Professional Resources in Science & Mathematics

PRISM

MONTCLAIR STATE UNIVERSITY

NGSS Fundamentals for Administrators

NEXT GENERATION SCIENCE STANDARDS

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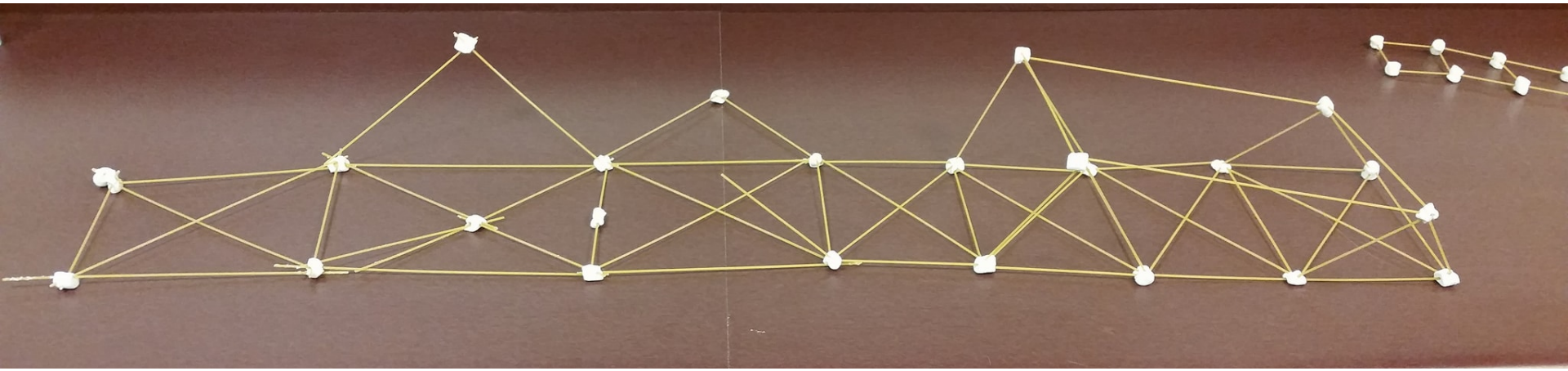
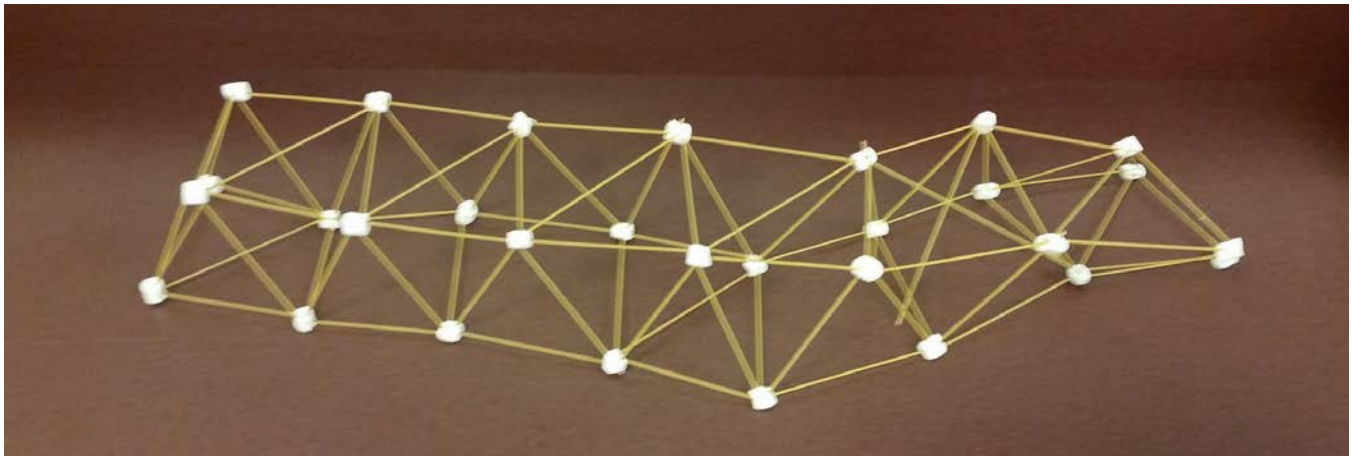
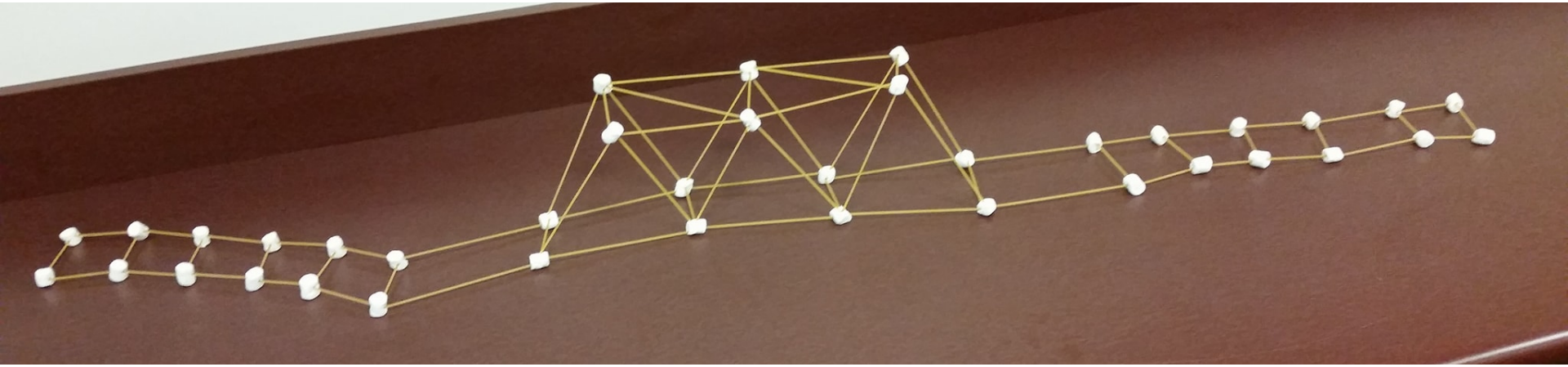
Bristol-Myers Squibb

