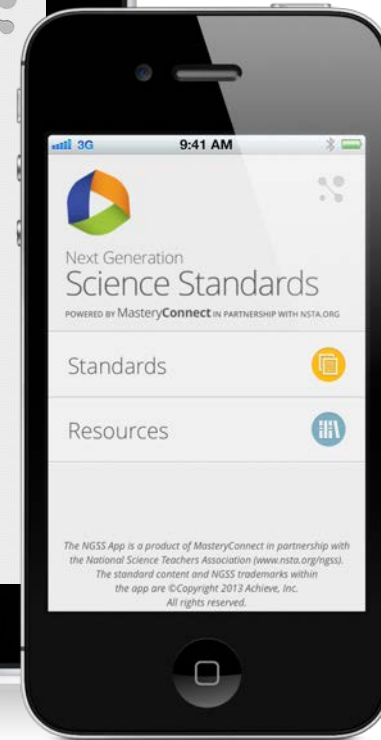
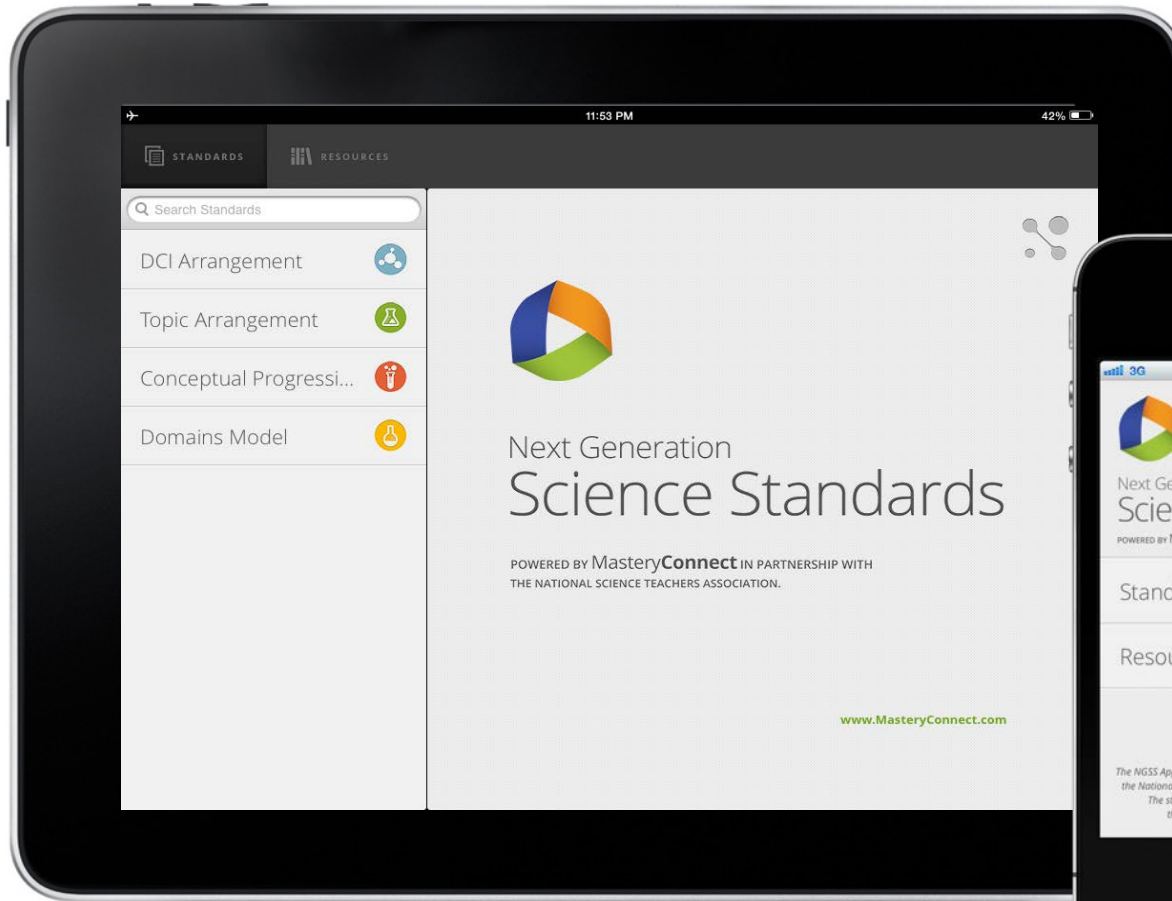




NEXT GENERATION SCIENCE





Or go to: <http://www.nextgenscience.org/>



Level of Familiarity with NGSS

- A. Today is my first exposure to it.
- B. I've heard about it, but don't know many details.
- C. I've seen examples of it, and I know a few details.
- D. I've attended one or more presentations about it and/or read about it in detail.
- E. I participated in a lead state review or critical stakeholder review of one of the earlier drafts.

Poll page:

<http://www.easypolls.net/poll.html?p=589a0524e4b0d85706c8dd08>



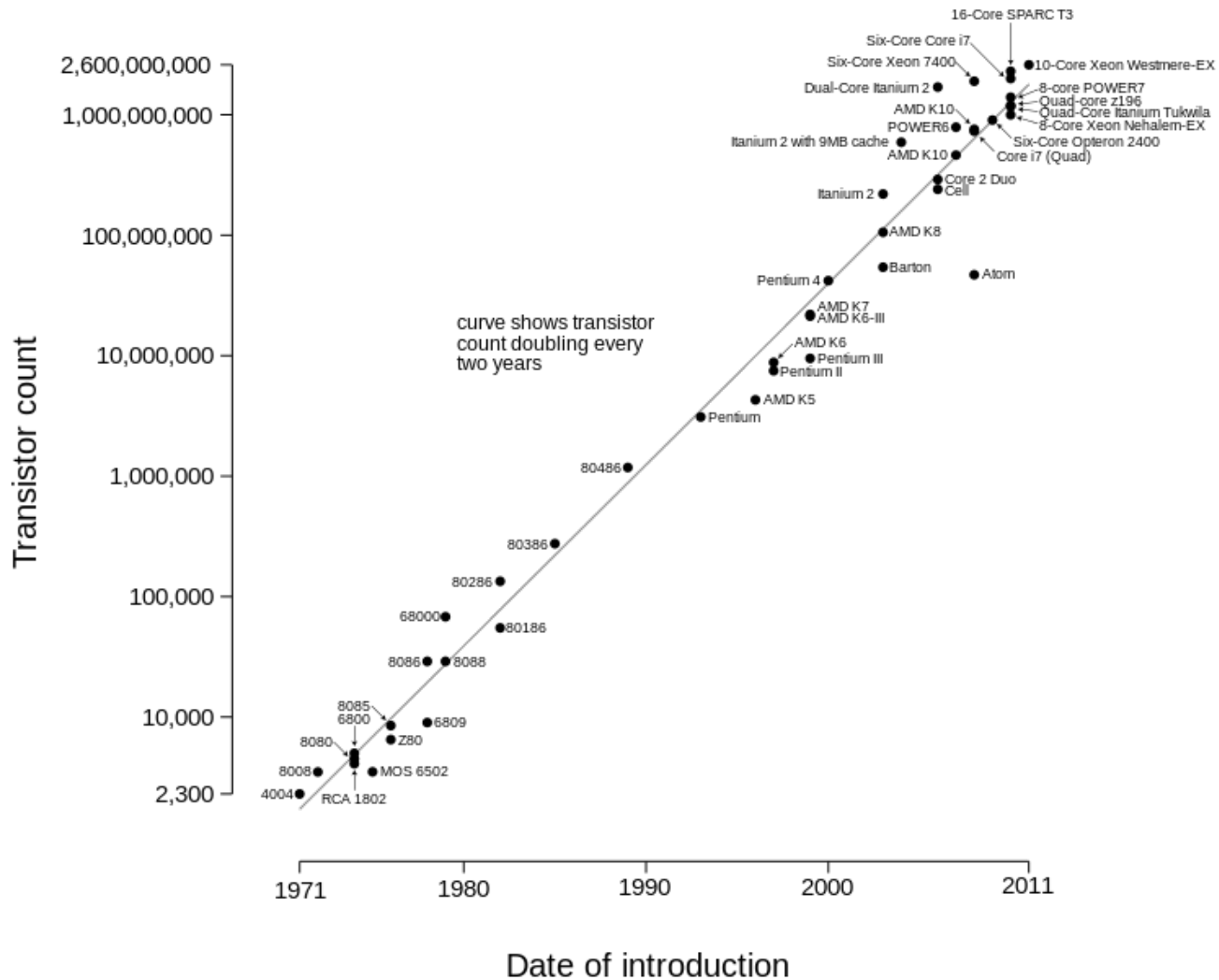
Brief History of NGSS

- Final standards released in April 2013.
- Based on the latest research in science teaching and learning.
- Integrates CCSS skills, College and Career Readiness Standards, and STEM.
- Many states and districts support the new standards and the methodology.
- Publishers identifying the best materials to support this instruction.
- <http://ngss.nsta.org/conducting-assessments.aspx>

