Understanding NGSS- A Parent's Survival Guide

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"I miss the 3 R's."

What is NGSS?

- The Next Generation Science Standards (NGSS) are a 'new' set of K-12 science standards that identify scientific and engineering practices, crosscutting concepts, and core ideas in science that all K-12 students should master in order to prepare for success in college and 21st-century careers.
- Developed by National Research Council (NRC), the working arm of the National Academy of Sciences (NAS)
  - '**Standards**' provide clarity about what students should know and be able to do by the end of each grade level.
  - '**Curriculum**' refers to how students meet those expectations
  - NGSS are Standards, not Curriculum
  - http://blogs.edweek.org/edweek/curriculum/2017/04/helping_parents_understand_the_next_generation_science_standards.html

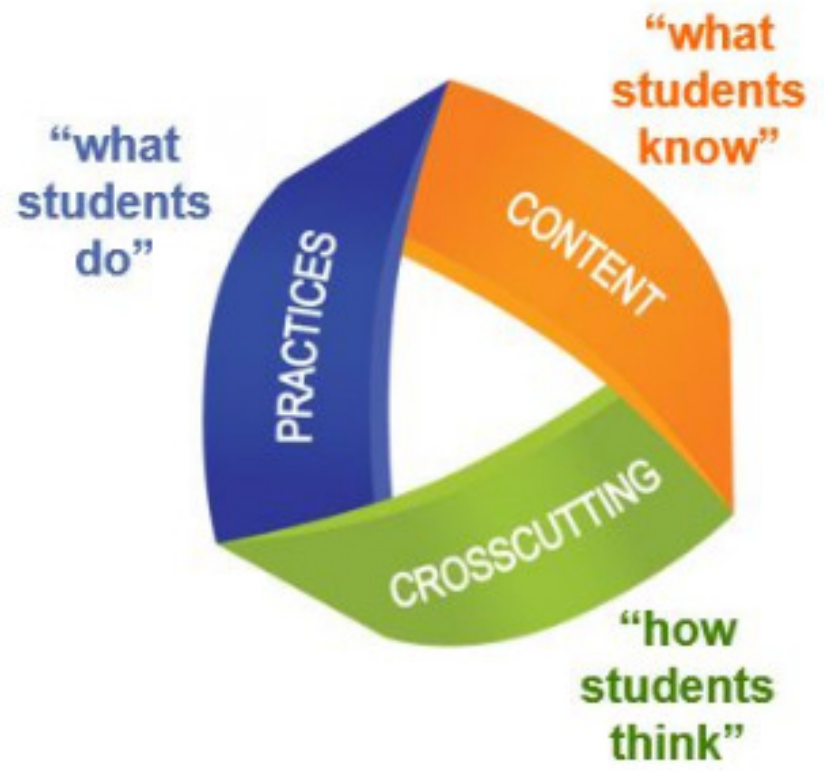
How do the NGSS Work for Students?

- The NGSS allow students to learn science by doing what scientists and engineers do. (Science & Engineering Practices)
- The NGSS allow students to think of science learning not as memorization of disconnected facts, but as a cohesive understanding of integrated and interrelated concepts. (Crosscutting Concepts)
- The NGSS allow students to develop their knowledge of science as they progress from grade to grade. (Disciplinary Core Ideas)
- **CONTENT AND PRACTICE SHOULD BE COMBINED AND ARE IN NGSS, AS THEY ARE IN SCIENCE AND ENGINEERING**
  - **PRACTICES ALONE ARE ACTIVITIES, CONTENT ALONE IS MEMORIZATION**