Center for Science Teaching and Learning



BRIDGES





Science and Engineering Practices

1. Asking questions (science) and defining problems (engineering)

2. Developing and using models

3. Planning and carrying out investigations

4. Analyzing and interpreting data

5. Using mathematics and computational thinking

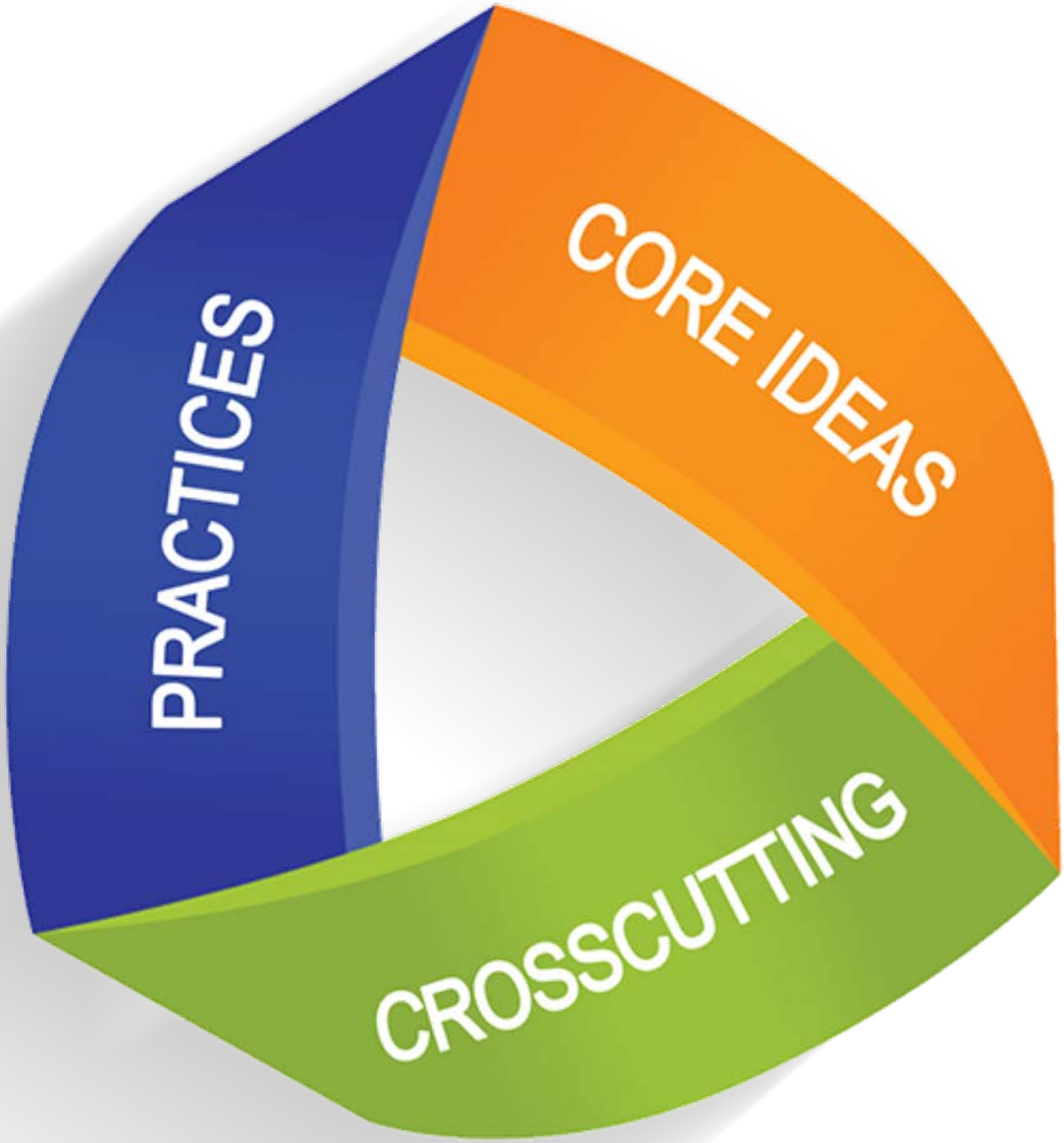
6. Constructing explanations (science) Designing solutions (engineering)

