Assessing Three-Dimensional Learning in the Next Generation Science Standards

John Howarth & Maia Willcox
SEPUP
The Lawrence Hall of Science
University of California, Berkeley
Disciplinary Core Ideas

• **Physical Science**
  • Matter and its interactions
  • Motion and stability: Forces and interactions
  • Energy
  • Waves and their applications in technologies for information transfer

• **Life Science**
  • From molecules to organisms: Structures and processes
  • Ecosystems: Interactions, energy, and dynamics
  • Heredity: Inheritance and variation of traits
  • Biological evolution: Unity and diversity

• **Earth and Space Science**
  • Earth’s place in the universe
  • Earth’s systems
  • Earth and human activity

• **Engineering**
  • Engineering design
Crosscutting Concepts

- Cause and Effect
- Energy and Matter
- Patterns
- Scale, Proportion, and Quantity
- Stability and Change
- Structure and Function
- Systems and System Models
Science and Engineering Practices

- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking
Performance Expectations

• Middle school examples:
  • **MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
  • **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
Clam Catch

- The Challenge
  - How might the introduction of a competing species, such as zebra mussels, affect a population of native clams?
The Procedure – Part A

- Some of you will be clams, some plankton, and some recorders
- Clams stand inside the circles – one clam per circle
- Plankton stand on one side
- Plankton move quickly to the other side
- Clams try to catch the plankton
  - Tag with one hand only
  - Stay inside your circle
The Procedure – Part A

- A clam has to catch plankton to survive
- Any clam that does not catch plankton dies and leaves the circle. You will join the plankton
- Any plankton that is caught will join the clams IF there is an available circle
- The number of clams is recorded
- The process is repeated 10 times
Summarizing the Data – Part A

- Was the population of clams the same from year to year?
- What prevented the population of clams from continuing to increase?
- Overall, was the population stable or unstable?

- The data can be graphed (time permitting)
Part B - Competition

- Some of you will be zebra mussels and will wear the red arm band!
- Zebra mussels are smaller than the clams and two can occupy a circle OR one zebra mussel and one clam
- Zebra mussels are voracious filter feeders. In the model they can use two hands to catch plankton.
- Same rules apply as before
- The number of clams and zebra mussels are recorded
- The process is repeated 10 times
Summarizing the Data – Part B

- Graph the populations of clams and mussels over time. (Use a line graph)
- How did the population of clams change over time?
- How did the population of zebra mussels change over time?
- What happened to the clam population after the zebra mussels were introduced?
- Why did zebra mussels have this effect on the clam population? Explain.
Extensions and Variations

- Add a mobile predator.
- Vary the initial numbers of clams, plankton, and zebra mussels.
- Discuss the strengths and limitations of this model.
### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>MS-LS2.A: Interdependent Relationships in Ecosystems:</th>
<th>Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (LS2-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (LS2-1)</td>
</tr>
<tr>
<td></td>
<td>Growth of organisms and population increases are limited by access to resources. (LS2-1)</td>
</tr>
<tr>
<td></td>
<td>Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (LS2-2)</td>
</tr>
<tr>
<td>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</td>
<td>Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (LS2-4)</td>
</tr>
</tbody>
</table>
## Crosscutting Concepts

<table>
<thead>
<tr>
<th>Cause and Effect</th>
<th>Cause and effect relationships may be used to predict phenomena in natural systems. (LS2-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patterns</td>
<td>Patterns can be used to identify cause and effect relationships. (LS2-2)</td>
</tr>
<tr>
<td></td>
<td>Graphs, charts, and images can be used to identify patterns in data.</td>
</tr>
<tr>
<td>Stability and Change</td>
<td>Small changes in one part of a system might cause large changes in another part.</td>
</tr>
</tbody>
</table>
## Science and Engineering Practices

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>Analyze and interpret data to provide evidence for phenomena. (LS2-1)</td>
</tr>
<tr>
<td></td>
<td>Analyze and interpret data to determine similarities and differences in findings.</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (LS2-2)</td>
</tr>
<tr>
<td>Developing and Using Models</td>
<td>Develop a model to predict and/or describe phenomena. (LS2-3)</td>
</tr>
<tr>
<td>Using Mathematics and Computational Thinking</td>
<td>Use mathematical representations to describe and/or support scientific conclusions and design solutions.</td>
</tr>
</tbody>
</table>
Performance Expectations

- **MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Each performance expectation is at the end of a learning pathway, as illustrated on the next two slides. This activity is on the learning pathways of three performance expectations and provides the opportunity for formative assessment of conceptual understanding (DCI), practices, and crosscutting concepts, along with associated common core state standards in ELA and Math.
Contact Information

- John Howarth
  - john_howarth@berkeley.edu

- Maia Willcox
  - mwillcox@berkeley.edu

This slide show and activity will be available at sepuplhs.org/news