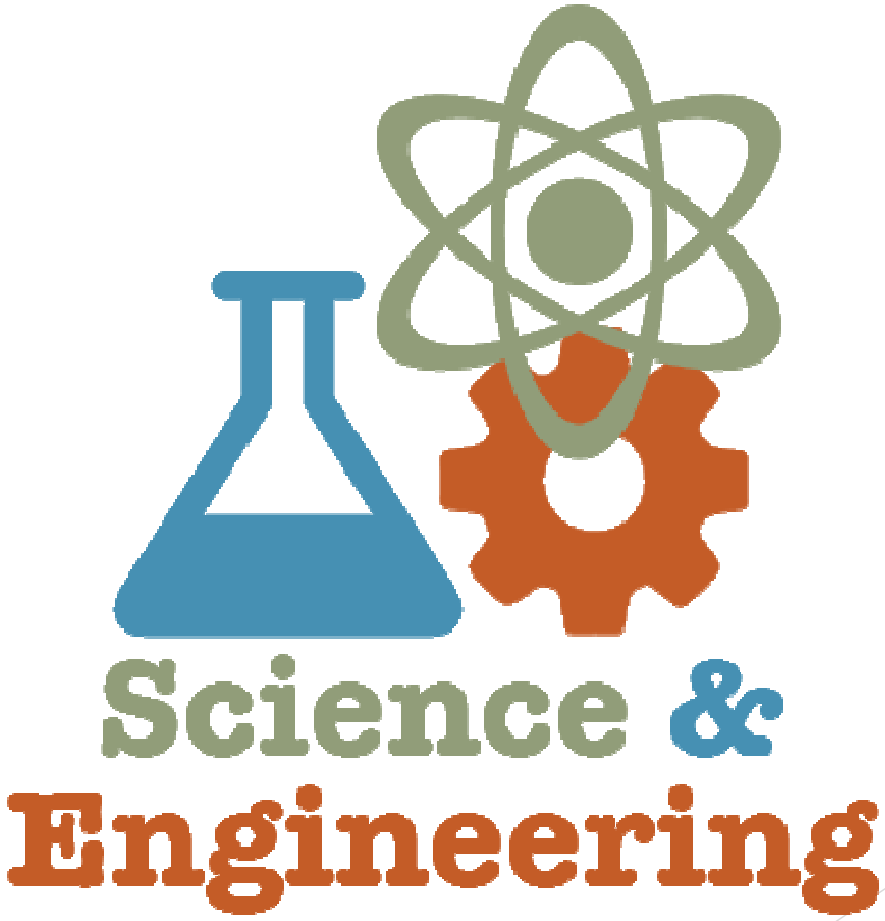
What Does NGSS Mean for Parents?

- The NGSS are designed to describe what all students should know and be able to do in science, regardless of their background
- The standards are intended to provide all students with an internationally benchmarked education in science
- The new standards emphasize hands-on learning and encourage students to ask questions.
- The new standards provide an engaging gateway for children to become engaged in learning at an early age, by harnessing and building on their innate curiosity.
- NASEM (National Academies of Science, Engineering and Medicine) recently published a report showing that one effective way to help students learn is to engage them in science investigation and engineering design by asking questions, collecting and analyzing data, and using this evidence to better understand the natural and built world.

NGSS is Referred to as Three-Dimensional Learning: Performance Expectations (PE): the Three Pillars of NGSS



Dimension #1: Science & Engineering Practices (SEP)



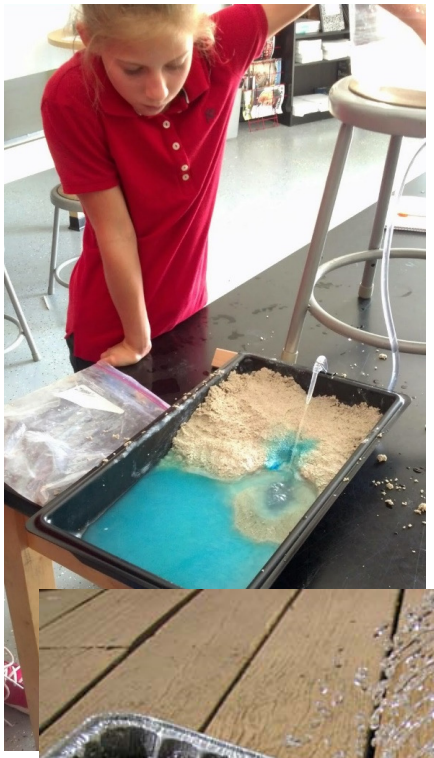
SEP: Science & Engineering Practices are the same behaviors that scientists use to answer questions and engineers use to solve problems in the real world.

