

Next Generation Science for Macomb County



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Objectives for Today



- **Next Generation Science Standards (NGSS)**
 - Vision/Architecture
 - Shifts in Instructional Practice

- **District Implementation of the New Science Standards**
 - Scope, Sequence and Curriculum
 - MISD: Support for 2018 and Beyond



Let's Do A Thing...

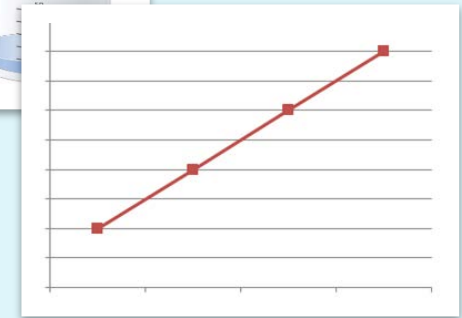
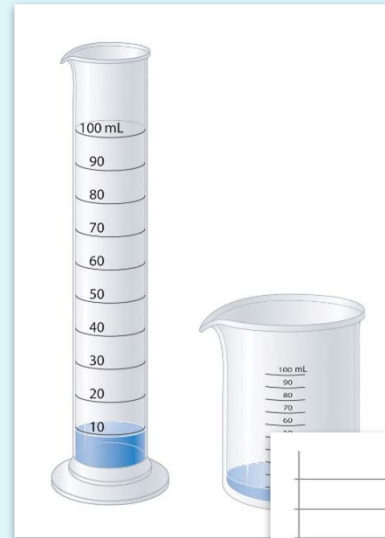


- Using the equipment available at your desk find the mass of several different amounts of water in a graduated cylinder (at least 4 or 5)
- Graph your results on large poster paper
- As you create your graph, write about three things that you noticed or are wondering
- Hang your poster on the wall when you are done

What Do You Notice, What do You Wonder?



- How are the graphs similar? How are they different?
- What might the lines mean?
- Should they be similar? The same? Different?



Next Generation Science Standards



VISION

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ARCHITECTURE



Our New Standards - When and What



- **November 2015:** State Board of Education adopted the new standards
- **Michigan Science Standards** (but really...they're NGSS)

