SimScientists Assessment Systems

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WestEd

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SimScientists Assessment Goals

- Create simulation environments that represent dynamic science system phenomena “in action”
- Take advantage of technology to represent causal and temporal relationships, patterns, and changes in scale
- Develop age appropriate science system models
- Take advantage of technology to support active application of science practices
- Establish the scientific and technical quality of simulation-based assessments
- Gather evidence of feasibility of implementation of simulation based assessments
- Conduct research to examine impacts of formative uses of simulation-based assessments on deep science learning
SimScientists Assessment Suites
(Curriculum-embedded Assessments and Unit Benchmark)

Life Science
- Ecosystems
- Cells
- Human Body Systems
- Genetics
- Evolution

Physical Science
- Force and Motion
- Atoms and Molecules
- Energy
- Waves
Theory and Research Base

Integrates research on

• **Model-based learning** (Buckley, 2012; Gobert & Buckley, 2000)
  System Framework-components, interactions, and emergent system behavior
  The formation, use, evaluation and revision of mental models of complex science systems

• **Evidence-centered assessment design** (Mislevy et al, 2003)
  A systematic assessment development process that links targets, tasks & data

• **Cognitive science**
  Guides design and use of representations & interactions in tasks
SimScientists Assessments
Embedded & Benchmark

- Regular Instruction
  - Embedded Assessment + Reflection Activity

- Regular Instruction
  - Embedded Assessment + Reflection Activity

- Regular Instruction
  - Benchmark Assessment

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Next Generation Science Standards
Addressed in Life Science Examples

Cross Cutting concepts
  System and system models
  Energy and matter
  Structure and function

Life science core ideas
  From molecules to organisms: Structures and processes (MS LS 1)
  Ecosystems: Interactions, energy and dynamics (MS LS 2)

Science practices
  Developing and using models
  Planning and carrying out investigations
  Constructing explanations
  Engaging in arguments from evidence
# Ecosystems Target Model

<table>
<thead>
<tr>
<th>Model Level</th>
<th>Descriptions</th>
<th>Content Targets</th>
<th>Science Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>What are the components of the system and their rules of behavior?</td>
<td>Every ecosystem has a similar pattern of organization with respect to the roles (producers, consumers, and decomposers) that organisms play in the movement of energy and matter through the system. (NGSS: LS2.A—Interdependent Relationships in Ecosystems)</td>
<td>Analyzing and Interpreting Data</td>
</tr>
<tr>
<td>Interaction</td>
<td>How do the individual components interact?</td>
<td>Matter and energy flow through the ecosystem as individual organisms participate in feeding relationships within an ecosystem. (NGSS: LS2.B—Cycles of Matter and Energy Transfer in Ecosystems)</td>
<td>Developing &amp; Using Models; Analyzing and Interpreting Data</td>
</tr>
<tr>
<td>Emergent</td>
<td>What is the overall behavior or property of the system that results from many interactions following specific rules?</td>
<td>Interactions among organisms and among organisms and the ecosystem’s nonliving features cause the populations of the different organisms to change over time. (NGSS: LS2.C—Ecosystems Dynamics, Functioning and Resilience)</td>
<td>Planning and Carrying Out Investigations; Analyzing and Interpreting Data</td>
</tr>
</tbody>
</table>
SimScientists Assessments
Ecosystems
Formative Assessment Features within the Simulation

• Immediate feedback
  – On core ideas/misconceptions
  – On practices

• Graduated coaching

• Progress Report
  – On Track, Making Progress, Needs Help by content and practices targets

• For individual student

• Teachers
  – Class summary with drill-down into student detail
  – Used to suggest teams and groups for jig-saw structured reflection activities that adjust instruction and support collaboration and discourse
Progress Reports to Students

Report for Grasslands - Food Web

Roles
- Every ecosystem has a similar pattern of organization with respect to the roles that organisms play in the movement of energy and matter through the system. Every ecosystem has organisms that play the roles of Producers, Consumers, and Decomposers.

Interactions
- Matter and energy flow through the ecosystem as individual organisms interact with each other. Food web diagrams indicate the feeding relationships among organisms in an ecosystem. All ecosystems have a flow of energy from a nonliving source, to producers, to consumers.

Identifying
- Identifying Science Principles focuses on students' ability to recognize, recall, define, relate, and represent basic science principles. The practices assessed in this category draw on declarative knowledge or "knowing that."