- NGSS uses the eight science and engineering practices identified by the National Research Council:
  - Asking questions (for science) and defining problems (for engineering)
  - Developing and using models
  - Planning and carrying out investigations
  - Analyzing and interpreting data
  - Using mathematics and computational thinking
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Engaging in argument from evidence
  - Obtaining, evaluating, and communicating information

https://www.knowatom.com/blog/explore-the-3-dimensions-of-the-next-generation-science-standards

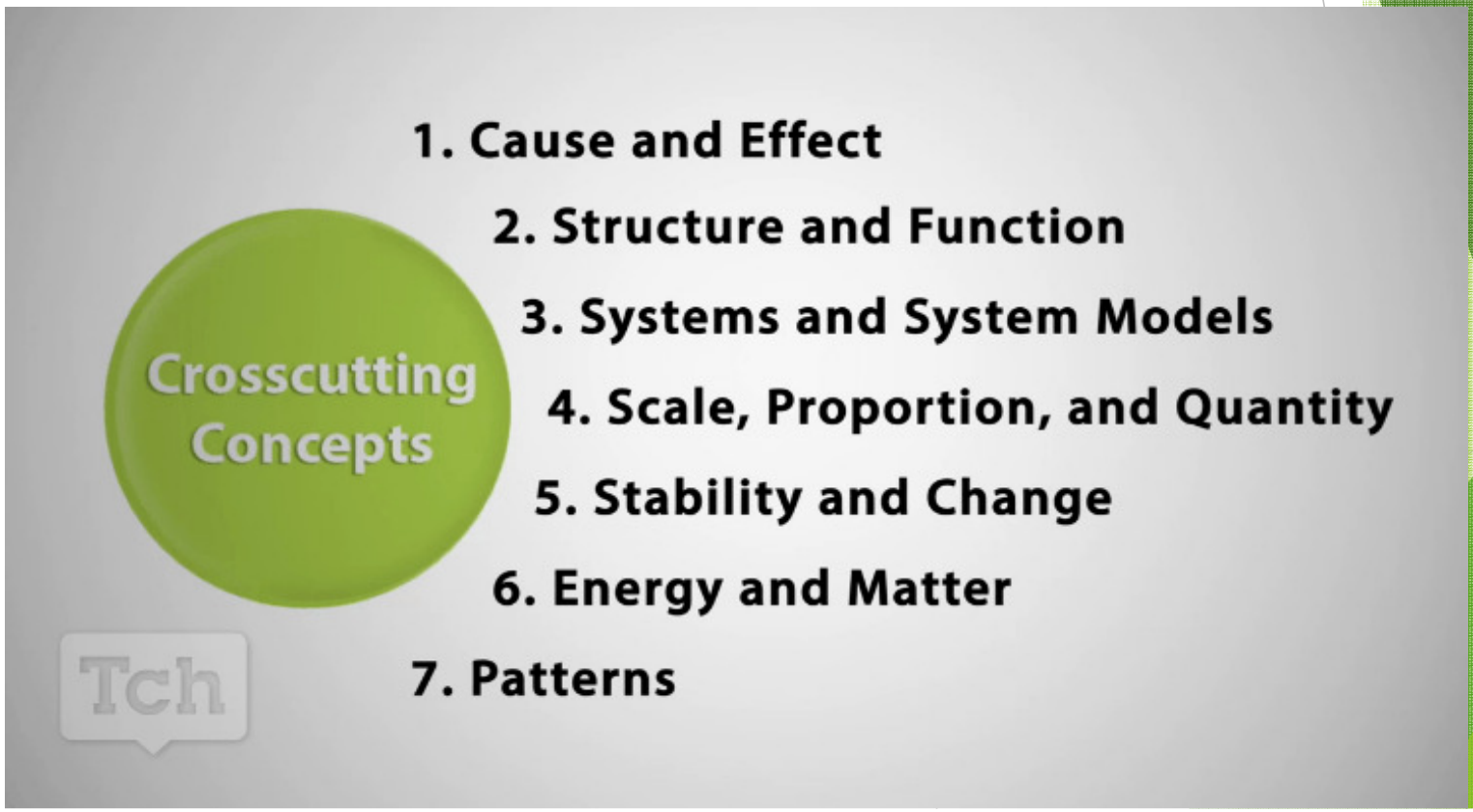
What Do the Science & Engineering Practices Look Like?