Connection to the Framework



MS Structure and Properties of Matter		
<p>MS Structure and Properties of Matter</p> <p>Students who demonstrate understanding can:</p> <p>MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. <i>[Clarification Statement:]</i> Examples of simple molecules could include water, carbon dioxide, methane, and ammonia. Examples of extended structures could include sodium chloride, diamond, graphite, and silicon. Examples of computer representations showing different molecules with different types of atoms, [Assessment Boundary: Assessment does not include electron shells and bonding energy. Describe the basic nature of solids of various structures, or a complete reaction of all individual atoms in a discrete molecule or extended structure.]</p> <p>MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. <i>[Clarification Statement:]</i> Examples of natural resources that undergo a chemical process to form the synthetic materials. Examples of new materials could include new plastics, foams, and alternative fuels. [Assessment Boundary: Assessment is limited to qualitative information.]</p> <p>MS-PS1-4. 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. <i>[Clarification Statement:]</i> Examples of qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles and a change of state occurs. Examples of models could include diagrams. Examples of particles could include molecules or ions atoms. Examples of pure substances could include water, carbon dioxide, and others.</p> <p><i>The performance expectations above were developed using the following practices from the 8-12 document: 4. Framework for 2-12 Science Education</i></p>		
<p>Science and Engineering Practices</p> <p>Developing and Using Models</p> <p>Building on 5-8 builds on 5-8 and progresses to developing, using and refining models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> Develop a model to predict and/or describe phenomena. (MS-PS1-1)(MS-PS1-3) <p>Obtaining, Evaluating, and Communicating Information</p> <p>Obtaining, analyzing, and communicating information in 8-12 builds on 5-8 and progresses to evaluating the merit and validity of ideas and methods.</p> <ul style="list-style-type: none"> Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and suitability for each problem and method used, and describe how they are supported or not supported by evidence. (MS-PS1-3) 	<p>Disciplinary Core Ideas</p> <p>PS1.A: Structure and Properties of Matter</p> <ul style="list-style-type: none"> Substances are made from different types of atoms, which combine with one another in various ways, across four molecules that range in size from two to thousands of atoms. (MS-PS1-1) Each pure substance has characteristic physical and chemical properties that are bulk quantities under conditions that can be used to identify it. (MS-PS1-2) <i>(Note: The Disciplinary Core Idea is also addressed by MS-PS1-2.)</i> Gases and liquids are made of molecules or just atoms that are moving about relative to each other. (MS-PS1-4) In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely packed and stay in their position but do not change relative locations. (MS-PS1-4) Solids may be formed from molecules, or they may be extended structures with repeating subunits (i.e., crystals). (MS-PS1-4) The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) <p>PS1.B: Chemical Reactions</p> <ul style="list-style-type: none"> Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2) <i>(Note: The Disciplinary Core Idea is also addressed by MS-PS1-2 and MS-PS1-4.)</i> <p>PS1.C: Definition of Energy</p> <ul style="list-style-type: none"> The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for the second meaning; it refers to the energy transferred due to the temperature difference between two objects. (MS-PS1-4) The temperature of a system is proportional to the average kinetic energy and potential energy per atom or molecule (whatever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the work of the system. (MS-PS1-4) 	<p>Crosscutting Concepts</p> <p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) <p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> Time, space, and energy phenomena can be observed at various scales and models to study systems that are too large or too small. (MS-PS1-4) <p>Structure and Function</p> <ul style="list-style-type: none"> Structures are designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3) <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Interdependence of Science, Engineering, and Technology</p> <ul style="list-style-type: none"> Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and established systems. (MS-PS1-3) <p>Influence of Science, Engineering and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the defining of scientific research; and by the design of scientific research; and by the economic, cultural, and societal conditions. That technology use varies from region to region and over time. (MS-PS1-3)
<p>Connections to other parts of the Framework: MS-PS1-1, MS-PS1-2, MS-PS1-3, MS-PS1-4, MS-PS1-5, MS-PS1-6, MS-PS1-7, MS-PS1-8, MS-PS1-9, MS-PS1-10, MS-PS1-11, MS-PS1-12, MS-PS1-13, MS-PS1-14, MS-PS1-15, MS-PS1-16, MS-PS1-17, MS-PS1-18, MS-PS1-19, MS-PS1-20, MS-PS1-21, MS-PS1-22, MS-PS1-23, MS-PS1-24, MS-PS1-25, MS-PS1-26, MS-PS1-27, MS-PS1-28, MS-PS1-29, MS-PS1-30, MS-PS1-31, MS-PS1-32, MS-PS1-33, MS-PS1-34, MS-PS1-35, MS-PS1-36, MS-PS1-37, MS-PS1-38, MS-PS1-39, MS-PS1-40, MS-PS1-41, MS-PS1-42, MS-PS1-43, MS-PS1-44, MS-PS1-45, MS-PS1-46, MS-PS1-47, MS-PS1-48, MS-PS1-49, MS-PS1-50, MS-PS1-51, MS-PS1-52, MS-PS1-53, MS-PS1-54, MS-PS1-55, MS-PS1-56, MS-PS1-57, MS-PS1-58, MS-PS1-59, MS-PS1-60, MS-PS1-61, MS-PS1-62, MS-PS1-63, MS-PS1-64, MS-PS1-65, MS-PS1-66, MS-PS1-67, MS-PS1-68, MS-PS1-69, MS-PS1-70, MS-PS1-71, MS-PS1-72, MS-PS1-73, MS-PS1-74, MS-PS1-75, MS-PS1-76, MS-PS1-77, MS-PS1-78, MS-PS1-79, MS-PS1-80, MS-PS1-81, MS-PS1-82, MS-PS1-83, MS-PS1-84, MS-PS1-85, MS-PS1-86, MS-PS1-87, 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<p>Connections to other parts of the Framework: MS-PS1-1, MS-PS1-2, MS-PS1-3, MS-PS1-4, MS-PS1-5, MS-PS1-6, MS-PS1-7, MS-PS1-8, MS-PS1-9, MS-PS1-10, MS-PS1-11, MS-PS1-12, MS-PS1-13, MS-PS1-14, MS-PS1-15, MS-PS1-16, MS-PS1-17, MS-PS1-18, MS-PS1-19, MS-PS1-20, MS-PS1-21, MS-PS1-22, MS-PS1-23, MS-PS1-24, MS-PS1-25, MS-PS1-26, MS-PS1-27, MS-PS1-28, MS-PS1-29, MS-PS1-30, MS-PS1-31, MS-PS1-32, MS-PS1-33, MS-PS1-34, MS-PS1-35, MS-PS1-36, MS-PS1-37, MS-PS1-38, MS-PS1-39, MS-PS1-40, MS-PS1-41, MS-PS1-42, MS-PS1-43, MS-PS1-44, MS-PS1-45, MS-PS1-46, MS-PS1-47, MS-PS1-48, MS-PS1-49, MS-PS1-50, MS-PS1-51, MS-PS1-52, MS-PS1-53, MS-PS1-54, MS-PS1-55, MS-PS1-56, MS-PS1-57, MS-PS1-58, MS-PS1-59, MS-PS1-60, MS-PS1-61, MS-PS1-62, MS-PS1-63, MS-PS1-64, MS-PS1-65, MS-PS1-66, MS-PS1-67, MS-PS1-68, MS-PS1-69, MS-PS1-70, MS-PS1-71, MS-PS1-72, MS-PS1-73, MS-PS1-74, MS-PS1-75, MS-PS1-76, MS-PS1-77, MS-PS1-78, MS-PS1-79, MS-PS1-80, MS-PS1-81, MS-PS1-82, MS-PS1-83, MS-PS1-84, MS-PS1-85, MS-PS1-86, MS-PS1-87, MS-PS1-88, MS-PS1-89, MS-PS1-90, MS-PS1-91, MS-PS1-92, MS-PS1-93, MS-PS1-94, MS-PS1-95, MS-PS1-96, MS-PS1-97, MS-PS1-98, MS-PS1-99, MS-PS1-100.</p>		
<p>Connections to other parts of the Framework: MS-PS1-1, MS-PS1-2, MS-PS1-3, MS-PS1-4, MS-PS1-5, MS-PS1-6, MS-PS1-7, MS-PS1-8, MS-PS1-9, MS-PS1-10, MS-PS1-11, MS-PS1-12, MS-PS1-13, MS-PS1-14, MS-PS1-15, MS-PS1-16, MS-PS1-17, MS-PS1-18, MS-PS1-19, MS-PS1-20, MS-PS1-21, MS-PS1-22, MS-PS1-23, MS-PS1-24, MS-PS1-25, MS-PS1-26, MS-PS1-27, MS-PS1-28, MS-PS1-29, MS-PS1-30, MS-PS1-31, MS-PS1-32, MS-PS1-33, MS-PS1-34, MS-PS1-35, MS-PS1-36, MS-PS1-37, MS-PS1-38, MS-PS1-39, MS-PS1-40, MS-PS1-41, MS-PS1-42, MS-PS1-43, MS-PS1-44, MS-PS1-45, MS-PS1-46, MS-PS1-47, MS-PS1-48, MS-PS1-49, MS-PS1-50, MS-PS1-51, MS-PS1-52, MS-PS1-53, MS-PS1-54, MS-PS1-55, MS-PS1-56, MS-PS1-57, MS-PS1-58, MS-PS1-59, MS-PS1-60, MS-PS1-61, MS-PS1-62, MS-PS1-63, MS-PS1-64, MS-PS1-65, MS-PS1-66, MS-PS1-67, MS-PS1-68, MS-PS1-69, MS-PS1-70, MS-PS1-71, MS-PS1-72, MS-PS1-73, MS-PS1-74, MS-PS1-75, MS-PS1-76, MS-PS1-77, MS-PS1-78, MS-PS1-79, MS-PS1-80, MS-PS1-81, MS-PS1-82, MS-PS1-83, MS-PS1-84, MS-PS1-85, MS-PS1-86, MS-PS1-87, MS-PS1-88, MS-PS1-89, MS-PS1-90, MS-PS1-91, MS-PS1-92, MS-PS1-93, MS-PS1-94, MS-PS1-95, MS-PS1-96, MS-PS</p>		

Architecture of the NGSS: Performance Expectations



Performance Expectations:

- These describe what a student should be able to do at the end of a unit
- They are not meant to be lesson sequences or required activities

MS-Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. (Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.) (Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.)

MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. (Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, or physical models.) (Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.)

MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wireless devices, and conversion of stored binary patterns to make sound or text on a computer screen.) (Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.)

Performance expectations show work developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
<p>Develop and Use Models</p> <p>Modeling in 6-8 builds on K-5 and progresses to developing, using, and refining models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> - Develop and use a model to describe phenomena. (MS-PS4-2) <p>Using Mathematics and Computational Thinking</p> <p>Mathematical and computational thinking in 6-8 builds on K-5 and progresses to identifying outcomes in large data sets and using mathematical concepts to support explanations and arguments.</p> <ul style="list-style-type: none"> - Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1) <p>Obtaining, Evaluating, and Communicating Information</p> <p>Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluate the merit and validity of ideas and methods.</p> <ul style="list-style-type: none"> - Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3) 	<p>A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)</p> <ul style="list-style-type: none"> - A sound wave needs a medium through which it is transmitted. (MS-PS4-2) <p>PS4.B: Electromagnetic Radiation</p> <ul style="list-style-type: none"> - When light strikes 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-PS4-2) - 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. (MS-PS4-2) - A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) - However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2) <p>PS4.C: Information Technologies and Instrumentation</p> <ul style="list-style-type: none"> - Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3) 	<p>Patterns</p> <ul style="list-style-type: none"> - Graphs and charts can be used to identify patterns in data. (MS-PS4-1) <p>Structure and Function</p> <ul style="list-style-type: none"> - Structures can be designed to serve particular functions by taking into account constraints of different materials, and how materials can be shaped and used. (MS-PS4-2) - Structures can be designed to serve particular functions. (MS-PS4-3) <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> - Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3) <p>Connections to Nature of Science</p> <p>Science is a Human Endeavor</p> <ul style="list-style-type: none"> - Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

Connections to other DCIs in this grade band: MS-LS1.D, MS-PS4-2.

Additional cross-grade bands: 4.PS3.A (MS-PS4-1); 4.PS3.B (MS-PS4-1); 4.PS4.A (MS-PS4-1); 4.PS4.B (MS-PS4-2); 4.PS4.C (MS-PS4-3); MS-PS4.A (MS-PS4-1); MS-PS4-2); MS-PS4-3); MS-PS4.B (MS-PS4-1); MS-PS4-2); MS-PS4.C (MS-PS4-3).

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-2)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of that text distinct from prior knowledge or opinions. (MS-PS4-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-PS4-3)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1); (MS-PS4-2)

Mathematics –

MP.2 Reason abstractly and quantitatively. (MS-PS4-1)

MP.4 Model with mathematics. (MS-PS4-1)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS4-1)

8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS4-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas*. Integrated and reprinted with permission from the National Academy of Sciences.

April 2013 NGSS Release 45

Architecture of the NGSS: 3 Dimensions



MS.Waves and Electromagnetic Radiation	
<p>Students who demonstrate understanding can:</p> <p>MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. (Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.) (Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.)</p> <p>MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. (Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.) (Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.)</p> <p>MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi technology, and the use of stored binary patterns to make sound or text on a computer.) (Assessment Boundary: Assessment does not include the specific mechanism of any given technology.)</p>	
<p>Science and Engineering Practices</p> <p>Develop and Use Models Modeling in 6-8 builds on K-5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> - Develop and use a model to describe phenomena. (MS-PS4-2) <p>Using Mathematics and Computational Thinking Mathematical and computational thinking at the 6-8 level builds on K-5 and progresses to identifying outcomes in large data sets and using mathematical concepts to support explanations and argument.</p> <ul style="list-style-type: none"> - Use mathematical representations to describe and support scientific conclusions and design solutions. (MS-PS4-1) <p>Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluate the merit and validity of ideas and methods.</p> <ul style="list-style-type: none"> - Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3) <p>Connections to Nature of Science</p> <p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> - Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1) 	<p>Disciplinary Core Ideas</p> <p>PS4.A: Wave Properties Simple waves have a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) Sound waves need a medium through which to transmit. (MS-PS4-2)</p> <p>PS4.B: Electromagnetic Radiation When light strikes 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-PS4-2) The path that light travels can be traced as straight lines, not at surface between different transparent materials (air and water, air and glass) where the light path bends. (MS-PS4-2) A wave model of light is useful for explaining brightness, color, and frequency-dependent bending of light at a surface between media. (MS-PS4-2) Light, because light can travel through space, is carried by a medium wave, like sound or water waves. (MS-PS4-2)</p> <p>PS4.C: Information Technologies and Instrumentation Digital signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)</p>
<p>Crosscutting Concepts</p> <p>Patterns Graphs and charts can be used to identify patterns in data. (MS-PS4-1)</p> <p>Structure and Function Structure can be designed to serve particular functions by taking into account constraints of different materials, and how materials can be shaped and used. (MS-PS4-2) Structure can be designed to serve particular functions. (MS-PS4-3)</p> <p>Connections to Engineering, Technology, and Applications of Science Advances in Science, Engineering, Technology on Society and the Natural World Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)</p> <p>Connections to Nature of Science Science is a Human Endeavor Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)</p>	
<p>Connections to other DCI in this grade band: (MS-LS1-1), (MS-PS4-2), (MS-PS4-3)</p> <p>Anchor standards: 4.PS4.A (MS-PS4-1); 4.PS4.B (MS-PS4-2); 4.PS4.C (MS-PS4-3); 4.PS4.A (MS-PS4-1); 4.PS4.B (MS-PS4-2); 4.PS4.C (MS-PS4-3)</p> <p>Common Core State Standards:</p> <p>ELA/Literacy –</p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-3)</p> <p>RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-PS4-3)</p> <p>RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-PS4-3)</p> <p>W.HST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3)</p> <p>SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1), (MS-PS4-2)</p> <p>Mathematics –</p> <p>MP.2 Reason abstractly and quantitatively. (MS-PS4-1)</p> <p>MP.4 Model with mathematics. (MS-PS4-1)</p> <p>6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)</p> <p>6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1)</p> <p>7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS4-1)</p> <p>8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS4-1)</p>	
<p>*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.</p>	

