criticism and uncertainty, and a clearer demonstration of the relationship between logic, evidence, and current knowledge.

Unifying Concepts 1.3 - Constancy, change, and measurement. Some properties of objects and processes are characterized by constancy, other by change. These may include properties of materials, position of objects, motion, and form and function of systems. Interactions within and among systems result in changes which can be quantified. Different systems of measurement are used for different purposes. Scale includes understanding that different characteristics, properties, or relationships within a system might change as its dimensions are increased or decreased. Rate involves comparing one measured quantity with another measured quantity.

Unifying Concepts 1.1 - Systems, order, and organization. The goal of this standard is to think and analyze in terms of systems.

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: 7.4.2.1.1. Identify a variety of populations and communities in an ecosystem and describe the relationships among the populations and communities in a stable ecosystem.

MCA III: 7.4.2.1.2. Compare and contrast predator/prey, parasite/host and producer/consumer/decomposer relationships.

MCA III: 7.4.2.1.3. Explain how the number of populations an ecosystem can support depends on the biotic resources available as well as abiotic factors such as amount of light and water, temperature range and soil composition.

MCA III: 7.4.2.2.1. Recognize that producers use the energy from sunlight to make sugars from carbon dioxide and water through a process called photosynthesis. This food can be used immediately, stored for later use, or used by other organisms.

MCA III: 7.4.2.2.2. Describe the roles and relationships among producers, consumers and decomposers in changing energy from one form to another in a food web within an ecosystem.

MCA III: 7.4.2.2.3. Explain that the total amount of matter in an ecosystem remains the same as it is transferred between organisms and their physical environment, even though its form and location change. For example: Construct a food web to trace the flow of matter in an ecosystem

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)

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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