Using
- Using Science Principles focuses on the ability to use patterns in observations and theoretical models to predict and explain observations that they make now or that they will make in the future. The practices assessed in this category draw primarily on schematic knowledge or "knowing why."
## Embedded Progress Report: Class Summary

### Summary Report: Grasslands - Food Web

#### Assessment: Grasslands - Food Web

**Class:** Period 4

<table>
<thead>
<tr>
<th>Content</th>
<th>NH: Needs Help</th>
<th>P: Making Progress</th>
<th>OT: On Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roles</td>
<td>4 (17%)</td>
<td>6 (25%)</td>
<td>14 (58%)</td>
</tr>
<tr>
<td>Interactions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 (63%)</td>
<td>5 (21%)</td>
<td>4 (17%)</td>
</tr>
<tr>
<td>Inquiry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identifying</td>
<td>9 (38%)</td>
<td>3 (13%)</td>
<td>12 (50%)</td>
</tr>
<tr>
<td>Using</td>
<td>8 (33%)</td>
<td>5 (21%)</td>
<td>11 (46%)</td>
</tr>
</tbody>
</table>

**NH** = needs help  
**P** = making progress  
**OT** = on track
### Embedded Progress Report: Student Details

**Detailed Report: Grasslands - Food Web**

<table>
<thead>
<tr>
<th>Student 1</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>NH</td>
<td>NH</td>
<td>NH</td>
<td>NH</td>
<td>P</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student 2</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>OT</td>
<td>NH</td>
<td>OT</td>
<td>NH</td>
<td>NH</td>
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</table>

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<thead>
<tr>
<th>Student 3</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>NH</td>
<td>NH</td>
<td>NH</td>
<td>NH</td>
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<thead>
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<th>Student 4</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>P</td>
<td>NH</td>
<td>NH</td>
<td>NH</td>
<td>P</td>
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<thead>
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<th>Student 5</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>P</td>
<td>NH</td>
<td>NH</td>
<td>NH</td>
<td>P</td>
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</tbody>
</table>

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<thead>
<tr>
<th>Student 6</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
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</thead>
<tbody>
<tr>
<td>B</td>
<td>OT</td>
<td>NH</td>
<td>OT</td>
<td>NH</td>
<td>P</td>
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<thead>
<tr>
<th>Student 7</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
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<tbody>
<tr>
<td>B</td>
<td>OT</td>
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<td>OT</td>
<td>OT</td>
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<thead>
<tr>
<th>Student 8</th>
<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
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</thead>
<tbody>
<tr>
<td>A</td>
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<td>OT</td>
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<th>Reflection Gr.</th>
<th>Roles</th>
<th>Interactions</th>
<th>Identifying</th>
<th>Using</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>OT</td>
<td>OT</td>
<td>OT</td>
<td>OT</td>
<td>OT</td>
</tr>
</tbody>
</table>

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Group A students needed little help on either roles or interactions.
Group B students needed help with interactions, but not with roles.
Group C students needed help with understanding the roles of organisms in an ecosystem.
Classroom Reflection Activity

• Formative use of assessment results
  – Students assigned to teams based on embedded results
• Transfer to different, more complex system
• Jigsaw structure
  – Allows differentiated instruction via tasks of varying difficulty
  – Promotes small and large group discourse and collaboration
Transfer to new, more complex ecosystem

Develop a model of energy flow through ecosystem
## Human Body Systems target model

<table>
<thead>
<tr>
<th>System Model Levels</th>
<th>Content Targets</th>
<th>Science Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components</td>
<td>Organisms and their parts are made of cells, which are the structural units of life and which themselves have molecular substructures that support their functioning.</td>
<td>2. Developing &amp; Using Models</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Planning &amp; Carrying Out Investigations</td>
</tr>
<tr>
<td>Interactions</td>
<td>Different groups of large numbers of cells work together to form systems of tissues and organs that are specialized for particular functions.</td>
<td>4. Analyzing &amp; Interpreting Data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Constructing Explanations based on Evidence</td>
</tr>
<tr>
<td>Emergent Behaviors</td>
<td>Organ systems work together to maintain a stable internal environment and enable whole body functions.</td>
<td>7. Defending &amp; Critiquing Arguments</td>
</tr>
</tbody>
</table>
SimScientists Assessments
Human Body Systems
Research Findings

Field test of two assessment suites in 2 states with 26 teachers and 3,694 students

Significantly better performance on pre/post and benchmark assessments of students using the curriculum-embedded assessments with those who did not

Benchmark assessments documented technical quality

Evidence of the effectiveness of simulation-based formative assessments on learning

Evidence of the potential of simulation-based assessments to enhance and augment state science assessment systems
Balanced, Multilevel Assessment System Models

1. Reporting benchmark results alongside district and state data
2. Matrix sampling of short “signature” tasks from different topics
Selected Publications


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