Disciplinary Core Ideas

Science and Engineering Practices

Crosscutting Concepts



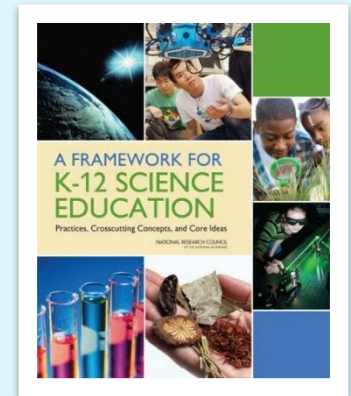
NGSS Resources



- www.nextgenscience.org



- www.tinyurl.com/scienceframework



- www.tinyurl.com/mstepScience



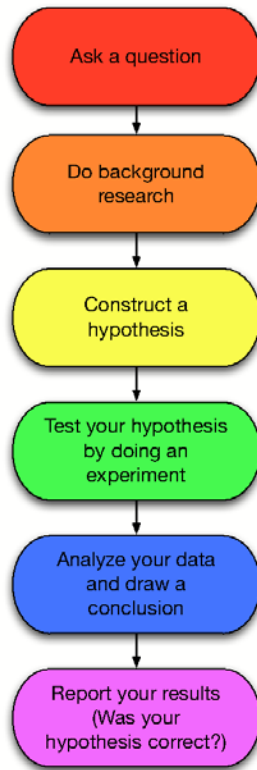
So what do the new standards mean for our classrooms?



Our shift in thinking...

From thinking that one scientific method fits all...

The Scientific Method

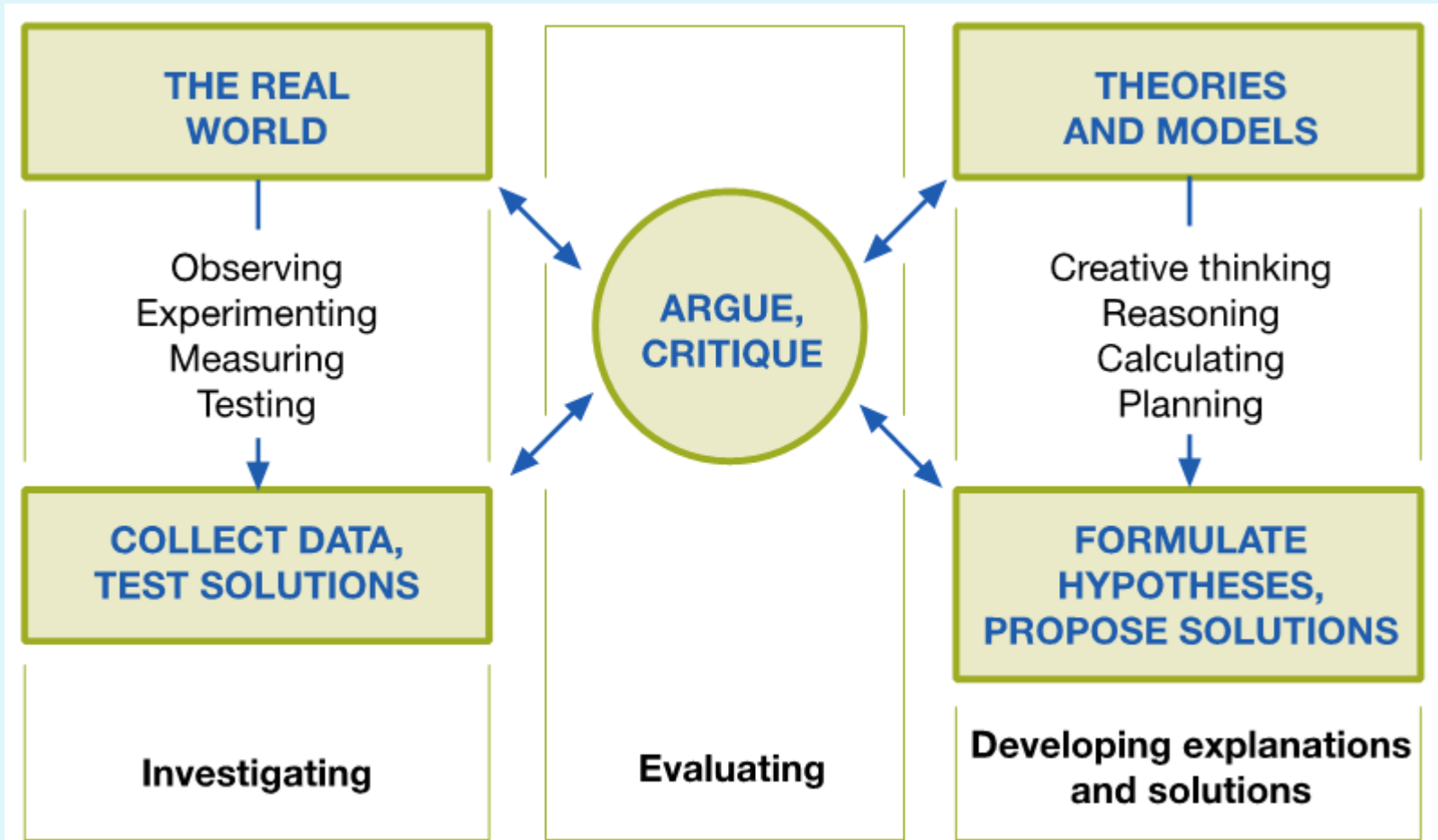


...To thinking about how to engage our students in the practices of scientists

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information



A new model for the practice of science



Grade Level Content Expectations and NGSS



GLCE

- P.EN.03.21 Demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light.
- P.EN.03.22 Observe what happens to light when it travels from air to water.

NGSS

- 1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.
- MS-PS4.2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Grade Level Content Expectations and NGSS



GLCE

- P.EN.03.21 **Demonstrate** that light travels in a straight path and that shadows are made by placing an object in a path of light.
- P.EN.03.22 **Observe** what happens to light when it travels from air to water.

NGSS

- 1-PS4-3. **Plan and conduct an investigation** to determine the effect of placing objects made with different materials in the path of a beam of light.
- MS-PS4.2. **Develop and use a model** to describe that waves are reflected, absorbed, or transmitted through various materials.

Shifts in Practice: Content

Conventional Science Instruction

Shifts in Practice for NGSS

P3.1 Basic Forces in Nature

Objects can interact with each other by "direct contact" (e.g., pushes or pulls, friction) or at a distance (e.g., gravity, electromagnetism, nuclear).

P3.1A Identify the force(s) acting between objects in "direct contact" or at a distance.

P3.1x Forces

There are four basic forces (gravitational, electromagnetic, strong, and weak nuclear) that differ greatly in magnitude and range. Between any two charged particles, electric force is vastly greater than the gravitational force. Most observable forces (e.g., those exerted by a coiled spring or friction) may be traced to electric forces acting between atoms and molecules.

P3.1B Explain why scientists can ignore the gravitational force when measuring the net force between two electrons.

P3.1C Provide examples that illustrate the importance of the electric force in everyday life.

P3.1d Identify the basic forces in everyday interactions.

P3.2 Net Forces

Forces have magnitude and direction. The net force on an object is the sum of all the forces acting on the object. Objects change their speed and/or direction only when a net force is applied. If the net force on an object is zero, there is no change in motion (Newton's First Law).

P3.2A Identify the magnitude and direction of everyday forces (e.g., wind, tension in ropes, pushes and pulls, weight).

P3.2B Compare work done in different situations.

P3.2C Calculate the net force acting on an object.

P3.2d Calculate all the forces on an object on an inclined plane and describe the object's motion based on the forces using free-body diagrams.

P3.3 Newton's Third Law

Whenever one object exerts a force on another object, a force equal in magnitude and opposite in direction is exerted back on the first object.

P3.3A Identify the action and reaction force from examples of forces in everyday situations (e.g., book on a table, walking across the floor, pushing open a door).

P3.3b Predict how the change in velocity of a small mass compares to the change in velocity of a large mass when the objects interact (e.g., collide).

P3.3c Explain the recoil of a projectile launcher in terms of forces and masses.

P3.3d Analyze why seat belts may be more important in autos than in buses.

P3.4 Forces and Acceleration

The change of speed and/or direction (acceleration) of an object is proportional to the net force and inversely proportional to the mass of the object. The acceleration and net force are always in the same direction.

P3.4A Predict the change in motion of an object.

P3.4B Identify forces acting on objects moving vertically.

P3.4C Solve problems involving force, mass, and acceleration.

P3.4D Identify the force(s) acting on objects moving in orbit.

P3.4e Solve problems involving force, mass, and acceleration for objects moving with no initial horizontal velocity with no initial velocity.

P3.4f Calculate the changes in velocity of a thrown object.

P3.4g Explain how the time of impact can affect the change in velocity.

P3.5x Momentum

A moving object has a quantity of motion called momentum. The total momentum of a system of objects is conserved.

P3.5a Apply conservation of momentum to solve problems.

Michigan Force and Motion High School Content Expectations

PS2.A: Forces and Motion

- Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)
- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-1)
- If a system interacts with objects outside of itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2), (HS-PS2-3)

PS2.B: Types of Interactions

- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
- Forces at a distance are explained by fields (gravitational, electrostatic, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4), (HS-PS2-5)
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6), (secondary to HS-PS2-1), (secondary to HS-PS2-3)

NGSS Force and Motion Disciplinary Core Ideas

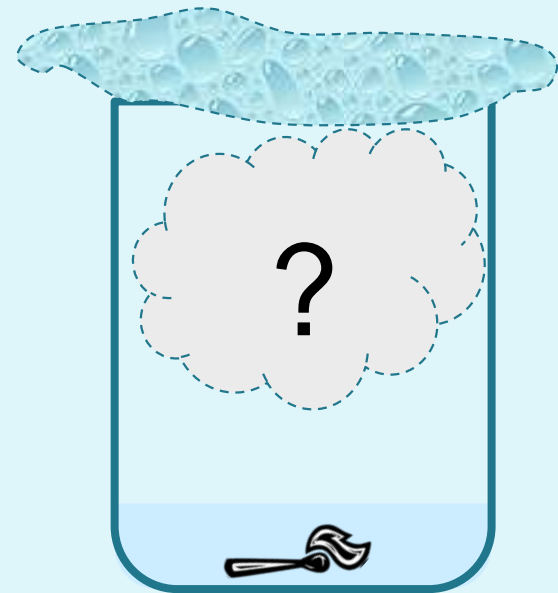
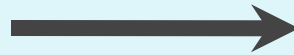
Shifting Instructional Practice: **Experimentation**



Conventional Science Instruction



Students read the text to learn vocabulary and background information about clouds.

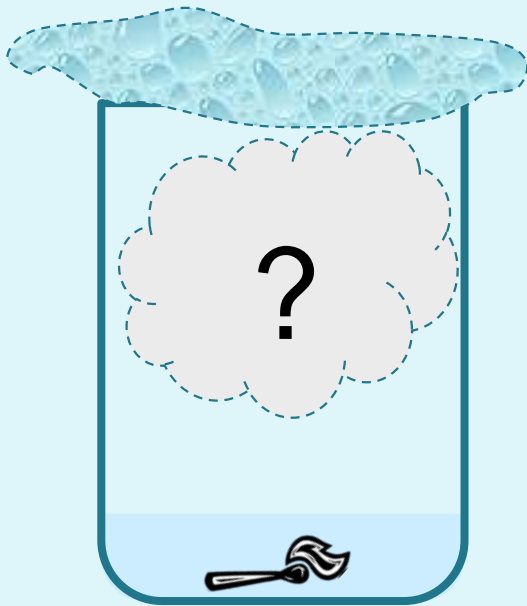


Students then observe the cloud in a jar that confirms what they already “know.”