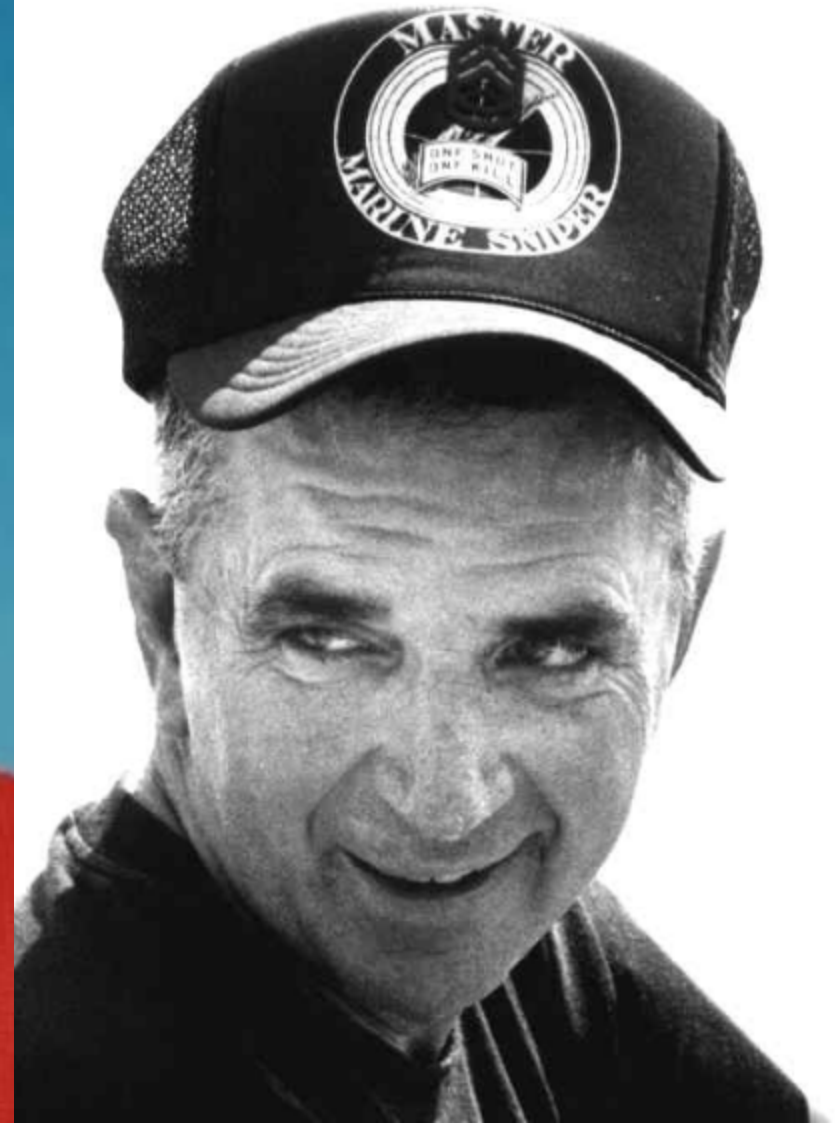


Moore's Law

Microprocessor Transistor Counts 1971-2011 & Moore's Law

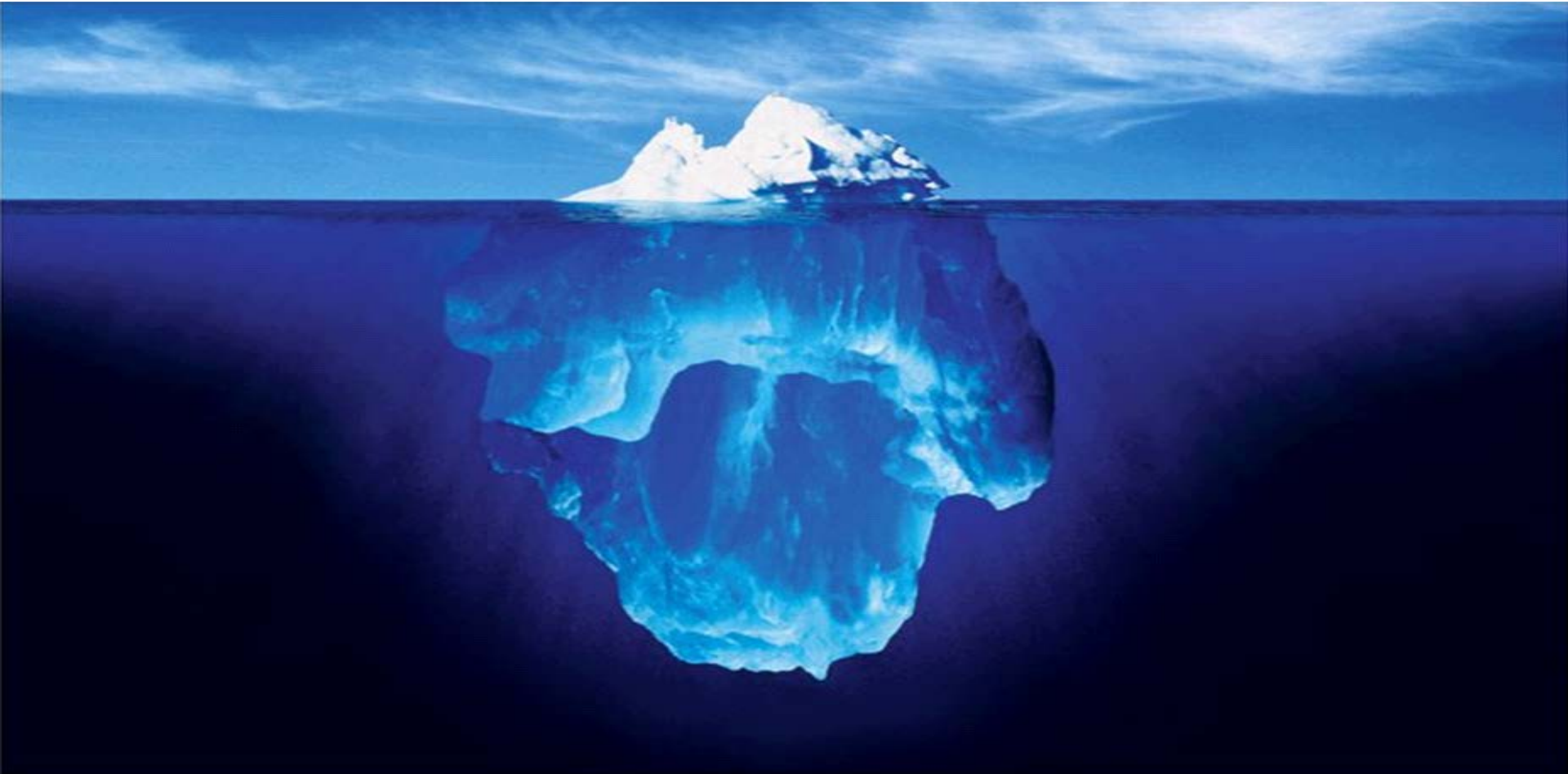


Credibility of sources



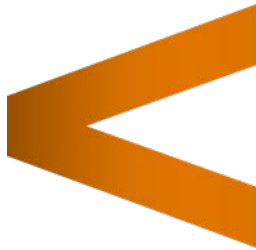
What's new in the NGSS "Framework"?

Content that is narrowed but deeper.



What's new in the NGSS "Framework"?

Fewer Factoids – More Process



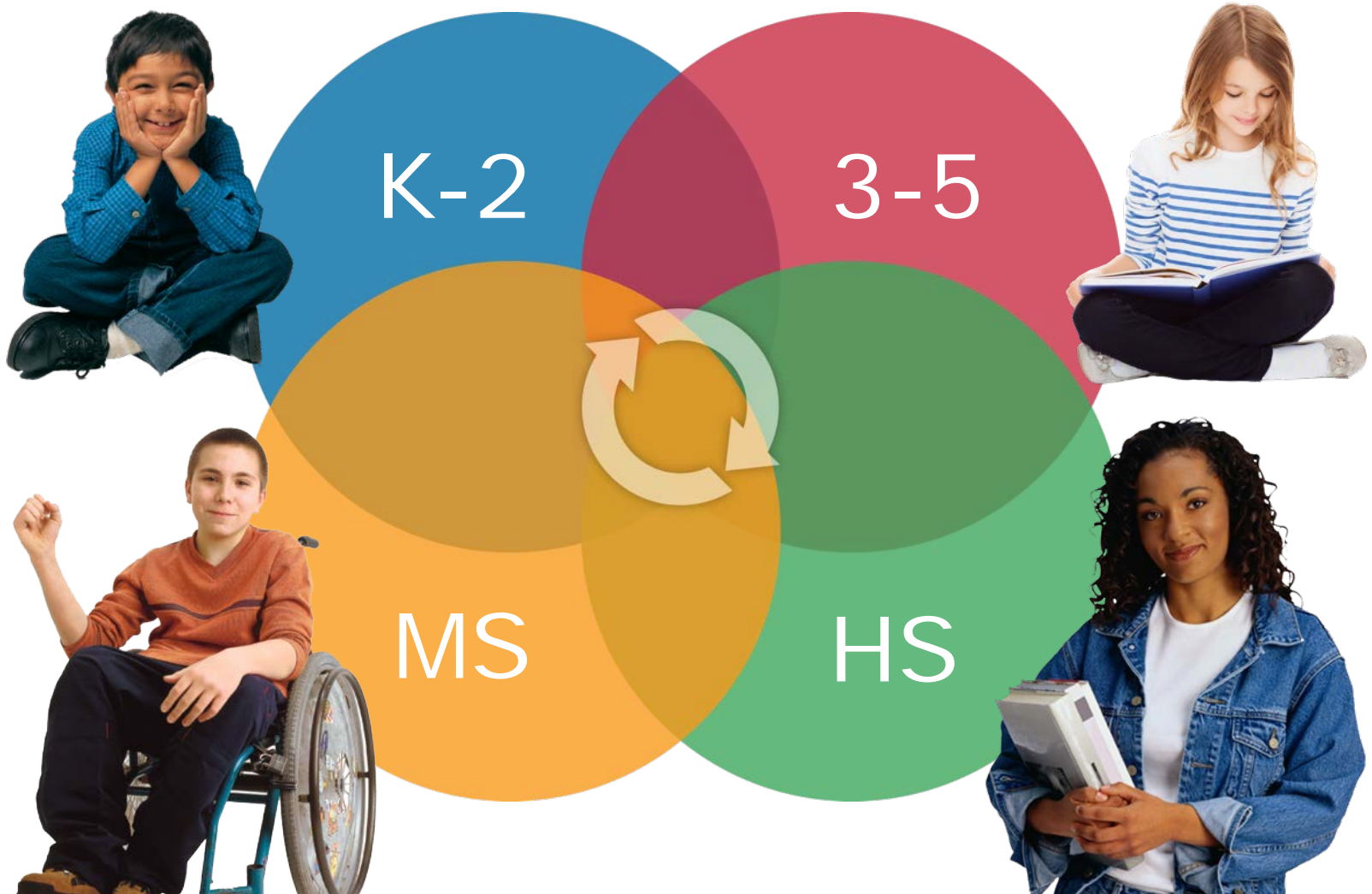
What's new in the NGSS "Framework"?

Greater Integration Among the Sciences



What's new in the NGSS "Framework"?

Greater Integration Across Grade Levels





Integration Across Grade Levels

	Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Life Science				
LS1: From Molecules to Organisms: Structures and Processes				
LS1.A: Structure and Function	<ul style="list-style-type: none">• All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)	<ul style="list-style-type: none">• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)	<ul style="list-style-type: none">• All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)• Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2)• Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)• In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)	<ul style="list-style-type: none">• Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)• All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (secondary to HS-LS3-1)• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)• Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

<http://ngss.nsta.org/AccessStandardsByDCI.aspx>



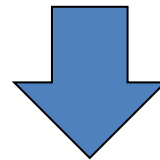
Development of NGSS

K-12 Science Framework (NRC)

DCI – Disciplinary Core Ideas – Content

SEP – Science and Engineering Practices – Inquiry and Design Skills

CCC – Crosscutting Concepts - Themes



Next Generations Science Standards =
Performance Expectations

 Performance Expectations Consist of...

Old Vs New

Old Typical State Standard: Explain the significance of the process of photosynthesis.

NGSS Standard (PE): Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms!



Performance Expectations Consist of...

