MS. Matter and Energy in Organisms and Ecosystems

Step 1- What performance expectations are related and can be included in instruction within the lessons/unit? (Cluster PEs)

MS-LS2-1 and MS-LS2-4

Step 2- What are the performance expectations, clarification statements, and assessment boundaries and how are they related in terms of instructional practices?

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. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

Step 3- What are the disciplinary core idea(s), practices, and crosscutting concepts coded to the performance expectations and how will they drive instruction?

Scientific and Engineering Practices:

- Analyzing and Interpreting Data
- Engaging in Argument from Evidence
- Scientific Knowledge is Based on Empirical Evidence

Disciplinary Core Ideas:

- LS2.A: Interdependent Relationships in Ecosystems
  - Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
  - 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. (MS-LS2-1)
  - Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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. (MS-LS2-4)

Crosscutting Concepts:
- Cause and Effect
- Stability and Change

### Step 4 - What understandings need to be developed for students to be successful in the performance expectation(s)? What content ideas will they need to know and what skills will they need to learn?

<table>
<thead>
<tr>
<th>Students will need to know...</th>
<th>Students will be able to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and their nonliving factors.</td>
<td>Analyze and interpret data to provide evidence for phenomena.</td>
</tr>
<tr>
<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.</td>
<td>Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.</td>
</tr>
<tr>
<td>Growth of organisms and population increases are limited by access to resources.</td>
<td></td>
</tr>
<tr>
<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.</td>
<td></td>
</tr>
</tbody>
</table>
Common student misunderstandings retrieved from the AAAS Assessment Website-

### Frequency of selecting a misconception

<table>
<thead>
<tr>
<th>Misconception ID Number</th>
<th>Student Misconception</th>
<th>Grades 6-8</th>
<th>Grades 9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEM022</td>
<td>If a population in a food web is disturbed, there will be little or no effect on populations that are not within the linear sequence in the food web (Webb &amp; Boltt, 1990).</td>
<td>31%</td>
<td>30%</td>
</tr>
<tr>
<td>IEM065</td>
<td>Varying the size of a population of organisms will affect only those populations of organisms that are directly connected to it in a feeding relationship, not organisms that are one or more steps removed/away from it (Griffiths &amp; Grant, 1985; Webb &amp; Boltt, 1990).</td>
<td>20%</td>
<td>19%</td>
</tr>
<tr>
<td>IEM021</td>
<td>If a population in a food web is disturbed, there will be little or no effect on populations below it in the food web (e.g., if a predator is removed, no effect on prey: Webb &amp; Boltt, 1990; Leach, 1996).</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td>IEM006</td>
<td>Organisms higher in a food web eat everything that is lower in the food web (Griffiths &amp; Grant, 1985).</td>
<td>15%</td>
<td>12%</td>
</tr>
<tr>
<td>IEM030</td>
<td>If the size of one population in a food web is altered, all other populations in the web will be altered in the same way (Griffiths &amp; Grant, 1985).</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>IEM029</td>
<td>A change in the size of a prey population has no effect on its predator population (Griffiths &amp; Grant, 1985).</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>IEM061</td>
<td>Changes in a population in a food web do not affect the populations of any other organism in the food web (AAAS Project 2061, n.d.).</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>IEM047</td>
<td>The top predator in a food web will never be significantly affected by changes in the populations of organisms below it in the food web (AAAS Project 2061, n.d.).</td>
<td>9%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Frequency of selecting a misconception was calculated by dividing the total number of times a misconception was chosen by the number of times it could have been chosen, averaged over the number of students answering the questions within this particular idea.

In all environments, individual organisms that depend on the same resource may compete for that resource when it is limited. Resources that can be limited include food, space, water, shelter, and light.

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<tr>
<th>Misconception ID Number</th>
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<th>Grades 9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEM053</td>
<td>Competition between organisms always involves direct, aggressive interaction. Exploitative competition (e.g., getting to the resource before other organisms) is not competition (AAAS Project 2061, n.d.).</td>
<td>63%</td>
<td>51%</td>
</tr>
<tr>
<td>IEM054</td>
<td>Plants do not compete for resources (AAAS Project 2061, n.d.).</td>
<td>31%</td>
<td>20%</td>
</tr>
<tr>
<td>IEM062</td>
<td>Organisms of the same species do not compete with each other for resources (AAAS Pilot testing 2007).</td>
<td>15%</td>
<td>11%</td>
</tr>
<tr>
<td>IEM052</td>
<td>Plants do not compete for light (AAAS Project 2061, n.d.).</td>
<td>10%</td>
<td>12%</td>
</tr>
<tr>
<td>IEM060</td>
<td>Different kinds of organisms (species) do not compete for resources (AAAS Project 2061, n.d.).</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>IEM055</td>
<td>Animals do not compete for resources (AAAS Project 2061, n.d.).</td>
<td>11%</td>
<td>7%</td>
</tr>
<tr>
<td>IEM049</td>
<td>Animals do not compete for shelter (AAAS Project 2061, n.d.).</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>IEM051</td>
<td>Plants do not compete for space (AAAS Project 2061, n.d.).</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>IEM048</td>
<td>Animals do not compete for water (AAAS Project 2061, n.d.).</td>
<td>7%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Frequency of selecting a misconception was calculated by dividing the total number of times a misconception was chosen by the number of times it could have been chosen, averaged over the number of students answering the questions within this particular idea.
Step 5: What Science and Engineering Practices are appropriate with the instruction of the disciplinary core ideas?

- Analyzing and Interpreting Data
- Engaging in Argument from Evidence
- Asking questions
- Planning and carrying out investigations
- Constructing Explanations
- Obtaining, evaluating, and communicating information
- Scientific Knowledge is based on Empirical Evidence (Nature of Science)

Step 6: What are the lesson level expectations (learning performances) and how will they build to meet the performance expectations?

- Ask questions about how a small change in an ecosystem can affect the entire ecosystem. (Teacher designs a question, then keeps a question board of student questions that arise from the activities, readings, lecture bursts, demonstrations and investigations) (Asking questions)
- Design and conduct an investigation to find relationships between resource availability and organisms (plants). The student-conducted investigation begins with a student-designed question. (Planning and carrying out Investigations)
- Evaluate their investigation design for possible sources of error regarding effects of resource availability and organisms. (Planning and carrying out investigations)
- Engage in discourse with peers regarding invasive species and their effect on ecosystems. (Engaging in argument from evidence)
- Cite specific textual evidence from science text to support their claims. (Obtaining, evaluating, and communicating information, and engaging in argument from evidence)
- Analyze other students’ claims regarding resource availability and population changes. (Engaging in argument from evidence)
- Justify their reasoning to others in support of their claim that changes in ecosystems affect populations. (Engaging in argument from evidence)
- Argue that physical and biological components of ecosystems effect populations. (Engaging in argumentation from evidence).
- Look for patterns and cause and effect relationships in ecosystem data sets. (Analyzing and interpreting data)

Step 7- What assessment (formative and summative) will provide evidence of the understanding and/or ability to perform lesson level expectations (learning performances)?
Performance Tasks/Projects-
- A written scientific explanation supporting the claim that resource availability affects organism population in ecosystems. [Constructing explanations (for science) and designing solutions (for engineering) Use rubric]
- A written scientific explanation that supports the claim that physical and biological components of ecosystems affect populations. [Constructing explanations (for science) and designing solutions (for engineering) Use rubric]
- A journal recording their plant investigation and their findings. [Planning and carrying out investigations Use rubric]

Other Evidence-
Observations during discourse (rubric)
Self-reflection after discourse (either video or written)
Data analysis activities

Student Self-Assessment-
Classroom discussions
Critical Friends
CER Rubric

Step 8 What is the storyline that helps learners apply what they know, build new, sophisticated ideas from observation and evidence, and use information to answer a science question or solve an engineering problem?

During these lessons students wonder explore and ask questions about how a biotic or abiotic change in an ecosystem can affect an entire ecosystem. The effects of these changes may directly or indirectly affect the populations of the species of organisms within an ecosystem. The abundance or scarcity of a resource may affect populations in complex ways. These changes may include increased predation, starvation, migration, changes in predator/prey relationships etc.

The Performance Expectations in Matter and Energy in Organisms and Ecosystems help students formulate answers to the questions: “How do organisms obtain and use matter and energy? How do matter and energy move through an ecosystem?” Middle school students can use conceptual and physical models to explain the transfer of energy and cycling of matter as they construct explanations for the role of photosynthesis in cycling matter in ecosystems. They can construct explanations for the cycling of matter in organisms and the interactions of organisms to obtain the matter and energy from the ecosystem to survive and grow. Students have a grade-appropriate understanding and use of the practices of investigations, constructing arguments based on evidence, and oral and written communication. They begin to understand that sustaining life requires substantial energy and matter inputs and the structure and functions of organisms contribute to the capture,
transformation, transport, release, and elimination of matter and energy. Adding to these crosscutting concepts is a deeper understanding of systems and system models that ties the performances expectations in this topic together. The learning performances shared for the performance expectations selected would occur in the middle of a unit. The unit would culminate after additional lessons with construction of an ecosystem model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Step 9 Reflect - How do the lessons and tasks help students move towards an understanding of the performance expectation(s)?

- Regarding the concepts of how a small change in an ecosystem can affect the entire ecosystem, the teacher designs a question then keeps a question board of student questions that arise from the activities, readings, lecture bursts, demonstrations and investigations. These student-generated questions are used as a basis for student investigations.
- While considering how matter cycles in organisms and the interactions of organisms to obtain the matter and energy from the ecosystem to survive and grow, students can design and conduct investigations to find relationships between abiotic and biotic conditions of the ecosystems. These student-conducted investigations need to begin with a student-designed question that is doable and testable.
- Based upon the student-generated question, students design and conduct an investigation to find relationships among abiotic and biotic factors of an ecosystem.
- After gathering qualitative and quantitative observations over time, students look for patterns as well as cause and effect relationships in ecosystem data sets.
- This process of data analysis enables students to develop an explanation answering their own questions. This process of explaining involves three steps. First, making a claim (the answer to the original student’s question.) Next, selecting and providing evidence from their data to support their own claim that answers their investigation question. Finally revealing their scientific thinking that offers their rationale as to why their selected evidence matters and indeed counts as evidence.
- It is one thing to write down or express thoughts in written answers. However, to engage in discourse with peers regarding impact of abiotic changes of the ecosystem on biotic components of the ecosystems involves a more sophisticated set of thinking skills.
- Students justify their reasoning to others in support of their claim that changes in ecosystems affect populations.
- Argue that physical (abiotic) and biological (biotic) components of ecosystems affect populations of organisms.

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Executive Director