NGSS: Science for the Future

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CTC
April 11, 2014
New Opportunities for all Learners

California Common Core State Standards (ELA and Math)

21st Century Skills

Next Generation Science Standards
Building on the Past; Preparing for the Future

1990s

Phase I

1990s-2009

Phase II

1/2010 - 7/2011

7/2011 – April 2013
Currently 10 states, DC and 2 territories have adopted the NGSS
California Adoption

They’re Here!

Celebrate
And
Prepare
Next Generation Science Standards

Science and Engineering

Core ideas in the discipline

Concepts across disciplines

What's the big idea?
### MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

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

**MS-LS2-3.** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy through ecosystems, and on defining the boundaries of the system. Assessment Question: Does not include the use of physical models or simulations to describe the processes.]

**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.]

**MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

### Science and Engineering Practices

**Developing and Using Models**
- Developing a model to describe phenomena. (MS-LS2-3)
- Analyzing and interpreting data
- Developing and using models to describe, test, and predict abstract phenomena and system behavior.
  - Developing a model to describe phenomena. (MS-LS2-3)
  - Testing a model against data from experiments or simulations.

**Conducting Experiments and Designing Solutions**
- Constructing an explanation and designing solutions in 6-8 builds on K-5 experiences and encourages students to construct an explanation based on the adequacy of the evidence. Examples of evidence consist of scientific ideas, principles, and theories.
- Constructing an explanation and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
- Evaluating competing design solutions based on joint development and agreement.

### Disciplinary Core Ideas

**LS2.A: Interdependent Relationships in Ecosystems**
- Organisms, populations, and ecosystems are dependent on each other in their environmental interactions with both other living things and with nonliving factors.
- 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 constraints their growth and reproduction.
- Organizations and populations increase limits by access to resources.
- Similarly, predation, competition, and mutualistic interactions vary across ecosystems.

**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**
- Food webs are models that demonstrate how matter and energy is transferred among organisms, decomposers, and energy. The energy level is transferred through primary, secondary, or tertiary consumers and decomposers.
- Decomposers recycle nutrients and other resources back to the soil or other living organisms.

**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 changes in its populations.
- Biodiversity describes the richness and variety of species found in Earth's terrestrial and oceanic ecosystems.

**LS2.D: Biodiversity and Humans**
- Changes in biodiversity can influence human/organisms, such as food, energy, and medicines, and as well ecosystem services that humans rely on for various reasons, such as water purification and recycling.

### Crosscutting Concepts

**Patterns**
- Patterns can be used to identify cause and effect relationships. (MS-LS2-2)

**Cause and Effect**
- Cause and effect may be used to predict phenomena in natural or designed systems. (MS-LS2-2)
- Energy and Matter
  - The energy transfer is tracked through some system. (MS-LS2-2)

**Stability and Change**
- Small changes in one part of a system may cause large changes in another part. (MS-LS2-2)

**Connections to Engineering, Technology, and the Nature of Science**

**Influence of Scientific, Engineering, and Technology on the Natural and Material World**
- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values. (MS-LS2-2)

**Connections to Nature of Science**

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS3-3)

**Science Addresses Questions About the Natural and Material World**
- Scientific knowledge can describe the consequences of actions that do not necessarily correlate with society's decisions. (MS-LS2-2)
Instruction Builds Toward PEs

Performance Expectation
# MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

**Science and Engineering Practices**
- Developing and Using Models: Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict abstract phenomena and design systems.
- Analyzing and Interpreting Data: Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to include new variables and larger data sets, using advanced statistical analysis techniques.
- Engaging in Argument from Evidence: Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing convincing arguments that support or refute claims in other explanations or solutions about the natural and designed world.

**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.
  - 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.
  - Growth of organisms and population increases are limited by access to resources.
  - Similarly, predators 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**
- **Cycles**
  - Matter is recycled in ecosystems.
  - Energy is conserved in ecosystems.

**Connections to Nature of Science**
- Scientific Questions Based on Empirical Evidence
- Connections to other Disciplines in this grade band
- Articulation Across Grade Bands

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**Foundation Boxes**
- **SEP**
- **DCI**
- **CCC**
Science and Engineering Practices

Why science teachers should not be given playground duty.
Scientific and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Developing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
The Big Idea

• If the goal is to answer a question, then students are doing science.

• If the goal is to define and solve a problem, then students are doing engineering.
Science and Engineering Practices

Students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined.