- To teach weathering and erosion, you would no longer just ask students to memorize definitions of the words, or follow the directions of an experiment to see wreathing & erosion in action.
- Students should be planning an investigation that they carry out themselves to gather evidence of the effects of weathering &/or the rates of erosion by water, ice, wind, etc.
- Not all students will be doing the same thing at the same time. Different groups will be testing different hypotheses and using different materials & procedures
- Students are thinking about the outcome they want to achieve, looking at available materials, and coming up with a process that will get them closer to the desired outcome.
- In Science, this means generating data to answer questions. In engineering, it's designing solutions that solve problems.



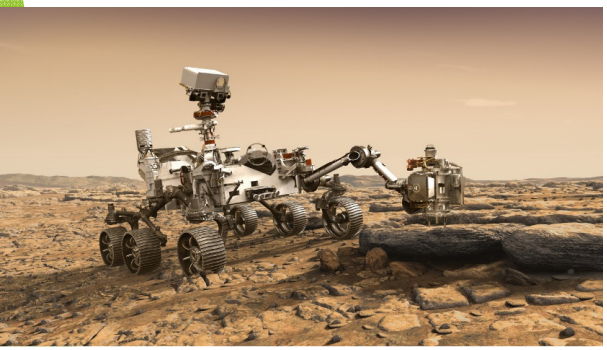
Dimension #2: Crosscutting Concepts (CC)

- CC: The seven Crosscutting Concepts are those fundamental concepts that apply across all scientific disciplines. They provide students with an organizational framework that connects ideas from different scientific disciplines.

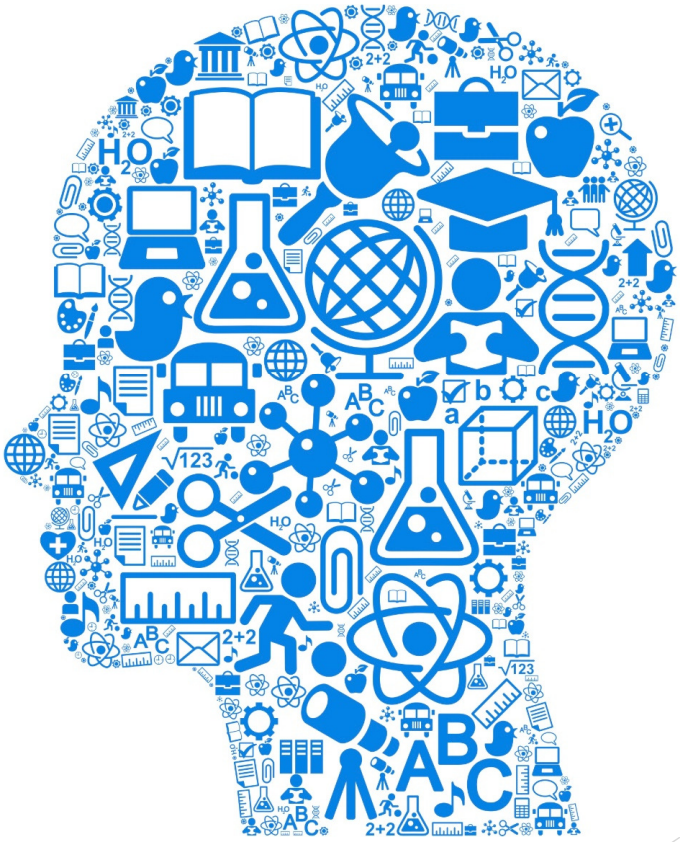


What do Crosscutting Concepts Look Like?