7. Engaging in argument from evidence

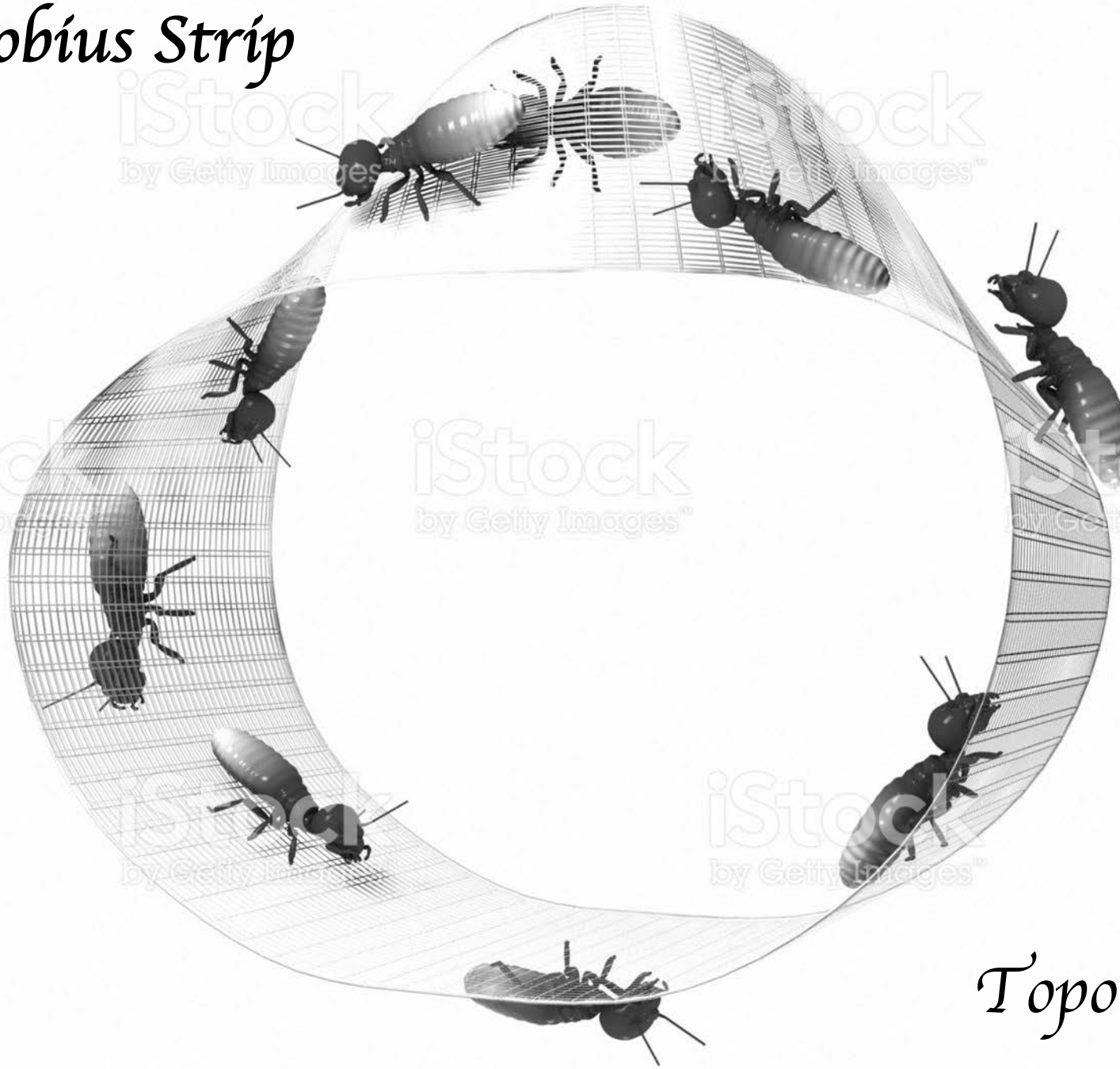
8. Obtaining, evaluating, and communicating information.

Cross Cutting Concepts

1. Patterns
2. Cause and effect
3. Scale, proportion, quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change


PRACTICES
CORE IDEAS
CROSSCUTTING

Mobius Strip



Topology

Conceptual Shifts Necessary for NGSS

1- Education must reflect real-world connections in science.

2- The Standards are student outcomes, NOT curriculum.

3- Concepts should build and spiral across K-12.