Appendix F
Crosscutting Concepts

1. Patterns
2. Cause and effect: mechanism and explanation
3. Scale, proportion and quantity
4. Systems and system models
5. Energy and matter: flows, cycles and conservation
6. Structure and function
7. Stability and change
## Cross Cutting Concepts

### Across Disciplines

<table>
<thead>
<tr>
<th>Life</th>
<th>Earth</th>
<th>Physical</th>
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<tr>
<td>Photosynthesis</td>
<td>Earthquakes</td>
<td>Electricity</td>
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### Within A Discipline

<table>
<thead>
<tr>
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<tr>
<td>Cells</td>
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<tr>
<td>Organ Systems</td>
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<tr>
<td>Ecosystems</td>
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<tr>
<td>Scale</td>
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### MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

**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-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. (Clarification statement: Emphasis is on predicting consistent patterns in the relationship between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutualistic.)

**MS-LS2-3.** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (Clarification statement: Emphasis is on describing, explaining, and modeling the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system. Assessment Boundary: Does not include the use of chemical reactions to describe the processes.)

**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 evidence supporting changes to an ecosystem.)

**MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (Examples of ecosystem services include water purification, nutrient cycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.)

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### Science and Engineering Practices

**Developing and Using Models**
- Modeling in 9–12 builds on K–8 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to describe phenomena. (MS-LS2-3)
- Analyze and interpreting data
- Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to include basic statistical analysis of data and trend analysis.
- Analyze and interpret data to provide evidence for phenomena. (MS-LS1-1)

**Constructing Explanations and Designing Solutions**
- Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to using a model to develop, revise, and compare possible solutions based on design criteria.
- Construct explanations and design solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
- Engaging in Argument from Evidence
- Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to using appropriate tools and/or models to develop, revise, and/or compare possible solutions based on design criteria.
- Evaluate competing design solutions based on jointly developed and agreed-upon criteria. (MS-LS2-3)

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### 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)
- Similarly, predation and other interaction 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 mutualistic interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-3)

**LS2.B: Cycle of Matter and Energy Transfer in Ecosystems**
- Food webs are models that demonstrate how matter and energy is transferred through producers, consumers, and decomposers as the three abiotic interact within an ecosystem. Transfers of matter into and out of the physical environment occur at any level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial ecosystems or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

**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)
- Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health. (MS-LS2-5)

**LS2.D: Biodiversity and Humans**
- Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (MS-LS2-5)

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### Crosscutting Concepts

**Patterns**
- Patterns can be used to identify causes and effect relationships. (MS-LS2-1)
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)
- Stability and Change
- Small changes in one part of a system may cause relatively large changes in another part. (MS-LS2-1)

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### Connections to Engineering, Technology, and Applications of Science

**Influence of Science, Engineering, and the Natural World**
- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of science; and by the differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-1)

**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**
- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)
- Science addresses questions about the natural and material world.
- Scientific knowledge can guide the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

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Connections within NGSS and to CCSS
Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
3 Dimensional Learning
Dissected

Analyze and interpret data to provide evidence

resource availability on organisms and populations of organisms in an ecosystem

the effects of resource availability on organisms and populations of organisms in an ecosystem
Implications for Instruction

Past 7th Grade Life Science CA Standard

Students know plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems and whole organism.

Current Middle Grades CA NGSS Adopted Standard

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
NGSS
Middle School Conversation
NGSS
Setting a New Course
California Science Expert Panel (SEP)

27 Science Experts who are representative of the SRT

- K-12 Teachers, COE Science Leaders, IHE Faculty, Business, Industry, and Informal Science Centers

- Noted Scientist Advisors
  - Dr. Bruce Alberts
  - Dr. Helen Quinn
  - Dr. Art Sussman
What Research Says

- CA SS&C: Students in integrated biology scored the same or better than students in traditional biology on the Golden State Exam. Scott, G (2000)

- All [top scoring] countries require participation in integrated science instruction through Lower Secondary and seven of 10 countries continue that instruction through Grade 10, providing a strong foundation in scientific literacy. Achieve (2010).
Criteria for Design
PEs must:

- Be arranged to provide a TRANSITION from elementary to high school
- ALIGN with CCSS ELA and Math
- Build WITHIN and ACROSS grade levels
- Be BALANCED in complexity and quantity at each grade
- INTEGRATE engineering appropriately
Reminder!!

PEs are a list at each grade level. Districts/teachers will need to decide how to “bundle” them for instruction.
District: Which to Choose?

SBE Preferred Integrated Model

SBE Alternative

Discipline Specific Model
Implementation Timeline

2013: Adoption of the Ca NGSS
2014: CST 5, 8, 10 Science Assessment on current Ca science standards
2014: Science Framework begins
2015-2016: Earliest Implementation (more likely 2016-2017)
2016-2017: Science Instructional Materials
???: Science assessment on CaNGSS
Shift Happens: Preservice

What does it mean to teach content through the practices and cross cutting concepts?

How is engineering incorporated into the classroom?

How do PEs inform classroom assessment?
WELL.... WHY NOT!