- To continue the weathering and erosion example, these concepts have implications for:
  - **Earth & Space Science**: think about how scientists look at surface erosion patterns on Mars to search for evidence of past liquid water flows, or studying the formation of the Grand Canyon on Earth
  - **Life Science**: Seeing how plant growth contributes to erosion (bio-erosion); erosion forms different types of topsoils in different areas, which affects plant growth and therefore animal populations.
  - **Physical Science**: Chemical and mechanical weathering
  - **Engineering, Technology, & Application of Science:** Designing solutions to reduce the impact of erosion



Dimension #3: Disciplinary Core Ideas (DCI)



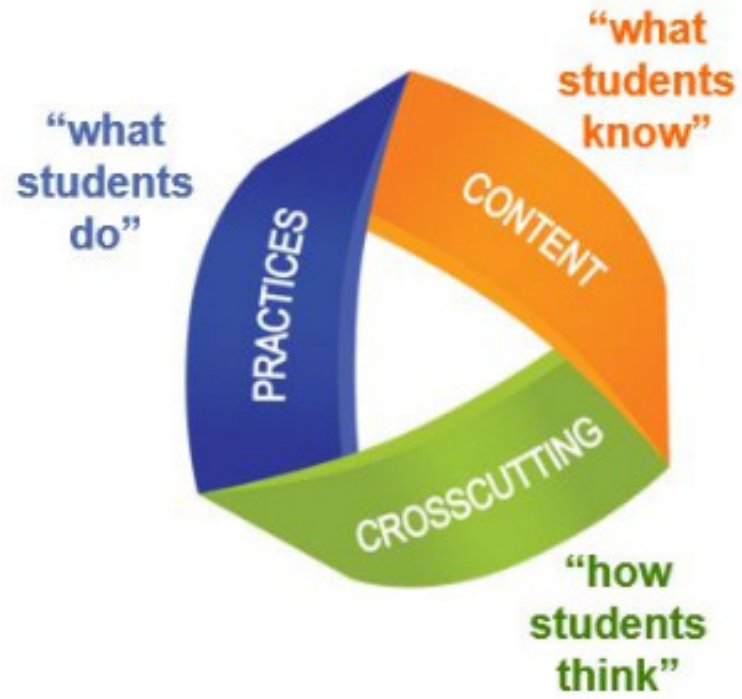
- DCI: Disciplinary Core Ideas form the basis of what most educators would consider STEM "content knowledge," also known as scientific facts, and are grouped into four content domains:
  - 1. Life Sciences
  - 2. Physical Sciences
  - 3. Earth Sciences
  - 4. Engineering, Technology and Application of Science

What do Disciplinary Core Ideas Look Like?

- Once more with the weathering and erosion example, an NGSS DCI like Earth Materials & Systems (ESS2.A) might include learning that:
  - Rainfall helps to shape the land and affects the types of living things found in a region
  - Water, ice, wind, living organisms and gravity break rocks, soils, and sediments into smaller particles and move them around

The Big Picture

- NGSS seeks to provide a strong science education that equips students with the ability to think critically, analyze information, and solve complex problems — the skills needed to pursue opportunities within and beyond STEM fields.



What Does NGSS Look Like in the Classroom? (K-5)

- Exemplary Lesson- Grade 1:
- In this unit, students start by exploring how many shapes can be seen in various locations around a darkened classroom on different pieces of paper.
- They can not see all the shapes in these conditions. This leads students to start noticing and wondering about other phenomena related to seeing in the dark, which in turn leads to new questions about ..
  - What could we see if we made our room completely dark?
  - How we can make our room as dark as possible?
  - How can we use light to communicate, throughout different places in the school, without making any noise?
- **What students figure out:** By the end of the unit, students develop powerful ideas about the interaction of different materials with light, and its effects on what we see.
- https://www.nextgenscience.org/resources/grade-1-how-does-light-help-me-see-things-and-communicate-others-v11

What Does NGSS Look Like in the Classroom? (K-5)

- Exemplary Lesson- Grade 5: “From Sun to Food”
  - In this unit, students consider the question: *We eat pizza made of many ingredients. How has this pizza been made?*
  - To try to explain this phenomenon, students will develop and refine a farm model throughout each lesson. They then focus on designing a farm that minimally harms the environment.
  - Students will see how matter is cycled through ecosystems and how energy flows from the sun to the consumers in a food chain.
  - As students engage in the activities in this unit, the Crosscutting Concepts of Energy and Matter and Systems and System Models are emphasized.