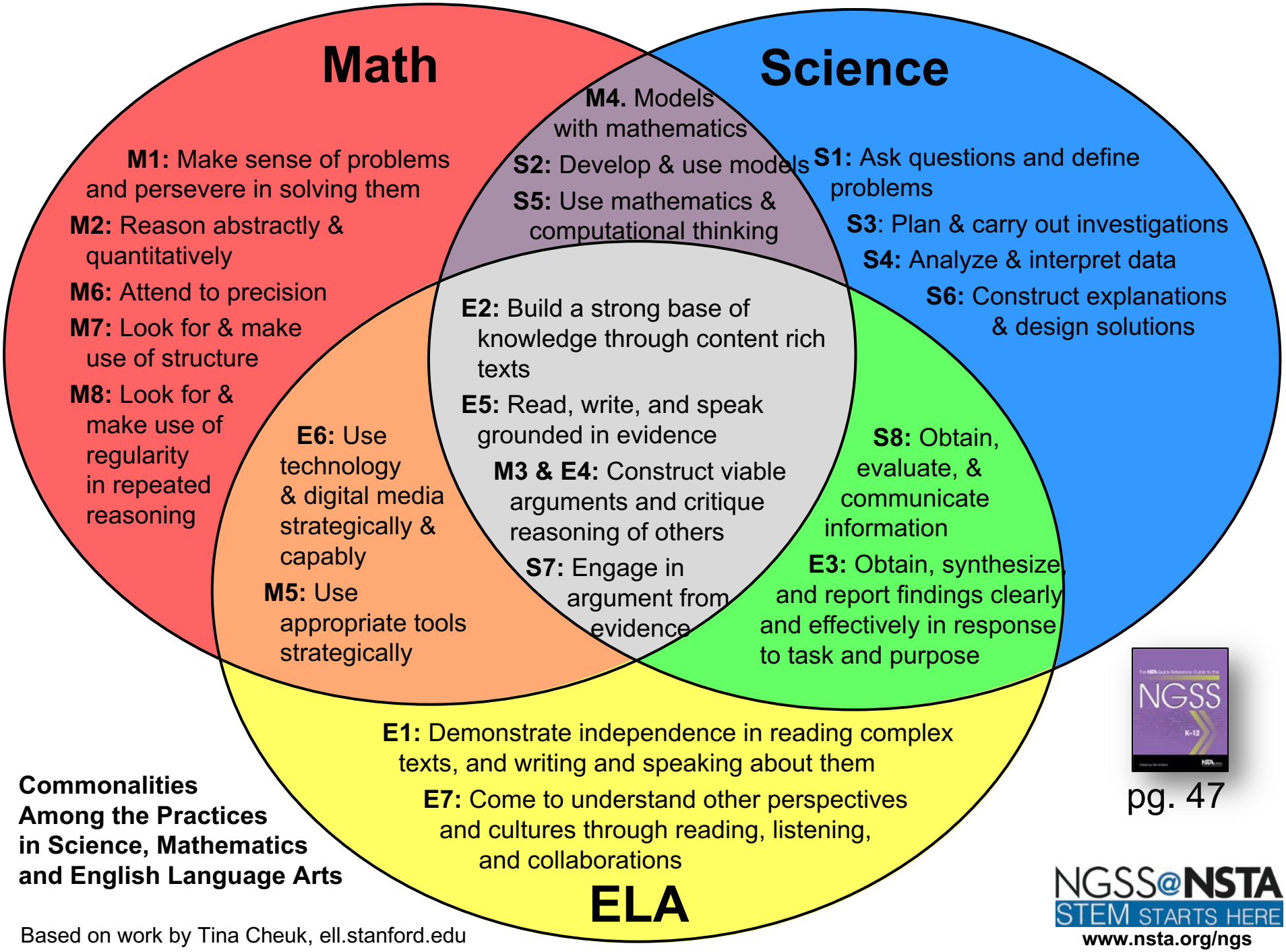
4- A focus on deeper understandings and applications.

5- Science and Engineering will be integrated K-12.

6- Prepare students for college, careers, and citizenship.

7- ELA /Math Common Core is coordinated with the NGSS.

Appendix Page 28: Common Core Integration Venn Diagram.



Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Cheuk, ell.stanford.edu

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NGSS@NSTA
STEM STARTS HERE
www.nsta.org/ngs

ELA Common Core State Standards in Science Literacy

Reading Tips for Science Texts

1. Reflection on prior knowledge
2. Locate new material
3. Use the graphics
4. Learn the jargon
5. Summarize the main idea
6. Teach what you learned to someone else

Disciplinary Core Ideas

Life Science	Physical Science
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	PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves and Their Applications in Technologies for Information Transfer
Earth & Space Science	**Engineering & Technology**
ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity	ETS1: Engineering Design ETS2: Links Among Engineering, Technology, Science, and Society

NGSS Matrix Organized by Disciplinary Core Ideas

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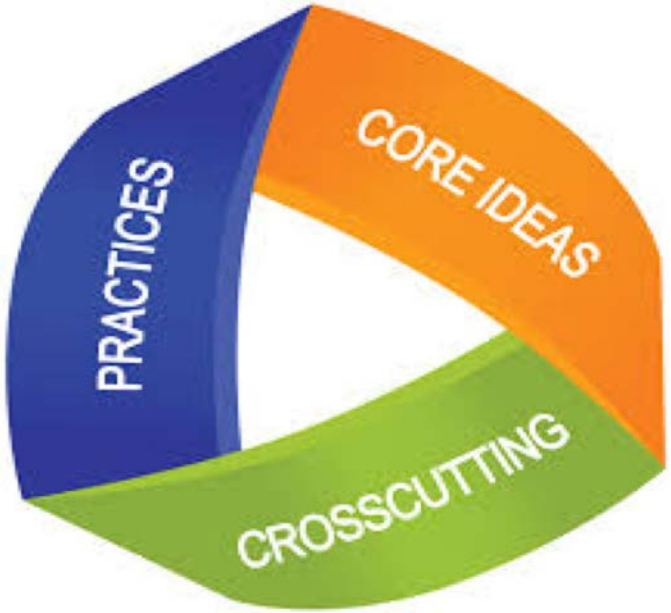
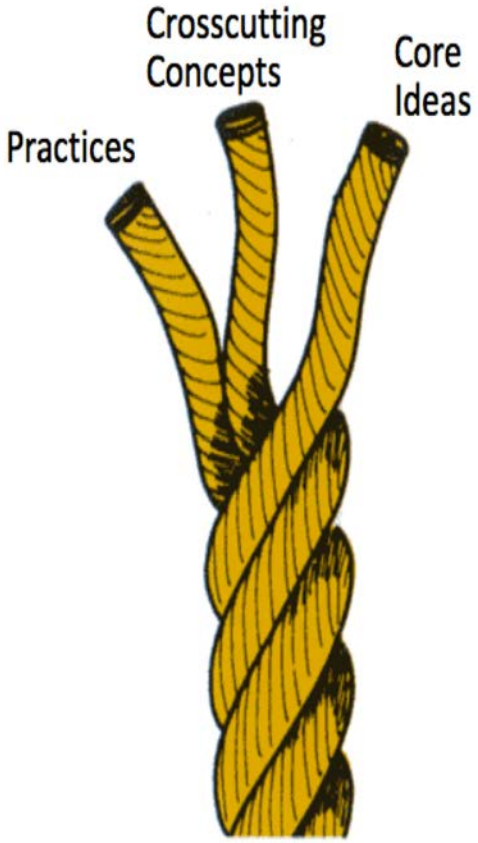
		Life Science	Earth & Space Science	Physical Science	Engineering
Elementary School	K	K-LS1 From Molecules to Organisms: Structures and Processes	K-ESS2 Earth's Systems K-ESS3 Earth and Human Activity	K-PS2 Motion and Stability: Forces and Interactions K-PS3 Energy	K-2-ETS1 Engineering Design
	1	1-LS1 From Molecules to Organisms: Structures and Processes 1-LS3 Heredity: Inheritance and Variation of Traits	1-ESS1 Earth's Place in the Universe	1-PS4 Waves and Their Applications in Technologies for Information Transfer	
	2	2-LS2 Ecosystems: Interactions, Energy, and Dynamics 2-LS4 Biological Evolution: Unity and Diversity	2-ESS1 Earth's Place in the Universe 2-ESS2 Earth's Systems	2-PS1 Matter and Its Interactions	
	3	3-LS1 From Molecules to Organisms: Structures and Processes 3-LS2 Ecosystems: Interactions, Energy, and Dynamics 3-LS3 Heredity: Inheritance and Variation of Traits 3-LS4 Biological Evolution: Unity and Diversity	3-ESS2 Earth's Systems 3-ESS3 Earth and Human Activity	3-PS2 Motion and Stability: Forces and Interactions	3-5-ETS1 Engineering Design
	4	4-LS1 From Molecules to Organisms: Structures and Processes	4-ESS1 Earth's Place in the Universe 4-ESS2 Earth's Systems 4-ESS3 Earth and Human Activity	4-PS3 Energy 4-PS4 Waves and Their Applications in Technologies for Information Transfer	
	5	5-LS1 From Molecules to Organisms: Structures and Processes 5-LS2 Ecosystems: Interactions, Energy, and Dynamics	5-ESS1 Earth's Place in the Universe 5-ESS2 Earth's Systems 5-ESS3 Earth and Human Activity	5-PS1 Matter and Its Interactions 5-PS2 Motion and Stability: Forces and Interactions 5-PS3 Energy	
Middle		MS-LS1 From Molecules to Organisms: Structures and Processes MS-LS2 Ecosystems: Interactions, Energy, and Dynamics MS-LS3 Heredity: Inheritance and Variation of Traits MS-LS4 Biological Evolution: Unity and Diversity	MS-ESS1 Earth's Place in the Universe MS-ESS2 Earth's Systems MS-ESS3 Earth and Human Activity	MS-PS1 Matter and Its Interactions MS-PS2 Motion and Stability: Forces and Interactions MS-PS3 Energy HS-PS4 Waves and Their Applications in Technologies for Information Transfer	MS-ETS1 Engineering Design
High School		HS-LS1 From Molecules to Organisms: Structures and Processes HS-LS2 Ecosystems: Interactions, Energy, and Dynamics HS-LS3 Heredity: Inheritance and Variation of Traits HS-LS4 Biological Evolution: Unity and Diversity	HS-ESS1 Earth's Place in the Universe HS-ESS2 Earth's Systems HS-ESS3 Earth and Human Activity	HS-PS1 Matter and Its Interactions HS-PS2 Motion and Stability: Forces and Interactions HS-PS3 Energy HS-PS4 Waves and Their Applications in Technologies for Information Transfer	HS-ETS1 Engineering Design