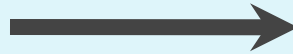
Shifting Instructional Practice: **Experimentation**



Shifts in Practice for NGSS



Students ask questions about cloud formation and do some investigating on their own.



Students search for answers to **their** questions as they read the text.

Shifting Instructional Practice: Experimentation

The image shows the PhET Pendulum Lab simulation interface. The main area is yellow and features a pendulum with a blue mass and a black string. A vertical dashed line indicates the equilibrium position. A curved scale at the top shows the pendulum's displacement. On the left, a vertical ruler is marked from 0 to 180 cm. At the bottom center, there is a pause/play button and the PhET logo.

On the right, a control panel is enclosed in a blue border. It includes the following settings:

- length:** 2.00 m
- mass:** 1.00 kg
- Show 2nd pendulum**
- length 2:** 1.00 m
- mass 2:** 0.50 kg
- friction:** A slider set to "none" (between "none" and "lots").
- Time:** Radio buttons for "real time" (selected), "1/4 time", and "1/16 time".
- Gravity:** Radio buttons for "Moon", "Earth" (selected), "Jupiter", "Planet X", and "g = 0".
- Show:** velocity, acceleration
- Show energy of:** Radio buttons for "1", "2", and "none" (selected).
- photogate timer
- other tools
- Reset** button

Shifting Instructional Practice: Experimentation



Conventional Science Instruction

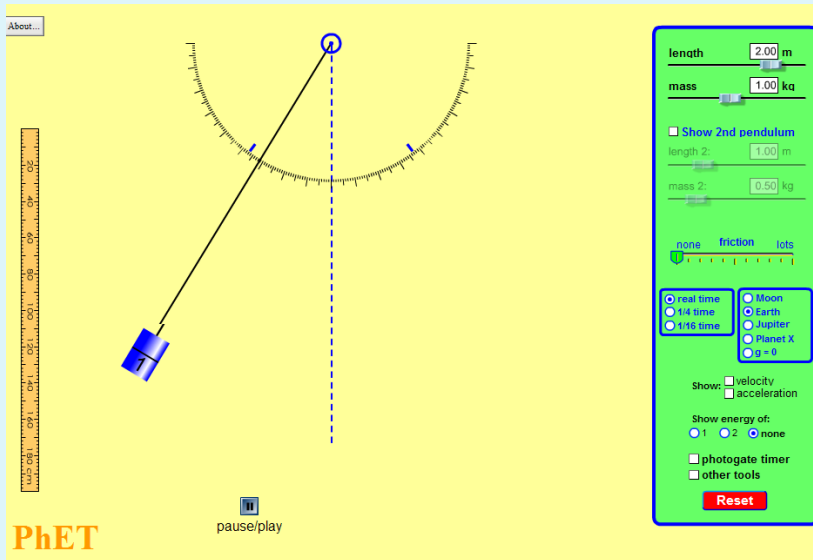
How does the period of the pendulum depend on the amplitude of the swing?

- Be sure to keep the mass and length constant
- Click on the button on the lower right which will activate the photogate timer
- Set the amplitude to 50° and start the pendulum.
- Start the photogate timer – this will automatically stop itself when it has recorded the time for one complete swing (period)
- Enter the amplitude and period in excel – **be sure to label the top of each column and the correct units**
- Continue to take readings for 40° , 30° and so on down to 10°
- Highlight the columns on your spreadsheet and insert a scatter plot of your results.
- **Choose a chart layout that will allow you to give the graph a title and label the axes with complete units**
- Click on the chart itself and look for the layout tab
- Open the trendline option and then open “more trendline options”
- Select linear trendline, and display equation and r^2 on graph
- Try other trendline options, (exponential, etc) until you find **an r^2 value closest to 1**
- Save the table, graph and trendline information

Shifting Instructional Practice: **Experimentation**



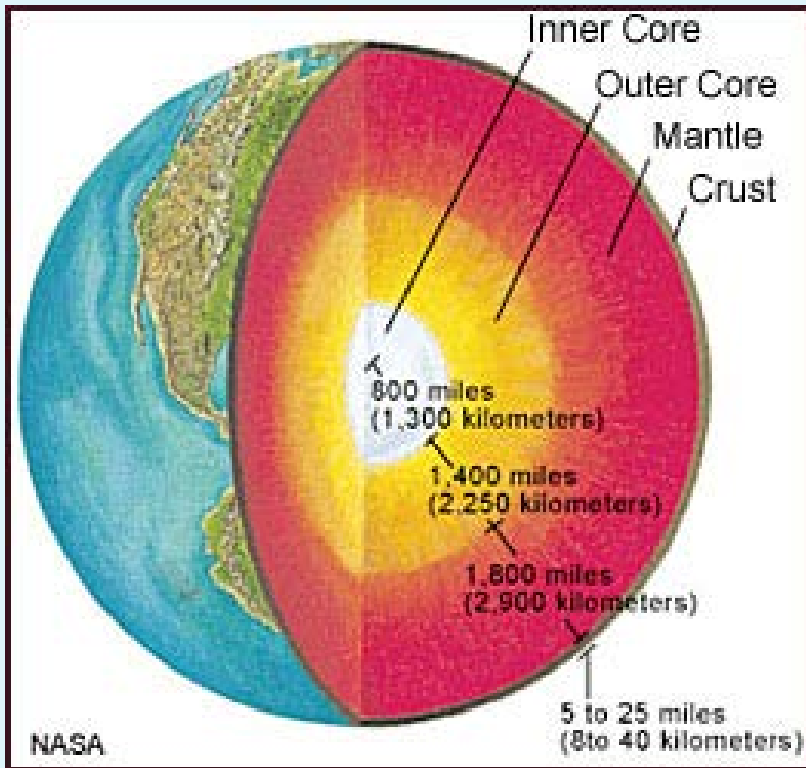
Shifts in Practice for NGSS



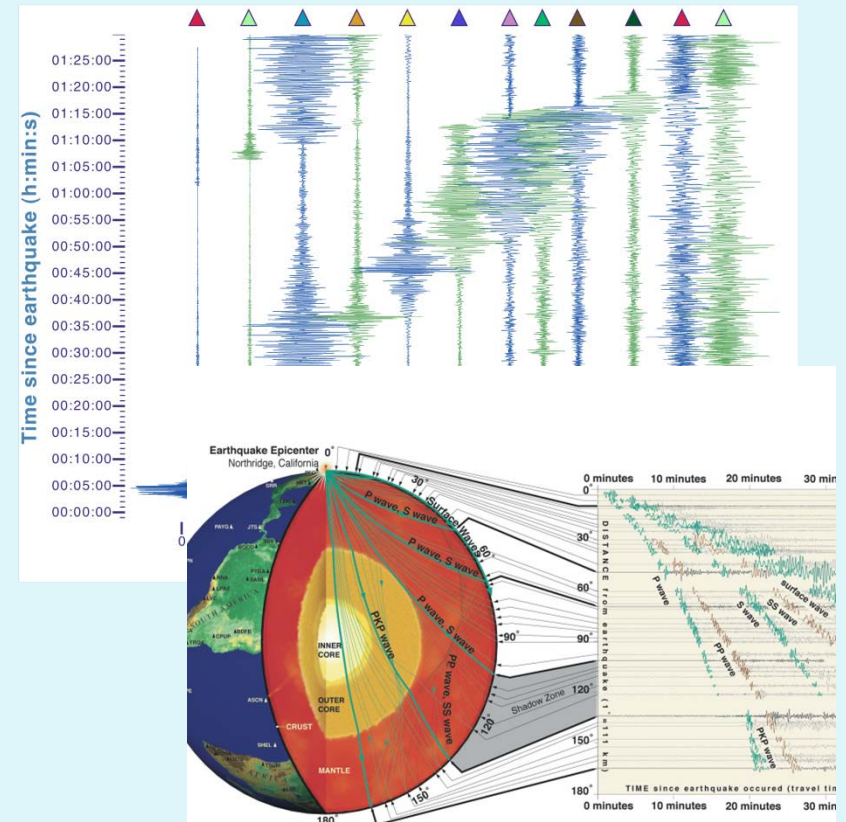
- What questions do you have about the motion of a pendulum?
- How might you use this simulation to answer your questions?
- What kind of models might you develop to represent the motion of the pendulum?

Shifting Instructional Practice: Scientific Models

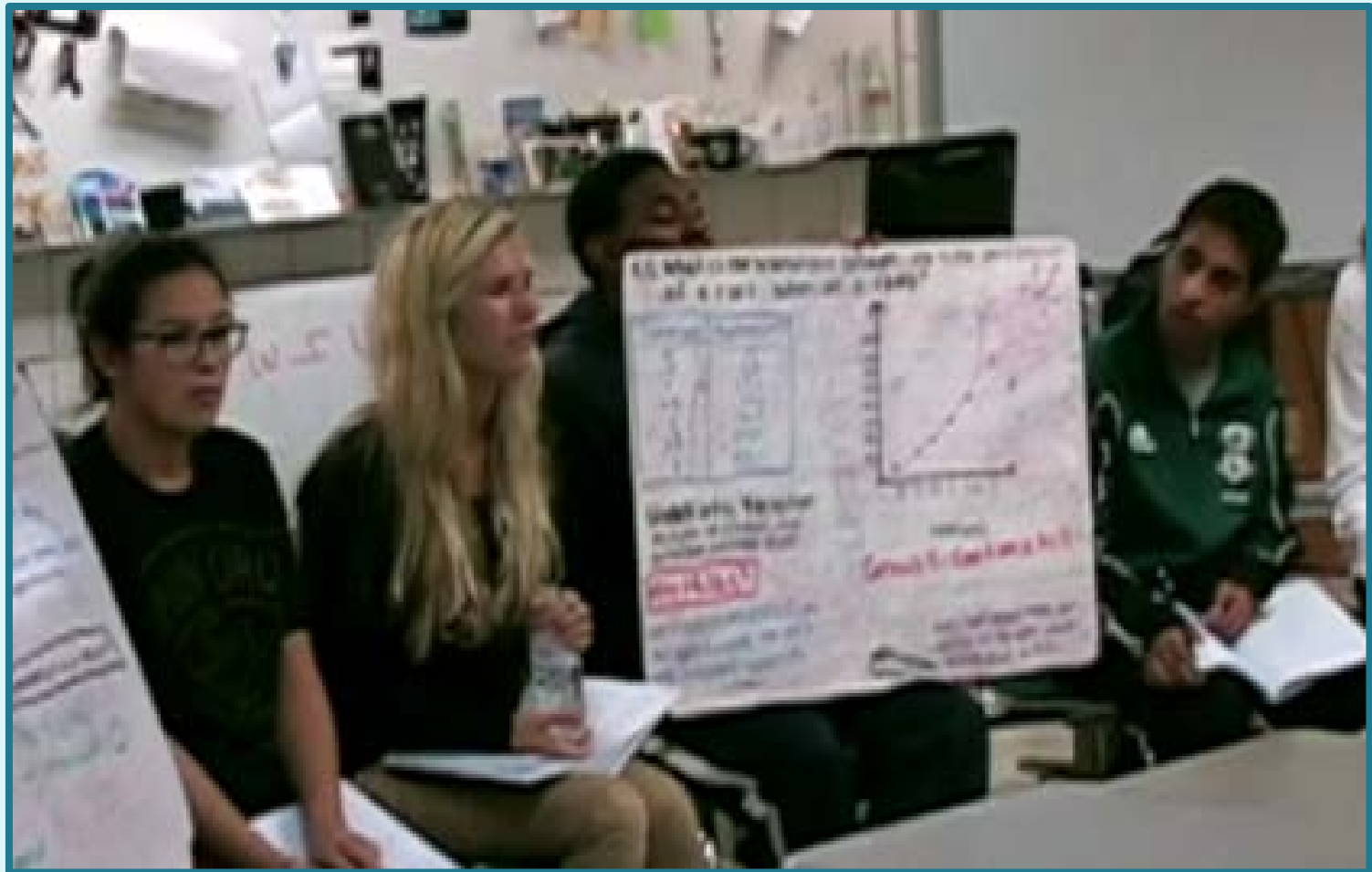
Conventional Science Instruction



Shifts in Practice for NGSS



Shifting Instructional Practice: **Social Interaction**



In summary, it is a shift...