- https://tinyurl.com/mySciFromSuntoFood-V-2

What Does NGSS Look Like in the Classroom? (6-8)

- Exemplary Lesson- Grades 6-8: Disruptions in Ecosystems
  - This middle school unit was designed to support the middle school NGSS related to Ecosystems: Interactions, Energy, and Dynamics integrated with elements of related Earth science NGSS (Human Impact).
  - The unit includes five chapters, each focused on a specific phenomenon related to ecosystem disruption, including questions around the reintroduction of wolves into Yellowstone and the invasion of zebra mussels in the Great Lakes and the Hudson River
- https://www.nextgenscience.org/resources/middle-school-disruptions-ecosystems

What Does NGSS Look Like in the Classroom? (9-12)

- Exemplary Lesson- Grades 9-12: Why do some clothes stick together when they come out of the dryer?
  - This is the first of four units that focus on answering a driving question designed to engage students in the learning goal and help them relate and build connections among ideas developed throughout the unit.
  - Each unit is made up of a series of investigations, which consist of several activities.
  - In this unit, students develop a model of electric interactions to explain electrostatic phenomena. To develop and revise their models, students collect evidence related to how charged objects interact with other objects.
  - They develop a particulate model of materials and a model of atomic structure to start building an understanding of the mechanism of charging objects
  - https://www.nextgenscience.org/resources/high-school-interactions-unit-1-why-do-some-clothes-stick-together-when-they-come-out

What Can You Do at Home?

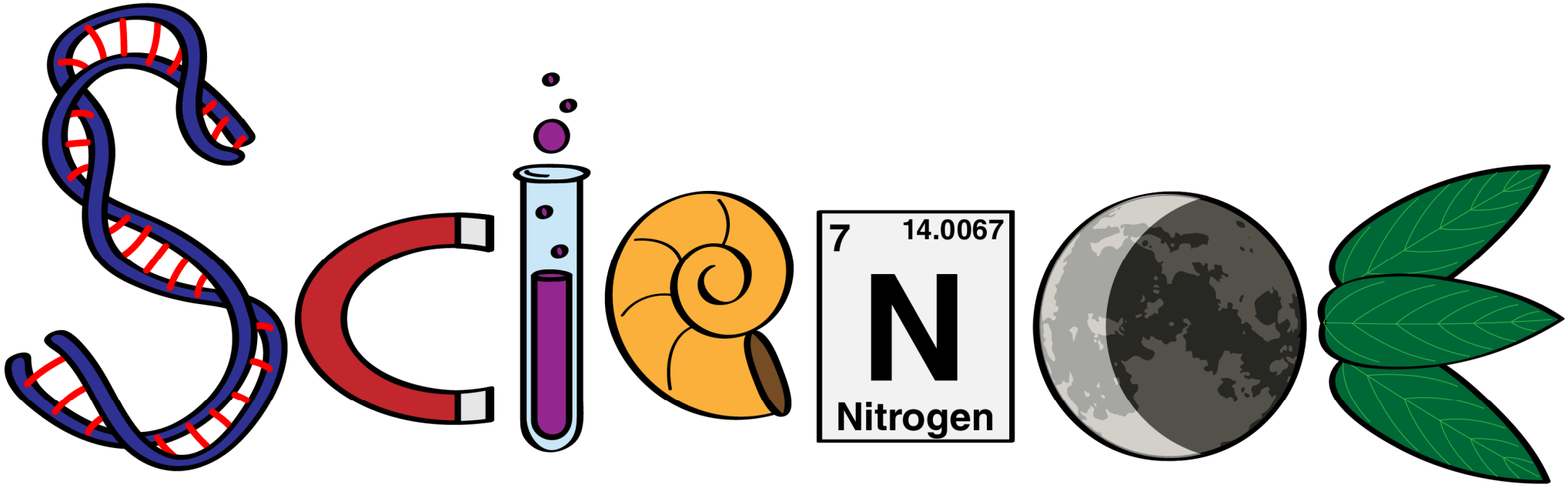
- DIY Field trips (related to current topic of study):
  - Aquariums, Zoos, Devil's Punchbowl (SA Fault), JPL, Griffith Observatory, Mt. Wilson Observatory, La Brea Tar pits, cave exploring, whale watching, local nature hikes, CA Academy of Sciences, Natural History Museum, CA Science Center, Piedras Blancas Elephant Seal Rookery, Tech Museum of Innovation, Exploratorium, Giant redwoods/sequoias, star-gazing at Anza-Borrego State Park, Lassen Volcanic National Park, Bristle Cone Pine Forest
- Go Collecting: Rocks, flowers, bugs, clouds, fossils, etc. etc.
- Photo safaris
  - Go on a topic-specific photo safari (also an alternative form of collecting)
- Volunteer: Junior Docent programs, beach cleanups, etc.
- Plant a Tree
- Enter Science Competitions
  - 3M/Discovery Young Scientists Challenge, Kavli Science Video Contest, DuPont Challenge, Jr. FIRST LEGO League, FIRST LEGO League, eCyberMission, Science Olympiad
- Photo Competitions
  - Imagemakers, Ranger Rick, Sony World Photography Awards, Young Travel Photographer of the Year

Helpful Links

- **You can find this PowerPoint on my website:** www.DoctorOschman.com
- Helpful article for parents about NGSS:
  - http://blogs.edweek.org/edweek/curriculum/2017/04/helping_parents_understand_the_next_generation_science_standards.html
- Bozeman Science video- Introduction to NGSS. He has a series of about 60 videos on NGSS:
  - https://www.youtube.com/watch?v=o9SrSBGDNfU
- Full listing of Bozeman Science NGSS videos can be found here:
  - http://www.bozemanscience.com/next-generation-science-standards
- NGSS Topics by Grade Level:
  - https://www.nextgenscience.org/overview-topics
- Lots of helpful information for parents looking to learn more about how NGSS, including an Introduction and Overview, Fact Sheet, Messaging Cards, and Parent Guides:
  - https://www.nextgenscience.org/parents
- Direct link to the Parent Guides for all grade levels:
  - https://www.nextgenscience.org/parentguides
- Examples of quality science units designed for NGSS at a variety of grade levels:
  - https://www.nextgenscience.org/resources/examples-quality-ngss-design
- NGSS Lesson Screener: provides criteria for a quick look at the degree to which lessons are designed for the NGSS:
  - https://www.nextgenscience.org/screener.


Additional
Materials

NGSS Topics By Grade Level



What Does NGSS Look Like in the Classroom? Topics for Grades K-5

KINDERGARTEN	FIRST GRADE	SECOND GRADE
K.Forces and Interactions: Pushes and Pulls	1.Waves: Light and Sound	2.Structure and Properties of Matter
K.Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment	1.Structure, Function, and Information Processing	2.Interdependent Relationships in Ecosystems
K.Weather and Climate	1.Space Systems: Patterns and Cycles	2.Earth's Systems: Processes that Shape the Earth
K-2.Engineering Design	K-2.Engineering Design	K-2.Engineering Design

THIRD GRADE	FOURTH GRADE	FIFTH GRADE
3.Forces and Interactions	4.Energy	5.Structure and Properties of Matter
3.Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms	4.Waves	5.Matter and Energy in Organisms and Ecosystems
3.Inheritance and Variation of Traits: Life Cycles and Traits	4.Structure, Function, and Information Processing	5.Earth's Systems
3.Weather and Climate	4.Earth's Systems: Processes that Shape the Earth	5.Space Systems: Stars and the Solar System
3-5.Engineering Design	3-5.Engineering Design	3-5.Engineering Design

What Does NGSS Look Like in the Classroom? Topics for Grades 6-8

PHYSICAL SCIENCE	LIFE SCIENCE	EARTH AND SPACE SCIENCES
MS.Structure and Properties of Matter	MS.Structure, Function, and Information Processing	MS.Space Systems
MS.Chemical Reactions	MS.Matter and Energy in Organisms and Ecosystems	MS.History of Earth
MS.Forces and Interactions	MS.Interdependent Relationships in Ecosystems	MS.Earth's Systems
MS.Energy	MS.Growth, Development, and Reproduction of Organisms	MS.Weather and Climate
MS.Waves and Electromagnetic Radiation	MS.Natural Selection and Adaptations	MS.Human Impacts

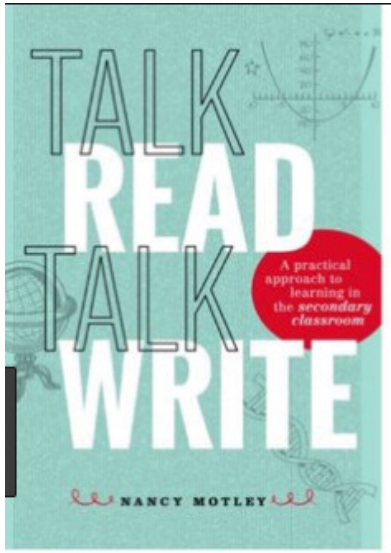
ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE
MS.Engineering Design

What Does NGSS Look Like in the Classroom? Topics for Grades 9-12

PHYSICAL SCIENCE	LIFE SCIENCE	EARTH AND SPACE SCIENCES
HS.Structure and Properties of Matter	HS.Structure and Function	HS.Space Systems
HS.Chemical Reactions	HS.Matter and Energy in Organisms and Ecosystems	HS.History of Earth
HS.Forces and Interactions	HS.Interdependent Relationships in Ecosystems	HS.Earth's Systems
HS.Energy	HS.Inheritance and Variation of Traits	HS.Weather and Climate
HS.Waves and Electromagnetic Radiation	HS.Natural Selection and Evolution	HS.Human Sustainability

ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE
HS.Engineering Design

Reading Like a Scientist/Reading with Purpose



The following table provides examples of discipline-specific purposes for reading.

Social Studies	Science	Mathematics	English Language Arts
analyze primary sources	evaluate information	ascertain how mathematic algorithms relate to procedure	analyze author's point of view
determine bias	interpret descriptions of data	identify extraneous information in word problems	evaluate literary quality
analyze the relevance of the source to a particular argument	critique/support hypotheses using data	identify the correct algorithm for each word problem	interpret printed works

Motley, N. (2016). *Talk read talk write: A practical routine for learning in all content areas (K-12)*. San Clemente, CA: Seidlitz Education.

What Does NGSS Look Like in the Classroom?

- The NGSS Lesson Screener is a tool used by educators to quickly review lessons
- The Lesson Screener allows educators to determine if the lesson is designed to engage all students in making sense of phenomena and/or designing solutions to problems through student performances that integrate the three dimensions of the NGSS.

- https://www.nextgenscience.org/sites/default/files/NGSSScreeningTool-2.pdf

NGSS Lesson Screener Criteria:

- Explaining Phenomena or Designing Solutions
  - The lesson should focus on having students make sense of a phenomenon or design solutions to a problem.
- Three Dimensions (SEPs, CCs, & DCIs)
  - The lesson helps students develop and use multiple elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs), which are selected to aid students in making sense of phenomena or designing of solutions.
- Integrating the Three Dimensions for Instruction and Assessment
  - The lesson requires student performances that integrate elements of the SEPs, CCCs, and DCIs to make sense of phenomena or design solutions to problems, and the lesson elicits student artifacts that show direct, observable evidence of three-dimensional learning.
- Relevance and Authenticity
  - The lesson motivates student sense-making or problem-solving by taking advantage of student questions and prior experiences
- Student Ideas
  - The lesson provides opportunities for students to make their thinking visible and to respond to peer and teacher feedback.
- Building on Students' Prior Knowledge
  - The lesson identifies and builds on students' prior learning in all three dimensions