Disciplinary Core Ideas

- Life Science
- Earth Science
- Physical Sciences
- Engineering

Science and Engineering Practices

- Ask Questions and Define Problems
- Develop and Use Models
- Plan and Carry out Investigations
- Analyze and Interpret Data
- Construct Explanations and Design Solutions
- Engage in Argument from Evidence
- Obtain, Evaluation, and Communicate Information
- Use Mathematics and Computational Thinking

Crosscutting Concepts

- Patterns
- Structure and function
- Cause and Effect
- Cycling of Energy and Matter
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter
- Stability and Change



Performance Expectations Consist of...

NGSS Standard (PE): Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms!

DCI – Disciplinary Core Ideas – Content –
role of photosynthesis in organisms

SEP – Science and Engineering Practices – Inquiry and Design Skills –
Construct a scientific explanation based on evidence for the role of
photosynthesis in organisms.

CCC – Crosscutting Concepts - Themes – Construct a scientific explanation
based on evidence for the role of photosynthesis in the cycling of matter and
flow of energy into and out of organisms.

Construct a scientific explanation based on evidence for the role of
photosynthesis in the cycling of matter and flow of energy into and out of
organisms.

Old Standards/Objectives vs NGSS PE

- PE is NOT just an activity to do.
- A single PE is taught through various activities, investigations, simulations, research and readings
- Will need to teach additional foundational content in order for students to accomplish a single PE
- Includes all 3 dimensions





