The Next Generation Science Standards (NGSS): An Overview

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SMCOE Goal

SMCOE will actively work to erase San Mateo County’s Achievement Gap by working with teachers, leaders, and systems to insure every student has access to academically rigorous, culturally responsive instruction and to a support system that fosters academic success. We will do this in this session by:

- Gaining a better understanding of the Next Generation Science Standards (NGSS)
- Understanding how the Next Generation Science Standards can be integrated across other content areas, leading to STEM education
Agenda

• Assessing Background Knowledge
• Adoption Timeline
• NRC Framework for K-12 Science Education
• Three Dimensions of the Next Generation Science Standards (NGSS)
• Inquiry Investigation
• The Structure and Cognitive Shifts of the NGSS
Where are we?

1. How would you describe your knowledge or implementation level with the Common Core State Standards (CCSS)?

2. How would you describe your knowledge of the Science Framework?

3. How would you describe your knowledge/implementation level of the NGSS?
NGSS Overview Video

Video Frame: Think about the following question as you watch the video:

Why Next Generation Science Standards?
Why Next Generation Science Standards?
Background info: Two-Step Process

http://www.nextgenscience.org
NGSS Development Timeline

Next Generation Science Standards Development Process

2011

September 2011: California Chosen as Lead State in Development of New Science Standards, Based on Framework

November 2011: First Meeting of State Review Team of Science Experts

2012

May 2012: First Public Draft of NGSS Released

February 2012: Second Meeting of State Review Team of Science Experts

October 2012: Third Meeting of State Review Team of Science Experts

March 2013: Final Draft of NGSS Released

2013

January 2013: Second Public Draft of NGSS Released

Spring 2013: Two Public Meetings of Final NGSS

July 31, 2013: SSPI Presents to California SBE Recommended Science Standards Based on the NGSS

2014

November 30, 2013: California SBE Adopts, Rejects, or Modifies Recommended Science Standards

2014*:

Implementation of New Science Standards

* pending SBE action

California Department of Education

Revised December 2012

www.smcoe.org
NGSS Next Steps

• The NGSS will get rolled out similarly to the Common Core:
  Awareness ➔ Transition ➔ Implementation

• February 2014 - 2015 – CA Science Framework

• 2014-2015 NGSS Professional Development Modules

• 2015 - 2016 – Assessments (at the earliest)

• 2016 - 2018 – K-8 Science Adoption
A Framework for Science Education

Vision

• Science for ALL Students
• Coherent Learning

Realizing the Vision

• Integrating the Three Dimensions
• Implementation of Science Curriculum
• Equity and Diversity
• Guidance for Standards Development
• Looking Toward the Future: Research to Inform K-12 Science Education Standards
Understanding A Framework for K-12 Science Education

Purposeful Reading – Critical Reading Strategy: Marking the Text

Before reading the text:

   Number the paragraphs

At your table, assign each person a number (1-4)

   Person 1: Understanding and applying…
   Person 2: Why practices?
   Person 3: Why engineering?
   Person 4: Complementing goals
Understanding A Framework for K-12 Science Education

• While reading the text:

  Number the paragraphs
  Circle key terms
  Underline sentences or phrases that resonate with you

Put a star next to the one phrase that stands out the most to you.
Next Generation Science Standards

Three Dimensions

Dimension 1: Science and Engineering Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world.

Dimension 2: Crosscutting Concepts

They are a way of linking the different domains in science.

Dimension 3: Disciplinary Core Ideas

Describes core ideas in the science disciplines and of the relationships among science, engineering and technology.
Dimension 1: Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
Science and Engineering Practices in K-12 Classrooms

1. Read your assigned practice and CIRCLE key terms, UNDERLINE phrases or examples that distinguish science practices from engineering practices.

2. Summarize (visually or in writing) your practice as a group. Be sure to explain the difference in Science and Engineering practices, and include a real life example.