From **telling** our kids
the science

TO

creating learning
opportunities that help
them **figure out** the
science.



Aligning with NGSS in your District

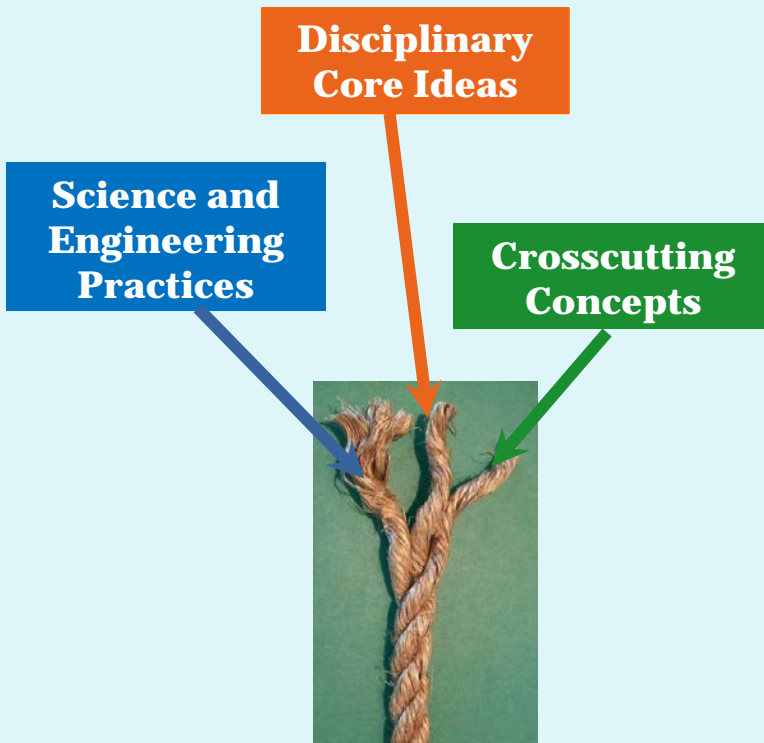


Implementing NGSS in your District



Instructional Alignment

3 Dimensional Teaching and Learning



Curricular Alignment

Scope and Sequence

When do they learn about plate tectonics?



Elementary Sequences



K-5 is articulated and defined! All of our sequences should look similar at any given grade level

- Lots of programs from a variety of publishers
- Be careful about *Mystery Science*...
- *Phenomenal Science* - Open source from CMU

Middle School Sequences



Middle School has to be 6th - 8th again

- Domains vs Conceptual
- Earth Science Dilemma
- *Mi-STAR - Open Resource (mostly)*
- *IQWST - not OER*

High School Sequences



High School - most schools are still using course sequences around physics/chemistry (or physical science), and biology

- Where do you put Earth Science...
- Modeling Curriculum
- *Interactions for Physical Science*
- *Model Based Biology*

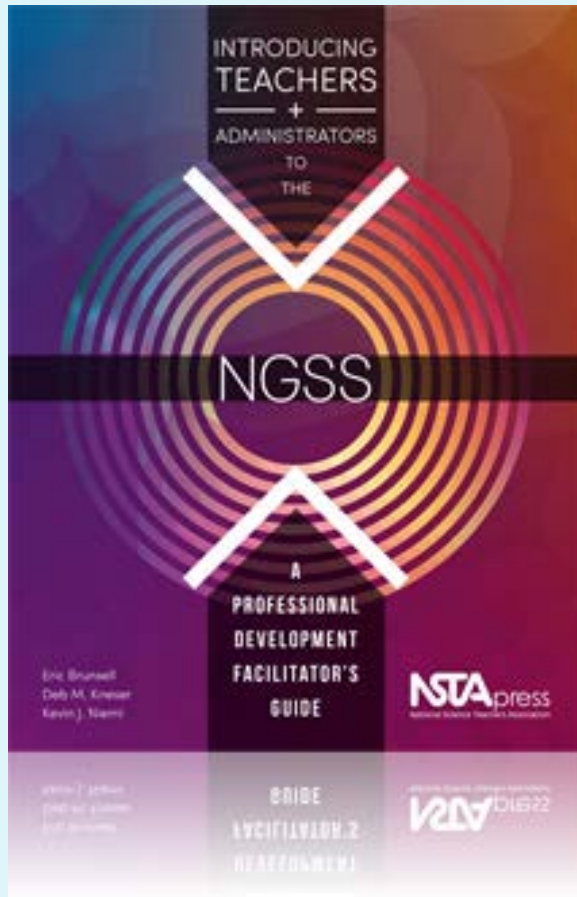
M-STEP Changes



- **2018** - Pilot test in 5th, 8th and 11th; length is 1/2 of the final assessment (only participation counts)
- **2019** - Field test in 5, 8 and 11, full length assessment (only participation counts)
- **2019** - Fully operational assessment



Getting Started



- Great activities for developing awareness about the NGSS.
- 30 minutes – 6 hours
- Every district has a copy

MISD Professional Development Support

- NGSx Training - 5 days
- NGSS – Next Steps
- K-5 Phenomenal Science
- Mi-STAR for MS
- Physical Science Interactions for HS
- Model Based Biology
- Modeling Workshops