Three Dimensions of NGSS

- Core Disciplinary Ideas
BRICKS

- Science and Engineering Practices
TOOLS

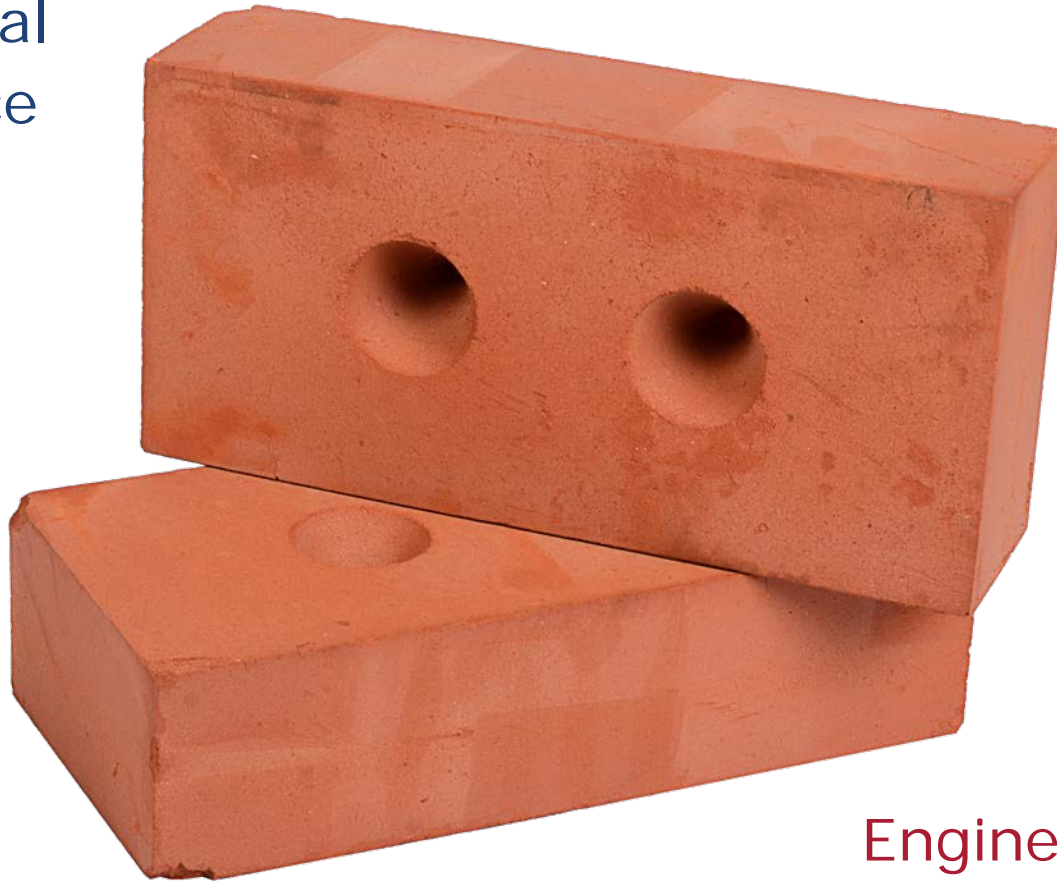
- Cross-cutting Concepts
MORTAR





Core Disciplinary Ideas

Physical
Science



Life
Science

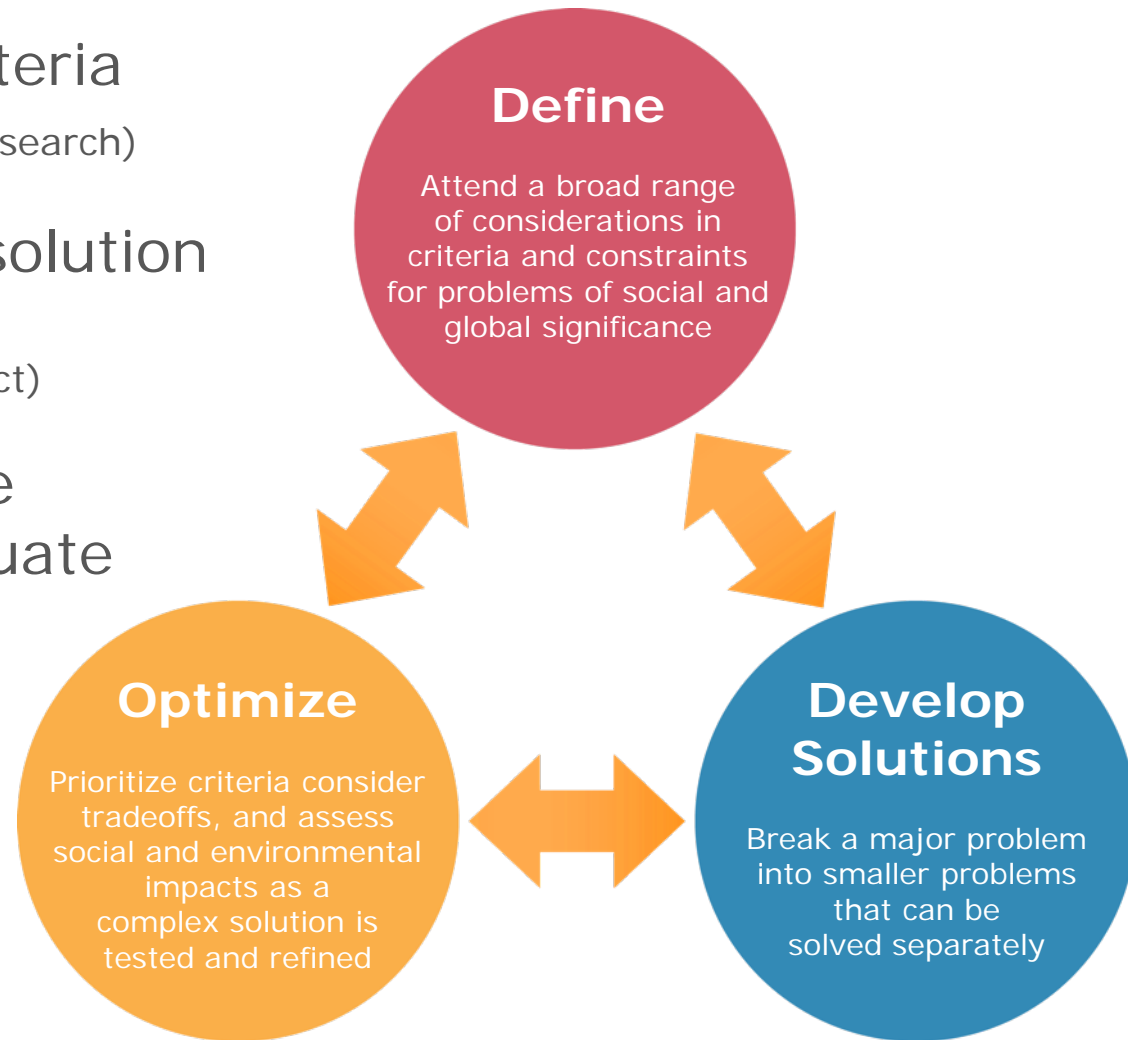
Earth &
Space
Science

Engineering &
Applied Science



Engineering – What Is It?

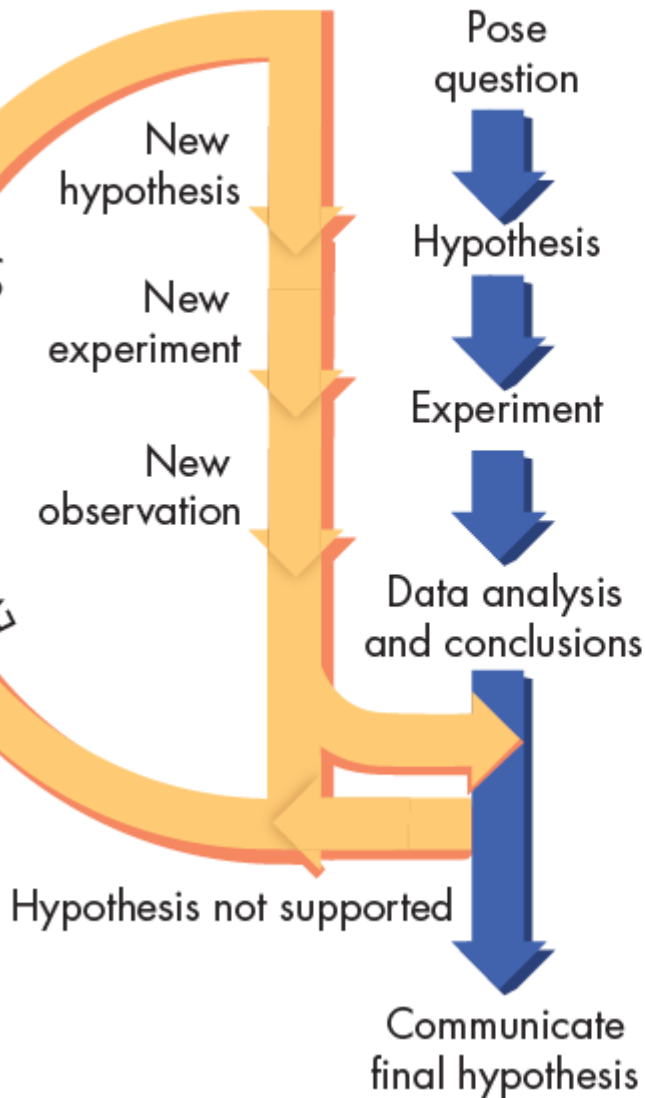
- **Define** – Identify criteria & constraints (Identify research)
- **Develop** – Possible solution via visual or physical (choose solution, design/construct)
- **Optimize** – Compare solutions, TEST, evaluate (test, communicate, evaluate, redesign)



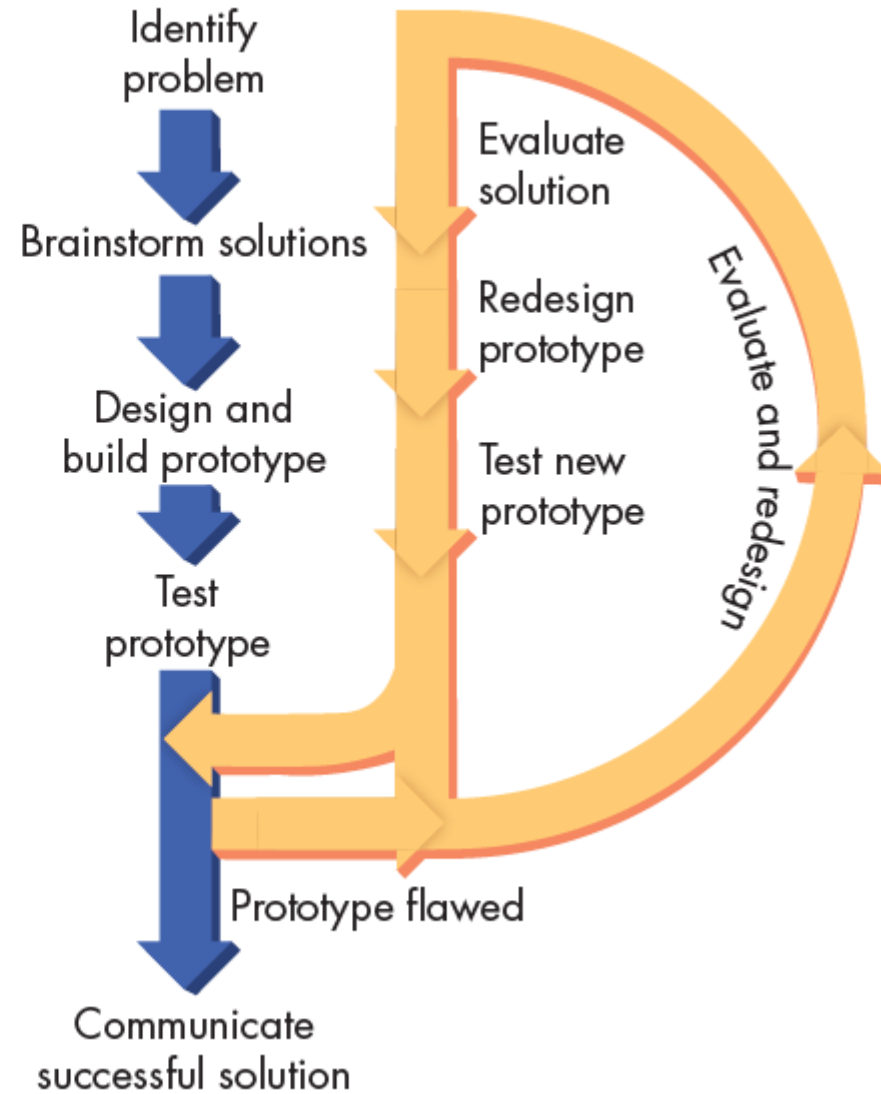


Engineering – What Is It?

