NGSS Evidence Statements

Executive Summary of the Front Matter

Overview

- The NGSS identify assessable performance expectations (PEs), or what students should know and be able to do at the end of instruction.
- Each PE represents the integration of three "dimensions" of science education: scientific and engineering practices, disciplinary core ideas (DCIs), and crosscutting concepts (CCCs). As such, both student learning and assessment around the NGSS should be "three dimensional".
- The evidence statements are meant to show what it looks like for students to fully satisfy the PE.

Purpose

- The evidence statements were designed to articulate how students can use the practices to demonstrate their understanding of the DCIs through the lens of the CCCs, and thus, demonstrate proficiency on each PE. The evidence statements do this by clarifying:
  - How the three dimensions could be assessed together, rather than in independent units
  - The underlying knowledge required for each DCI
  - The detailed approaches to science and engineering practices
  - How crosscutting concepts might be used to deepen content- and practice-driven learning
- Given the shift to three dimensional learning, it is important to note that "minimum proficiency" on the NGSS is higher than for most previous standards, and will not look the same.
- The evidence were **not** created to:
  - Be used as curriculum
  - Limit or dictate instruction

Structure

- The science and engineering practices are used as the organizing structure for the evidence statements (this **does not** mean that the practices are more important than the other dimensions). The proper integration of practices make students' thinking visible.
- As such, there are templates for each practice that contain the categories necessary for students to demonstrate full proficiency on that practice.
- The evidence statements and the associated templates **are not** meant to be used for the following:
  - As a description of teacher prompts, instructional techniques, or steps in a classroom activity
  - As a description of increasing levels of cognitive difficulty, Depth of Knowledge levels, or varying levels of student proficiency
  - As a checklist that denotes the ordering or sequence of steps in a student's performance

How to Use the Evidence Statements

- All users should spend time understanding the NRC's *Framework for K-12 Science Education* and NGSS prior to using the evidence statements
- For assessment: the evidence statements can be used to inform the development of summative assessments, but context would have to be added to the statements to align with the specific examples or prompts used in the assessment.
- For instruction: the evidence statements can be used in support of instructional design, but it is crucial to recognize that there are numerous pathways educators may use across the course of lessons and units to allow students to ultimately be prepared for success on the performance expectations (and thus to be able to demonstrate the evidence statements).
- Although evidence statements are listed individually for each performance expectation, **this does not indicate that they should be measured individually, or that performance expectations should be taught or assessed individually**. Classroom instruction should be focused on helping students build towards several PEs at one time because many concepts and practices are interrelated.

Limitations of the Evidence Statements

- The evidence statements cannot do the following:
  - Provide or proscribe the contexts through which the PEs may be taught or assessed
  - Be the rubrics on which levels of student success would be measured
  - Identify the sequence of instruction or assessment
  - Put limits on student learning or student coursework
  - Replace lesson plans or assessment items
  - Serve as complete scoring rubrics

Development Process & Criteria

- Discipline-based teams of scientists and educators — including many of the writers of the NGSS — worked together to create the evidence statements (starting with high school).
- These authors used the following guiding principles and criteria (among others) to craft the evidence statements:
  - Statements should describe observable evidence that a scorer or assessor could actually see and measure
  - Statements should be written as if they are the "proficient" level
  - Foundation box bullets from all three dimensions must be the focus of the statements and statements must not go beyond the bullets of each dimension's foundation box
  - Specific mathematical formulae should be highlighted when required for student use
  - Concepts that are included in prior grades' DCIs should not be repeated unless they are also in the current grade's DCIs

**Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.*

MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

MS-LS2-2. **Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.** [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- 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.

Crosscutting Concepts

Patterns

- Patterns can be used to identify cause and effect relationships.