3. Be prepared to share out your summary
Table Talk

What are the implications of these scientific practices for curriculum and instruction?
Next Generation Science Standards

Three Dimensions

Dimension 1: Science and Engineering Practices

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Dimension 2: Crosscutting Concepts

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Dimension 3: Disciplinary Core Ideas

Describes core ideas in the science disciplines and of the relationships among science, engineering and technology
Dimension 2: Crosscutting Concepts

- Patterns, similarity, and diversity
- Cause and effect
- Scale, proportional and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change
Dimension 3: Disciplinary Core Ideas

- Physical sciences
- Life sciences
- Earth and space sciences
- Engineering, technology and application of science
Dimension 3: Disciplinary Core Ideas

**Disciplinary Significance** - Has broad importance across multiple science or engineering disciplines

**Explanatory Power** - Can be used to explain a host of phenomena

**Generative** - Provides a key tool for understanding or investigating more complex ideas and solving problems

**Relevant to Peoples’ Lives** - Relates to the interests and life experiences of students, connected to societal or personal concerns

**Usable from K to 12** - Is teachable and learnable over multiple grades at increasing levels of depth and sophistication
Disciplinary Core Idea (DCI): Physical Sciences

- PS1. Matter and Its Interactions
- PS2. Motion and Stability
- PS3. Energy
- PS4. Waves and Their Applications
**DCI: Life Sciences**

- **LS1. From Molecules to Organisms: Structures and Processes**
- **LS2. Ecosystems: Interactions, Energy, and Dynamics**
- **LS3. Heredity: Inheritance and Variation of Traits**
- **LS4. Biological Evolution: Unity and Diversity**
DCI: Earth and Space Sciences

• ESS1. Earth’s Place in the Universe

• ESS2. Earth’s Systems

• ESS3. Earth and Human Activity
DCI: Engineering, Technology and Applications of Science

- ETS1. Engineering Design
- ETS2. Links among Engineering, Technology, Science and Society
Conceptual Shifts

1. K-12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world

2. The NGSS are student performance expectations – NOT curriculum

3. NGSS focuses on enduring Disciplinary Core Ideas, rather than isolated science facts

4. The science concepts build coherently from K-12
Conceptual Shifts

5. The NGSS focus on deeper understanding of content as well as application of content

6. Science and Engineering are integrated in the NGSS from K-12

7. The NGSS are designed to prepare students for college, career, and citizenship

8. The NGSS and Common Core State Standards are aligned
Table Talk

What are the implications for professional development that you can anticipate?
Convergences

Math

M1. Make sense of problems & persevere in solving them
M2. Reason abstractly & quantitatively
M6. Attend to precision
M7. Look for & make use of structure
M8. Look for & express regularity in repeated reasoning

E1. Demonstrate independence in reading complex texts, and writing and speaking about them
E7. Come to understand other perspectives & cultures through reading, listening, and collaborations
E6. Use technology & digital media strategically & capably
M5. Use appropriate tools strategically

Science

S2. Develop and use models
M4. Model with mathematics
S5. Use mathematics & computational thinking
E2. Build a strong base of knowledge through content rich texts
E5. Read, write, and speak grounded in evidence
M3 and E4. Construct viable arguments & critique reasoning of others
S7. Engage in argument from evidence

S1. Ask questions & define problems
S3. Plan & carry out investigations
S4. Analyze & interpret data
S6. Construct explanations & design solutions

ELA

Sources:

www.smcoe.org
Mobius Strip Investigation

Ants on a Mobius Strip by M.C. Escher
Convergences

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E1. Demonstrate independence in reading complex texts, and writing and speaking about them
E7. Come to understand other perspectives & cultures through reading, listening, and collaborations

ELA

E3. Obtain, synthesize, and report findings clearly and effectively in response to task and purpose
E8. Obtain, evaluate & communicate information

Sources:

www.smcoe.org
Standard Comparison

- **Old California State Science Standards (1998) - HS Biology -**
  Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

  - Students know how natural selection determines the differential survival of groups of organisms
  - Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment
  - Students know reproductive or geographic isolation affects speciation
  - Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction
Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
Standards Comparison:
Structure and Properties of Matter

Current State Middle School Science Standard

- **Distinguish** between atoms and molecules.
- **Describe** the difference between pure substances (elements and compounds) and mixtures.
- **Describe** the movement of particles in solids, liquids, gases, and plasmas states.
- **Distinguish** between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
- **Distinguish** between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
- **Recognize** that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
- **Identify and demonstrate** the Law of Conservation of Matter.

NGSS Middle School Sample

- **Construct and use models** to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.
- **Plan investigations to generate evidence** supporting the claim that one pure substance can be distinguished from another based on characteristic properties.
- **Use a simulation or mechanical model** to determine the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.
- **Construct an argument** that explains the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.
# NGSS Architecture

## Performance Expectations

### Foundation Boxes

<table>
<thead>
<tr>
<th>1-ESS1</th>
<th>Earth’s Place in the Universe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1-ESS1</strong></td>
<td>Earth’s Place in the Universe</td>
</tr>
<tr>
<td>Students who demonstrate understanding can:</td>
<td></td>
</tr>
<tr>
<td>1-ESS1.1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]</td>
<td></td>
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<tr>
<td>1-ESS1.2. Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]</td>
<td></td>
</tr>
</tbody>
</table>

### Science and Engineering Practices

| Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. |
| Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. |
| Analyzing and Interpreting Data: Analyzing and Interpreting Data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. |
| Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (1-ESS1) |

### Disciplinary Core Ideas

| **ESS1A:** The Universe and its Stars |
| Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1) |
| **ESS1B:** Earth and the Solar System |
| Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1) |

### Crosscutting Concepts

**Patterns:** Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-ESS1-1) (1-ESS1-2)

**Connections to Nature of Science:**

- Science assumes natural events happen today as they happened in the past. (1-ESS1-1)
- Many events are repeated. (1-ESS1-1)

**Connections to other DCIs in first grade: N/A**

### Articulation of DCIs across grade bands:

- 1-PS2.A (1-ESS1-1); 1-PS2.B (1-ESS1-1), (1-ESS1-2); 5-PS2.B (1-ESS1-1), (1-ESS1-2)

### Crosswalks

#### Common Core State Standards Connections:

**ELA/Literacy – Mathematics –**

- **W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-ESS1-1), (1-ESS1-2)
- **W.1.8** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-ESS1-1), (1-ESS1-2)
- **MP.2** Reason abstractly and quantitatively. (1-ESS1-2)
- **MP.4** Model with mathematics. (1-ESS1-2)
- **MP.5** Use appropriate tools strategically. (1-ESS1-2)
- **1.OA.A.1** Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations to represent the problem. (1-ESS1-2)
- **1.MD.C.4** Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. (1-ESS1-2)

- **1.MD.C.4** Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. (1-ESS1-2)

[www.smcoe.org](http://www.smcoe.org)
NGSS Architecture

How to Read the NEXT GENERATION SCIENCE STANDARDS
SMCOE NGSS Events

NGSS Overview Workshops 4:00 pm – 6:30 pm:
- Oct 9
- Oct 12
- Nov 13

Getting Ready for the NGSS 9:00 am – 3:00 pm
- December 14
Web Resources

• K-12 Science Framework download for free
  http://www.nap.edu/catalog.php?record_id=13165
• National Standards  www.corestandards.org
• California Standards
  http://www.cde.ca.gov/be/st/cc/index.asp
• Curriculum Maps:
  http://commoncore.org/maps/index.php
• Crosswalks:
  http://www.ccsesa.org/resources/zz%20K-12%20ELA_Crosswalks%20080410.pdf
• Next Generation Science Standards
  http://www.nextgenscience.org/