Scientific Inquiry Process



Engineering Design Process





Science and Engineering Practices

**Asking Questions and
Defining Problems**

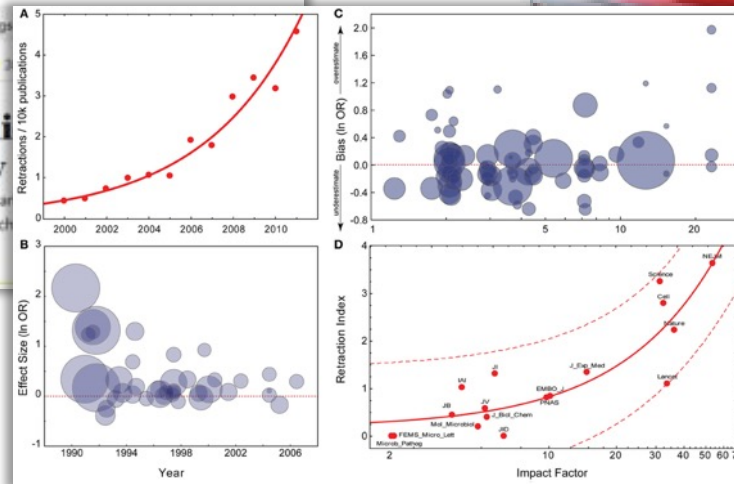
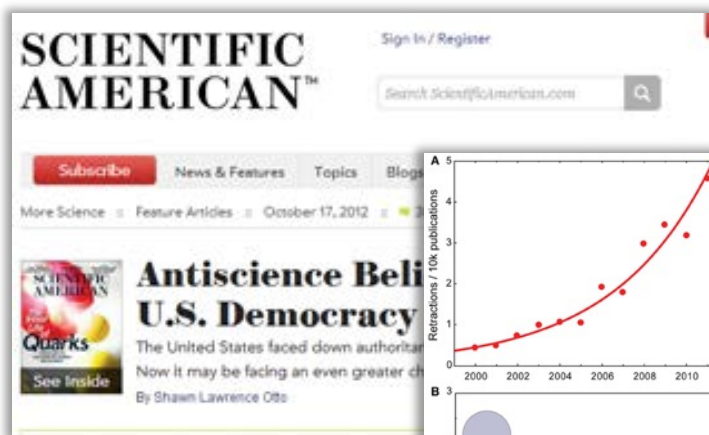
**Developing and
Using Models**

**Planning and Carrying
Out Investigations**

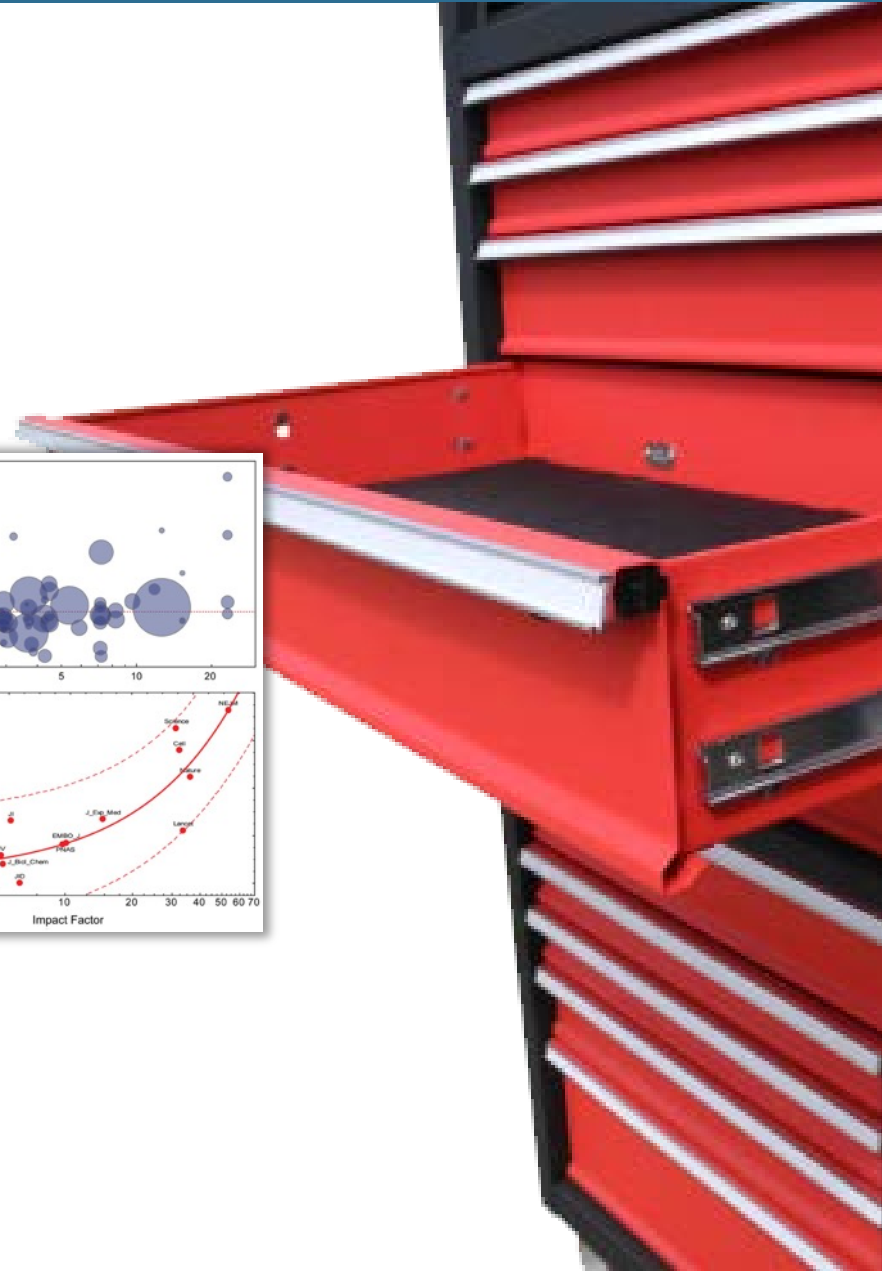




Engaging in Argument from Evidence



Analyzing and Interpreting Data





Science and Engineering Practices



**Using Mathematics and
Computational Thinking**

**Constructing Explanations
and Designing Solutions**



Science and Engineering Practices



**Obtaining, Evaluating,
and Communicating Information**



Cross Cutting Concepts

MORTAR

1. **Patterns**
2. **Cause and Effect: Mechanism and Prediction**
3. **Scale, Proportion, and Quantity**
4. **Systems and System Models**
5. **Energy and Matter: Flows, Cycles, and Conservation**
6. **Structure and Function**





Three Dimensions

- Science and Engineering Practices

TOOLS

- Cross-cutting Concepts

MORTAR

- Core Disciplinary

Ideas

BRICKS





Integrating the Three Dimensions

// Students actively engage in **Scientific and Engineering Practices** in order to deepen their understanding of **Cross-Cutting Concepts** and **Disciplinary Core Ideas** //

—A Framework for K-12 Science Education





And???

- Concerns for implementation of new standards?
- Any ideas for meeting the new standards in your classroom?



How to Read the NGSS

Performance Expectation represents the following: **HS-ESS3-4**

HIGH SCHOOL

**DOMAIN: EARTH/SPACE
SCIENCE**

TOPIC/DCI: ENERGY

STANDARD: 4

NOTE: Each grade level contains Performance Expectations from each Domain.