This matrix was prepared by NSTA based on the release of the Next Generation Science Standards in April 2013

Performance Expectations
NGSS Fundamentals





Close Look at a Performance Expectation

4-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.
Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence 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. • Construct an argument with evidence, data, and/or a model. (4-LS1-1)	**LS1.A: Structure and Function** • Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)	**Systems and System Models** • A system can be described in terms of its components and their interactions. (4-LS1-1)

Note: Performance expectations combine practices, core ideas, and crosscutting concepts into a single statement of ***what is to be assessed***.

They are not instructional strategies or objectives for a lesson.

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Traditional Vs. NGSS Action Verbs

Structure and Properties of Matter

Current State Middle School Science Standard

a. Explore the scientific theory of atoms (also known as atomic theory) by recognizing that atoms are the smallest unit of an element and are composed of subatomic particles (electrons surrounding a nucleus containing protons and neutrons).

b. Explore the scientific theory of atoms (also known as atomic theory) by using models to explain the motion of particles in solids, liquids, and gases.

c. Distinguish among mixtures (including solutions) and pure substances.

d. Classify and compare substances on the basis of characteristic physical properties that can be demonstrated or measured: for example, density; thermal or electrical conductivity; solubility; magnetic properties; melting and boiling points; and know that these properties are independent of the amount of the sample.

e. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).

f. Recognize that there are a finite number of elements and that their atoms combine in a multitude of ways to produce compounds that make up all of the living and nonliving things that we encounter.

g. Recognize that elements are grouped in the periodic table according to similarities of their properties.

NGSS Middle School Sample

Students who demonstrate understanding can:

1. Develop models to describe the atomic composition of simple molecules and extended structures.

2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

NGSS Teaching Strategies

- Inquiry and Discovery
- Classroom discourse by STUDENTS: see “Talk Moves”
- Student-centered investigations: see 5-E’s model
- Scientific models show how things work, not just structures
- Formative assessment: see Page Keeley books
- Learning as a social process
- Argumentation: CER- Claims, Evidence, Reasoning
- Writing: a tool to articulate ideas and advance understanding

NGSS RESOURCES

- The National Science Teachers Association (NSTA)Online standards: ngss.nsta.org
- Nextgenscience.org
- App for tablets and mobiles: ngss
- Book format: National Academies Press www.nap.edu
- A Framework for K-12 Science Education
- Workshops: PRISM/ Montclair State University prism.montclair.edu

In Summary: What's Different?

- Fewer topics, deeper coverage, more time on topics
- Emphasis on big ideas and frameworks of science
- Experiences in the practices of science and engineering
- Integration with Language Arts and Mathematics
- More guidance on vertical alignment of curriculum
- Greater use of teaching strategies that are research-based