Observable features of the student performance by the end of the course:

1	Articulating the explanation of phenomena		
	a	Students articulate a statement that relates the given phenomenon to a scientific idea, including that similar patterns of interactions occur between organisms and their environment, regardless of the ecosystem or the species involved.	
	b	Students use evidence and reasoning to construct an explanation for the given phenomenon.	
2	Evidence		
	a	Students identify and describe* the evidence (e.g., from students' own investigations, observations, reading material, archived data) necessary for constructing the explanation, including evidence that:	
		i.	Competitive relationships occur when organisms within an ecosystem compete for shared resources (e.g., data about the change in population of a given species when a competing species is introduced).
		ii.	Predatory interactions occur between organisms within an ecosystem.
		iii.	Mutually beneficial interactions occur between organisms within an ecosystem. Organisms involved in these mutually beneficial interactions can become so dependent upon one another that they cannot survive alone.
		iv.	Resource availability, or lack thereof, can affect interactions between organisms (e.g., organisms in a resource-limited environment may have a competitive relationship, while those same organisms may not be in competition in a resource-rich environment).
		v.	Competitive, predatory, and mutually beneficial interactions occur across multiple, different, ecosystems
	b	Students use multiple valid and reliable sources for the evidence.	
3	Reasoning		
	a	Students identify and describe* quantitative or qualitative patterns of interactions among organisms that can be used to identify causal relationships within ecosystems, related to the given phenomenon.	

	b	Students describe* that regardless of the ecosystem or species involved, the patterns of interactions (competitive, mutually beneficial, predator/prey) are similar.
	c	Students use reasoning to connect the evidence and support an explanation. In their reasoning, students use patterns in the evidence to predict common interactions among organisms in ecosystems as they relate to the phenomenon, (e.g., given specific organisms in a given environment with specified resource availability, which organisms in the system will exhibit competitive interactions). Students predict the following types of interactions:
		i. Predatory interactions.
		ii. Competitive interactions.
		iii. Mutually beneficial interactions.

**Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.*

MS-ESS3-4 Earth and Human Activity

Students who demonstrate understanding can:

MS-ESS3-4. **Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.** [Clarification Statement: ~~Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.~~ The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- 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.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

Observable features of the student performance by the end of the course:

1	Supported claims	
	a	Students make a claim, to be supported by evidence, to support or refute an explanation or model for a given phenomenon. Students include the following idea in their claim: that increases in the size of the human population ~~and per-capita consumption of natural resources affect Earth systems.~~
2	Identifying scientific evidence	
	a	Students identify evidence to support the claim from the given materials, including:
		i. Changes in the size of human population(s) in a given region or ecosystem over a given timespan.

		ii.	~~Per-capita consumption of resources by humans in a given region or ecosystem over a given timespan.~~
		iii.	Changes in Earth systems in a given region or ecosystem over a given timespan.
		iv.	The ways engineered solutions have altered the effects of human activities on Earth's systems.
3	Evaluating and critiquing evidence		
	a	Students evaluate the evidence for its necessity and sufficiency for supporting the claim.	
	b	Students determine whether the evidence is sufficient to determine causal relationships between ~~consumption of natural resources~~ and the impact on Earth systems.	
	c	Students consider alternative interpretations of the evidence and describe* why the evidence supports the claim they are making, as opposed to any alternative claims.	
4	Reasoning and synthesis		
	a	Students use reasoning to connect the evidence and evaluation to the claim. In their arguments, students describe* a chain of reasoning that includes:	
		i.	Increases in the size of the human population ~~or in the per-capita consumption of a given population~~ cause increases in the consumption of natural resources.
		ii.	~~Natural resource consumption causes changes in Earth systems.~~
		iii.	~~Because human population growth affects natural resource consumption and natural resource consumption has an effect on Earth systems, changes in human populations have a causal role in changing Earth systems.~~
		iv.	Engineered solutions alter the effects of human populations on Earth systems by changing the rate of natural resource consumption or mitigating the effects of changes in Earth systems.

Tool 2 (shortened version) Example: Evidence Statements

Middle School Ecology Unit

MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

MS-ESS3 Earth and Human Activity

Instructional Sequence 1

Performance Expectation MS-LS2-2

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.

Performance Expectation MS-ESS3-4

Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems.

Clarification Statement: ~~Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.~~ The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.

Evidence Statements

MS-LS2-2

1. Articulating the explanation of phenomena

1a. Students articulate a statement that relates the given phenomenon to a scientific idea, including that similar patterns of interactions occur between organisms and their environment, regardless of the ecosystem or the species involved.

1b. Students use evidence and reasoning to construct an explanation for the given phenomenon.

2. Evidence

2a. Students identify and describe the evidence (e.g., from students' own investigations, observations, reading material, archived data) necessary for constructing the explanation, including evidence that:

i. Competitive relationships occur when organisms within an ecosystem compete for shared resources (e.g., data about the change in population of a given species when a competing species is introduced).

ii. Predatory interactions occur between organisms within an ecosystem.

iii. Mutually beneficial interactions occur between organisms within an ecosystem. Organisms involved in these mutually beneficial interactions can become so dependent upon one another that they cannot survive alone.

iv. Resource availability, or lack thereof, can affect interactions between organisms (e.g., organisms in a resource0limited environment may have a competitive relationship, while those same organisms may not be in competition in a resource-rich environment).

v. Competitive, predatory, and mutually beneficial interactions occur across multiple, different, ecosystems.

2b. Students use multiple valid and reliable sources for the evidence.

3. Reasoning

3a. Students identify and describe quantitative or qualitative patterns of interactions among organisms that can be used to identify causal relationships within ecosystems, related to the given phenomenon.

3b. Students describe that regardless of the ecosystem or species involved, the patterns of interactions (competitive, mutually beneficial, predator/prey) are similar.

3c. Students use reasoning to connect the evidence and support an explanation. In their reasoning, students use patterns in the evidence to predict common interactions among organisms in ecosystems as they relate to the phenomenon, (e.g., given specific organisms in a given environment with specified resource availability, which organisms in the system will exhibit competitive interactions). Students predict the following types of interactions:

i. Predatory interactions.

ii. Competitive interactions.

iii. Mutually beneficial interactions.

MS-ESS3-4

1. Supported claims
1a. Students make a claim, to be supported by evidence, to support or refute an explanation or model for a given phenomenon. Students include the following idea in their claim: that increases in the size of the human population ~~and per capita consumption of natural resources~~ affect Earth systems.

2. Identifying scientific evidence
2a. Students identify evidence to support the claim from the given materials, including:

i. changes in the size of human population(s) in a given region or ecosystem over a given timespan.

~~ii. Per-capita consumption of resources by humans in a given region or ecosystem over a given timespan.~~

iii. Changes in Earth systems in a given region or ecosystem over a given timespan.

iv. The ways engineered solutions have altered the effects of human activities on Earth's systems.

3. Evaluating and critiquing evidence
3a. Students evaluate the evidence for its necessity and sufficiency for supporting the claim.

3b. Students determine whether the evidence is sufficient to determine causal relationships between ~~consumption of natural resources~~ increase in human population and the impact on Earth systems.

3c. Students consider alternative interpretations of the evidence and describe why the evidence supports the claim they are making, as opposed to any alternative claims.

4. Reasoning and synthesis
4a. Students use reasoning to connect the evidence and evaluation to the claim. In their arguments, students describe a chain of reasoning that includes:

i. Increases in the size of the human population ~~or in the per-capita consumption of a given population~~ cause increases in the consumption of natural resources.

~~ii. Natural resource consumption causes changes in Earth systems.~~

~~iii. Because human population growth affects natural resource consumption and natural resource consumption has an effect on Earth systems, changes in human populations have a causal role in changing Earth systems.~~

iv. Engineered solutions [See text in DCI (ESS3.C) change in activity (i.e. hunting, ranch borders, etc.)] alter the effects of human populations on Earth systems by changing the rate of natural resource consumption or mitigating the effects of changes in Earth systems.