How to Read the NGSS

Assessable Component (Performance Expectation)

Foundation Boxes (Three Dimensions)

Connection Boxes (Common Core, Articulation)

DCI Code	MS.WER Waves and Electromagnetic Radiation
MS.WER	Waves and Electromagnetic Radiation
	Students who demonstrate understanding can:
MS-PS4-a.	Design an investigation to produce data that supports the simple model for waves, including how the energy in a wave depends on the amplitude. (Clarification Statement: The simple model for waves describes waves in terms of wavelength, frequency, and amplitude, and explains why waves do not travel through a vacuum, are reflected, absorbed, or transmitted through various materials. [Assessment Boundary: Electromagnetic waves are not included, only mechanical waves.]
MS-PS4-b.	Develop a model to represent phenomena that are modeled by waves. (Clarification Statement: Various materials can be used to model wave propagation. Qualitative application to light, sound and seismic waves is expected.)
MS-PS4-c.	Analyze and interpret data on the behavior of mechanical waves as they intersect.
MS-PS4-d.	Construct an explanation using a wave model of light for why materials may look different depending on the composition of the material and the wavelength and amplitude of the light that shines on them. (Assessment Boundary: Qualitative, not quantitative. Restricted to the following wave properties: frequency, wavelength, and amplitude.)
MS-PS4-e.	Use digital tools and mathematical concepts to compare two or more digital representations of information to determine which representation is more effective in conveying information. An asterisk indicates an engineering connection in a practice, core idea, or crosscutting concept.
	Science and Engineering Practices
	Crosscutting Concepts
	Disciplinary Core Ideas
	Connections to Nature of Science
	Scientific Knowledge is Based on Empirical Evidence
	Connections to other DCIs in this grade-level: MS-WC.b (MS-PS4-a)
	Articulation to DCIs across grade-levels: HS-MS-PS4-a (MS-PS4-d); MS-MS-PS4-b (MS-PS4-a); HS-MS-PS4-c (MS-PS4-b); HS-MS-PS4-d (MS-PS4-b); HS-MS-PS4-e (MS-PS4-a); HS-WER.f (MS-PS4-d); HS-WER.g (MS-PS4-d); HS-WER.h (MS-PS4-a); HS-WER.i (MS-PS4-a). Elementary connections will be added in future draft releases.
	Common Core State Standards: Connections
	ELA / Literacy
	RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-d)
	RI.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, performing technical tasks. (MS-PS4-a)
	WHI.6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (MS-PS4-c) (MS-PS4-d)
	WHI.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-d)
	SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building others' ideas and expressing their own clearly. (MS-PS4-d)
	SL.8.4 Present claims and findings, emphasizing salient points, in a focused, coherent manner with relevant evidence, sound reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-PS4-c) (MS-PS4-d)
	Mathematics
	MP.4 Model with mathematics. (MS-PS4-a)
	6.EE Represent and analyze quantitative relationships between dependent and independent variables. (MS-PS4-d)

Example of an Earth-Space Science Performance Expectation

and its linking

Science and Engineering Practice

to

Connecting Concepts

and

Clarification and Assessment

DCI Code

MS.WER Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

MS-PS4-a. Design an investigation to produce data that supports the simple model for waves, including how the energy in a wave depends on the amplitude. (Clarification Statement: The simple model for waves describes waves in terms of wavelength, frequency, and amplitude, and explains what happens when waves are reflected, absorbed, or transmitted through various materials. [Assessment Boundary: Electromagnetic waves are not included, only mechanical waves.]

MS-PS4-b. Develop a model to represent the relationship between the physical and mathematical aspects of a wave phenomenon. Apply qualitative relationships to predict wave behavior. (Clarification Statement: Various materials can affect the behavior of waves. Qualitative application to light, sound and seismic waves is included. [Assessment Boundary: Mechanical waves on Earth. Lack of a material, a vacuum (bell jar), is also included.]

MS-PS4-c. Analyze and interpret data to describe the behavior of mechanical waves as they intersect and pass through openings. (Clarification Statement: Qualitative, not quantitative. Restricted to the following wave properties: frequency, wavelength, and amplitude.)

MS-PS4-d. Construct an explanation using a wave model of light for why materials may look different depending on the composition of the material and the wavelength and amplitude of the light that shines on them. (Assessment Boundary: Qualitative, not quantitative. Restricted to the following wave properties: frequency, wavelength, and amplitude.)

MS-PS4-e. Use digital tools and mathematical concepts to compare two or more digital representations of information to determine which representation is better suited to the task. (Clarification Statement: An asterisk indicates an engineering connection in a practice, core idea, or crosscutting concept. [Assessment Boundary: The performance expectation is not assessed.])

Names designate which of the performance expectations use this practice

Names designate which of the performance expectations incorporate this crosscutting concept

Names designate which of the performance expectations incorporate this crosscutting concept

Names designate which of the performance expectations incorporate this disciplinary core idea

Names designate which of the performance expectations incorporate this crosscutting concept

Italics indicate a potential connection, rather than required prerequisite knowledge

Connections to the Nature of Science concepts can be highlighted in either the practices or crosscutting concept foundation box

Assessable Component

Foundation Boxes

Connection Boxes

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

Connections to Nature of Science

Connections to other DCIs in this grade-level: MS-WC.b (MS-PS4-a); HS-MS-PS4-a (MS-PS4-a); HS-MS-PS4-b (MS-PS4-a); HS-MS-PS4-c (MS-PS4-b); HS-MS-PS4-d (MS-PS4-b); HS-MS-PS4-e (MS-PS4-a); HS.WER.f (MS-PS4-a); HS.WER.g (MS-PS4-d); HS.WER.h (MS-PS4-a). Elementary connections will be added in future draft releases.

Common Core State Standards: Connections

ELA/Literacy-

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-d)

RST.6-8.3 Follow a multistep procedure when carrying out experiments, taking measurements, performing technical tasks. (MS-PS4-a)

WH.15-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (MS-PS4-c) (MS-PS4-d)

WH.15-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-d)

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building others' ideas and expressing their own clearly. (MS-PS4-d)

SL.8.4 Present claims and findings, emphasizing relevant data and key ideas that support the claims, conclusions, and solutions. (MS-PS4-d)

SL.8.6 Present information, media, and real-world issues in a focused, coherent manner with relevant evidence, sound reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-PS4-d)

Mathematics-

MP.4 Model with mathematics. (MS-PS4-a)

6.EE Represent and analyze quantitative relationships between dependent and independent variables. (MS-PS4-d)

PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-a)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-b)
- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (MS-PS4-b)
- From the 2-5 grade band endpoints, Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sources can pass a location in different directions without getting mixed up.) (MS-PS4-c)

PS4.B: Electromagnetic Radiation

- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-b); (MS-PS4-d)
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. Lenses and mirrors are examples of transparent materials. (MS-PS4-b)
- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-e)

PS4.C: Information and Communications Technology

- Information and communication technologies use electromagnetic waves to detect and interpret many types of signals that cannot be sensed directly. Designers of such systems must account for both the signal and its interactions with matter. (MS-PS4-e)
- Many modern communication devices use electromagnetic waves (sent as wave pulses) as a more reliable way to encode and transmit information. (MS-PS4-e)

ETS1.C: Optimizing the Design Solution

- Once a suitable solution is determined, it is important to describe that solution, explain how it was developed, and describe the features that make it successful. (MS-PS4-e)

Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on their structure and relationship.
- Structures of particular functional components are often shaped and sized to perform a specific function.

Connections to Nature of Science

- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-e)

MS.ESS-EIP Earth's Interior Processes

Students who demonstrate understanding can:

- a) Use models to explain how the flow of energy drives a cycling of matter between the Earth's surface and deep interior.

[Assessment Boundary: The thermodynamic processes that drive convection are not required, only a description of those motions. Explanations should include mid-ocean ridges.]

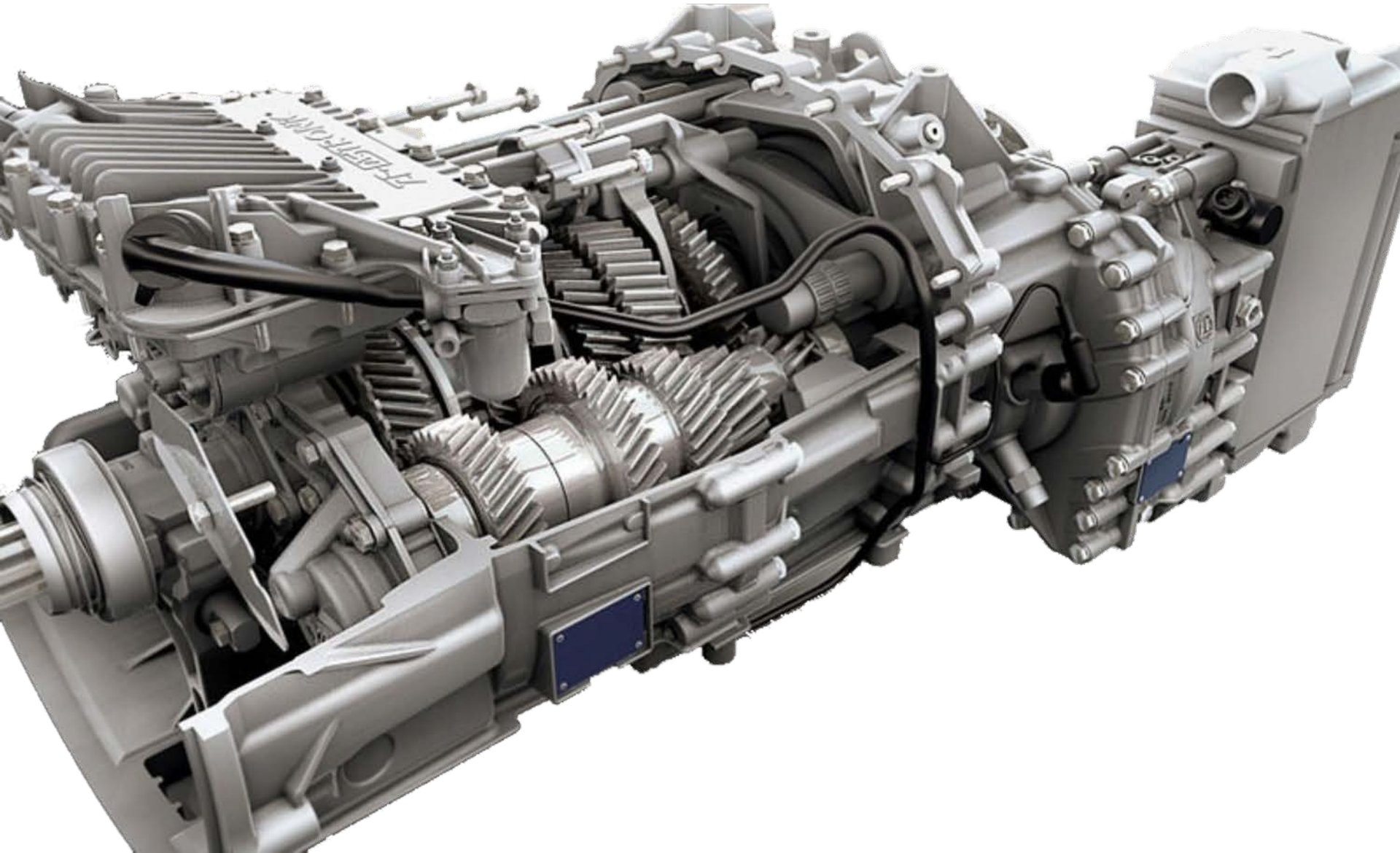
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Develop Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world.	Systems <ul style="list-style-type: none">▪ Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of	matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place. between objects and/or

Assessment Boundaries and Clarifying Statements

- Connections to other DCIs
- Articulation to DCIs Across Grade Levels
- Common Core and State Standards Connections



Let's Put Theory into Practice!





STEM ACTIVITY

Earth and Human Activity

Science and Engineering Practices

Designing Solutions

Design to Reduce Waste

As the world's human population soars, so does the problem of solid waste management. By 2025, some warn that people will be producing more than 6 billion kilograms of solid waste every day as compared to the more than 3.5 billion kilograms they produced each day in 2010. Managing all this waste costs hundreds of billions of dollars a year. However, without effective management, solid waste will pollute the environment, sicken people, and contribute greenhouse gases to the atmosphere.

Developed countries, especially the United States, contribute the major share of the daily solid waste produced globally. According to the Environmental Protection Agency (EPA), Americans generated about 707 million kilograms of solid waste every day in 2013. You might be surprised to learn that containers and packaging made up almost 30%, or about 211 million kilograms of that solid waste every day in 2013.

To reduce the amount of packaging heading to landfills, companies must find new ways to package their products. By redesigning their packaging, businesses can reduce the amount of solid waste entering landfills. However, different products need different types of packaging. Therefore, many new packaging options need to be developed.

Which Science & Engineering Practices did you engage in this activity?

How do I encourage students to:

NGSS Science & Engineering Practices	
1. Ask questions and define problems	<input type="checkbox"/>
2. Develop and use models	<input type="checkbox"/>
3. Plan and conduct investigations	<input type="checkbox"/>
4. Analyze and interpret data	<input type="checkbox"/>
5. Use mathematical and computational thinking	<input type="checkbox"/>
6. Construct explanations and design solutions	<input type="checkbox"/>
7. Engage in scientific argument from evidence	<input type="checkbox"/>
8. Obtain, evaluate, and communicate information	<input type="checkbox"/>



What Cross-Cutting Concepts were in this activity?

NGSS - Cross-Cutting Concepts

- | | |
|---|--------------------------|
| 1. Patterns | <input type="checkbox"/> |
| 2. Cause and Effect: Mechanisms and explanations | <input type="checkbox"/> |
| 3. Scale, Proportion, and Quantity | <input type="checkbox"/> |
| 4. Systems and System Models | <input type="checkbox"/> |
| 5. Energy and Matter: Flows, cycles, and conservation | <input type="checkbox"/> |
| 6. Structure and Function | <input type="checkbox"/> |
| 7. Stability and Change | <input type="checkbox"/> |



What to Look for in a Program

- Problem based learning
- No longer have Chapter 1 as Nature of Science (should be integrated)
- Integrated Engineering/STEM
- Doing science isn't enough – must be thinking critically, researching and reading.
- Student engagement (both mental engagement and physical engagement).
- Students should be: making claims – using evidence – supported by reasoning



An NGSS Program Should Include:

