Next Generation Science for Macomb County

MACA Meeting
March 21, 2018

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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…

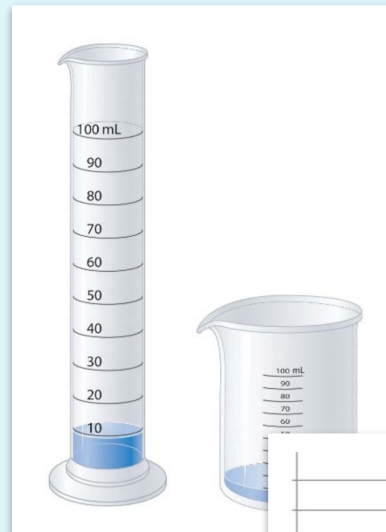
- Using the equipment available at your desk find the mass of several different amounts of water in a graduated cylinder (at least 4 or 5)
- Graph your results on large poster paper
- As you create your graph, write about three things that you noticed or are wondering
- Hang your poster on the wall when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

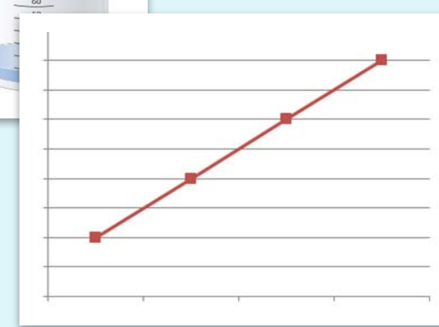
What Do You Notice, What do You Wonder?

- 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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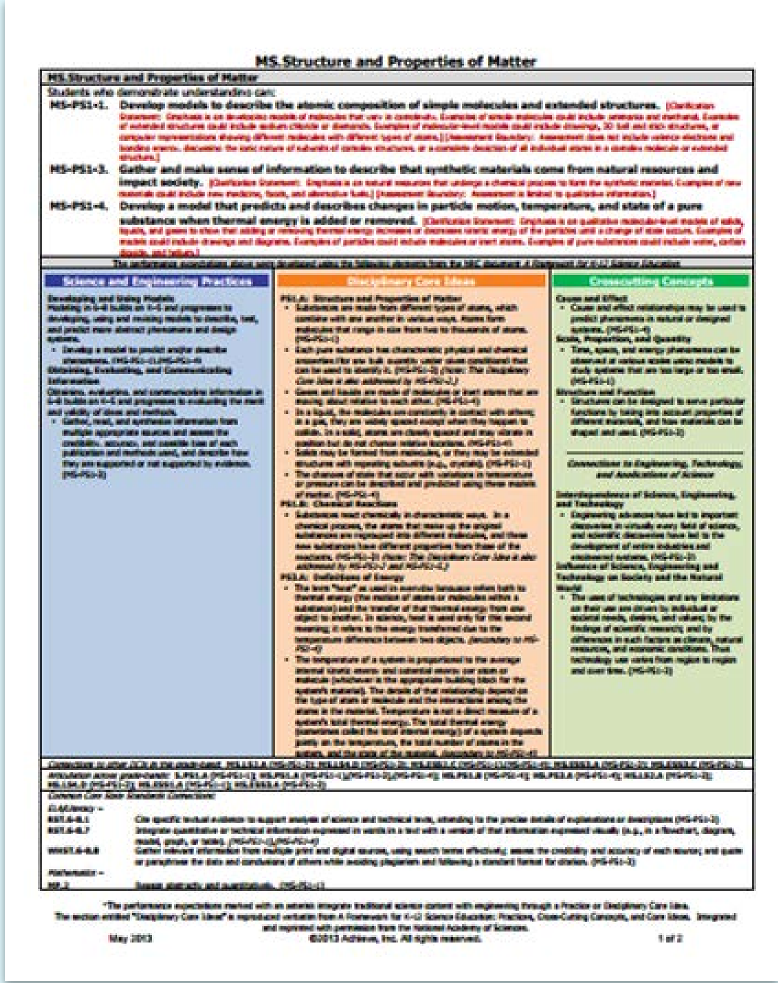
ARCHITECTURE

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

MS.Structure and Properties of Matter

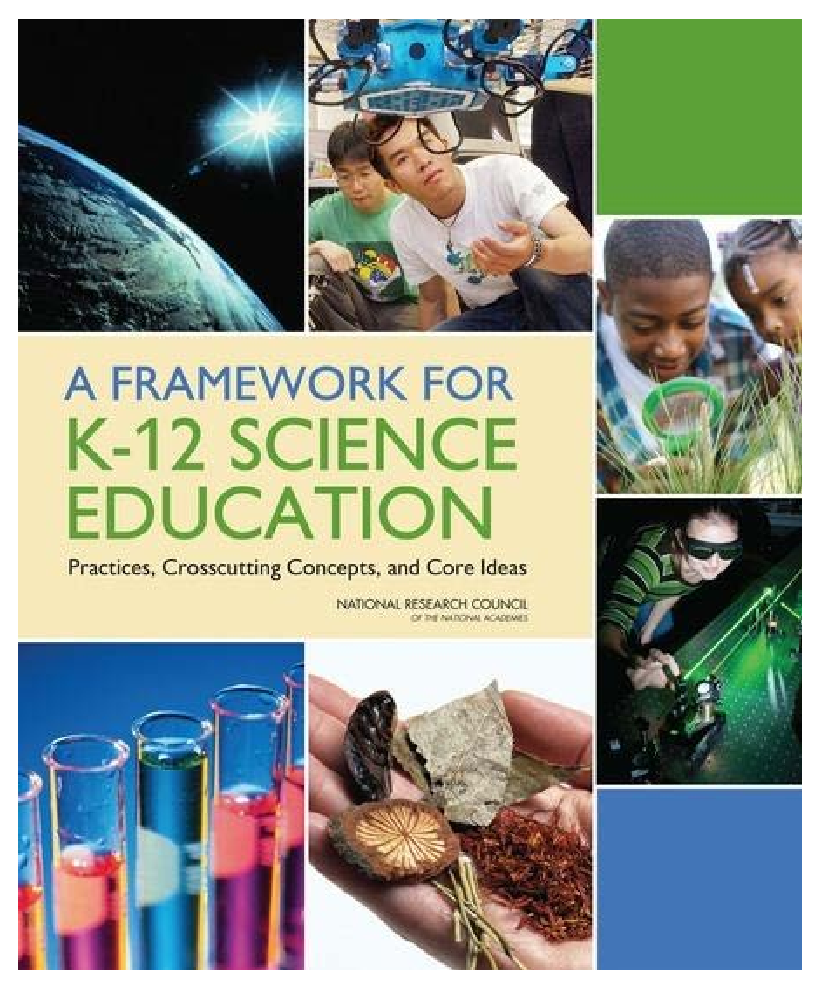
Students who demonstrate understanding can:

MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.

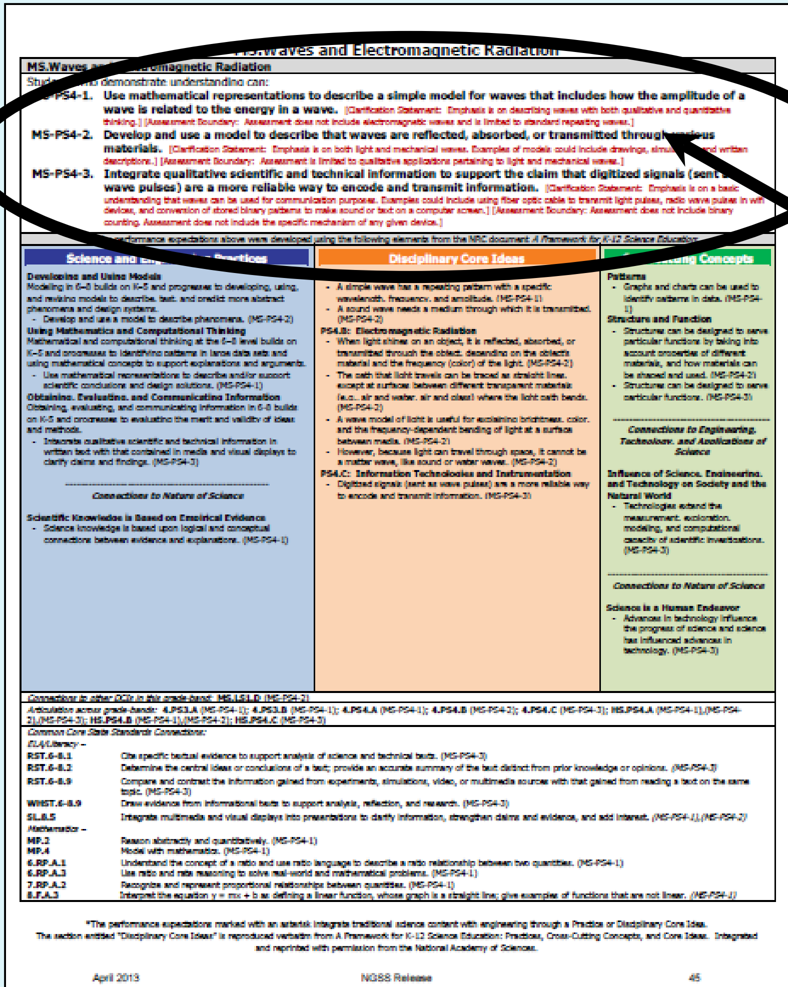
MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

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.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models	PS1.A: Structure and Properties of Matter	Cause and Effect



Architecture of the NGSS: Performance Expectations



MS.Waves and Electromagnetic Radiation

MS.Waves and Electromagnetic Radiation

demonstrate understanding can:

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, and written descriptions.] [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 wifi 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 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
Developing and Using 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. - Develop and use a model to describe phenomena. (MS-PS4-2) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. - Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods. - 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) *Connections to Nature of Science* **Scientific Knowledge is Based on Empirical Evidence** - Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)	- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) - A sound wave needs a medium through which it is transmitted. (MS-PS4-2) **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-PS4-2) - 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) **PS4.C: Information Technologies and Instrumentation** - Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)	**Patterns** - Graphs and charts can be used to identify patterns in data. (MS-PS4-1) **Structure and Function** - Structures can be designed to serve particular functions by taking into account properties 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) *Connections to Engineering, Technology, and Applications of Science* **Influence of Science, Engineering, and Technology on Society and the Natural World** - Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3) *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)

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

Articulation across 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); **HS.PS4.A** (MS-PS4-1),(MS-PS4-2),(MS-PS4-3); **HS.PS4.B** (MS-PS4-1),(MS-PS4-2); **HS.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-PS4-3)
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)*
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)
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems. (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.

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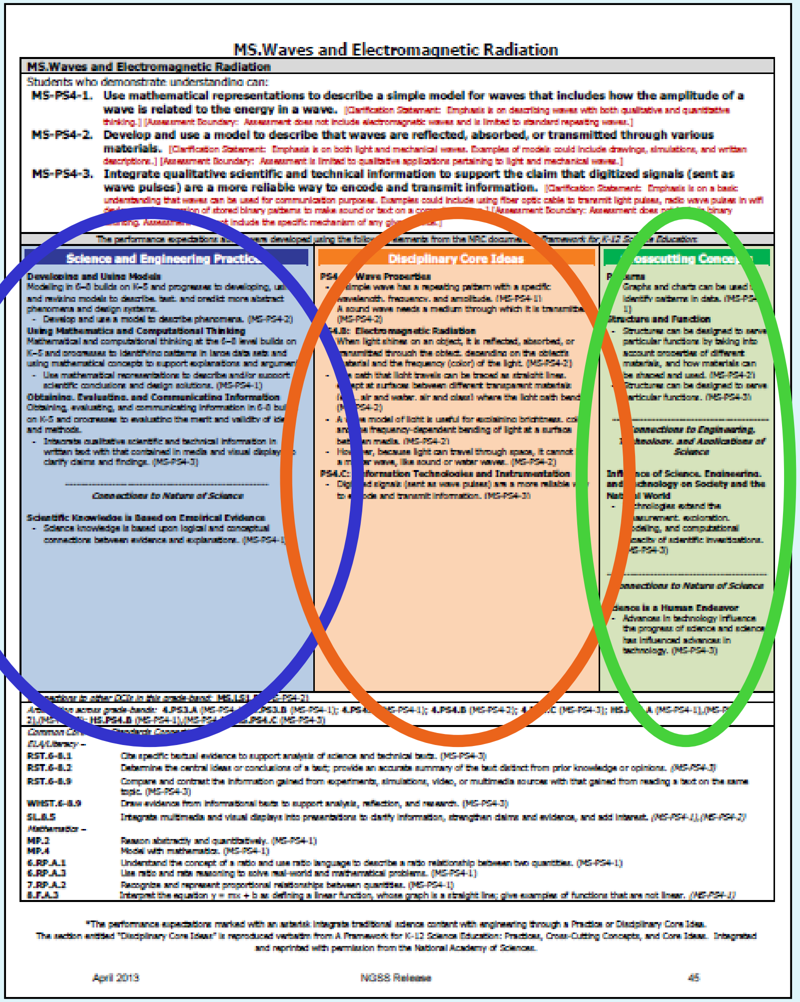
Performance Expectations:

- **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**

Architecture of the NGSS: 3 Dimensions



MS.Waves and Electromagnetic Radiation

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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.]

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 ...]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models	**Wave Properties**	**Patterns**
Using Mathematics and Computational Thinking	**PS4.B: Electromagnetic Radiation**	**Structure and Function**
Obtaining, Evaluating, and Communicating Information	**PS4.C: Information Technologies and Instrumentation**	*Connections to Engineering, Technology, and Applications of Science*
Connections to Nature of Science		*Connections to Nature of Science*
Scientific Knowledge is Based on Empirical Evidence		

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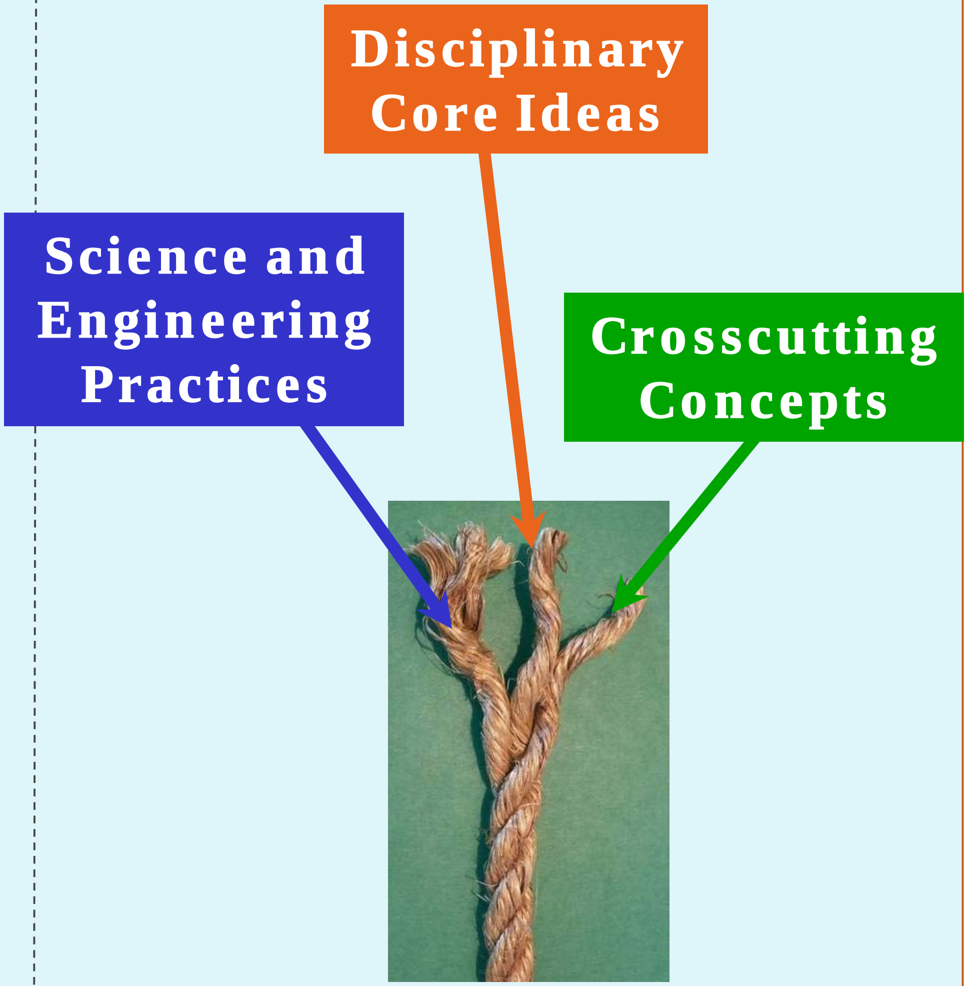
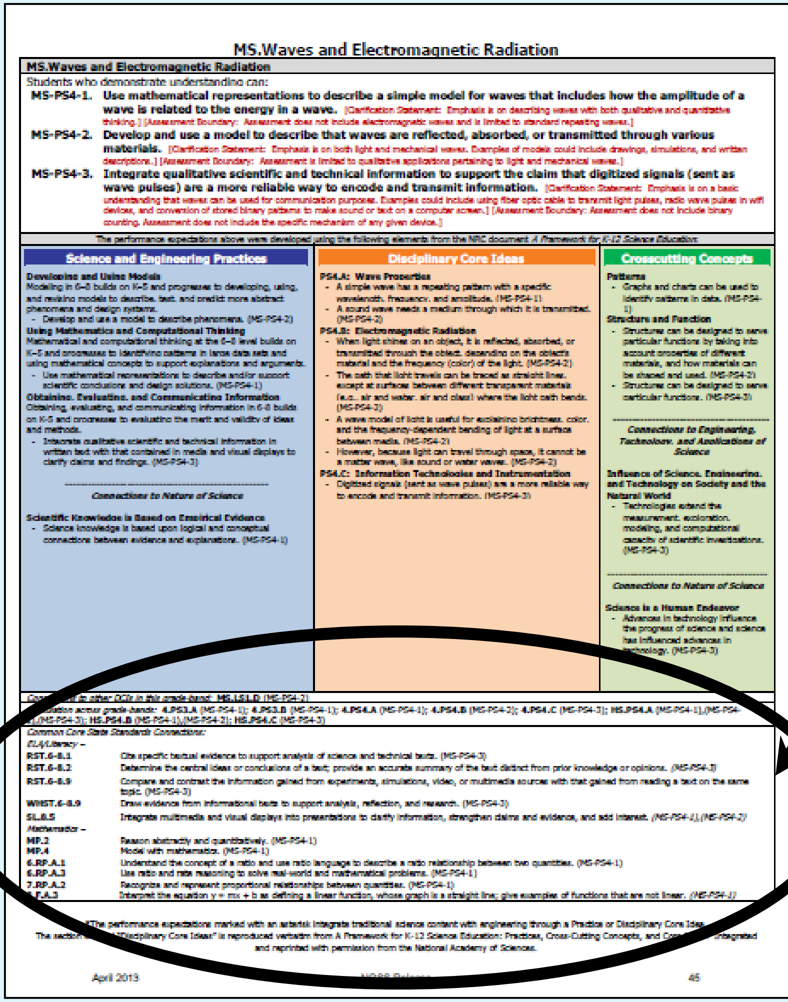


Architecture of the NGSS: Connections



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Science and Engineering Practices

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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.
- Develop and use a model to describe phenomena. (MS-PS4-2)

Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
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Connections to Nature of Science

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Disciplinary Core Ideas

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Crosscutting Concepts

Patterns
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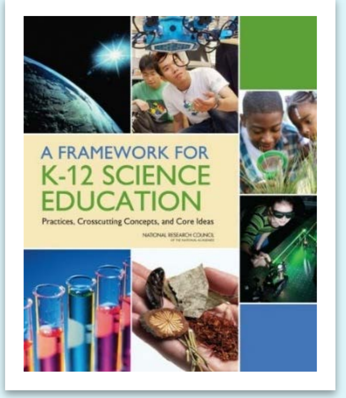
Connections to:

Other content / grade bands within the NGSS

Common Core State Standards for ELA / Literacy and Mathematics

NGSS Resources

- www.nextgenscience.org
- www.tinyurl.com/scienceframework

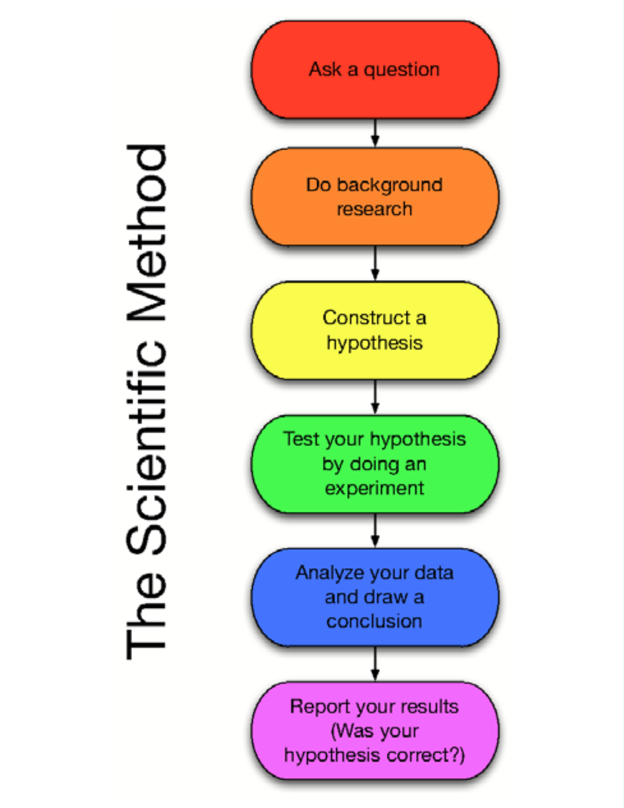


- www.tinyurl.com/mstepScience

So what do the new standards mean for our classrooms?

Our shift in thinking…

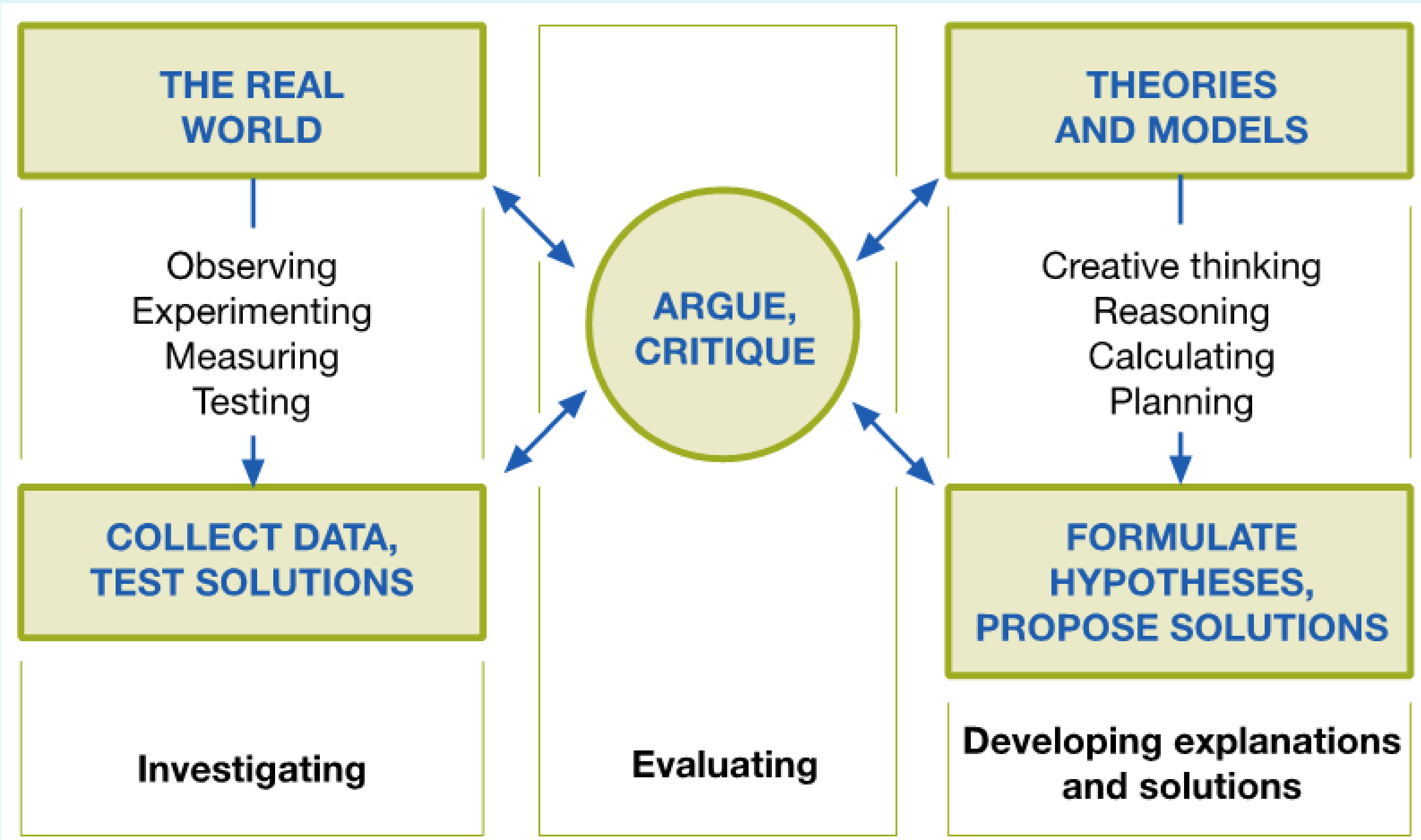
From thinking that one scientific method fits all…



…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	NGSS
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.	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.
P.EN.03.22 Observe what happens to light when it travels from air to water.	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	NGSS
• 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.	• 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

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 w
P3.4C Solve problems involving force, mass, and
P3.4D Identify the force(s) acting on objects mo
in orbit).
P3.4e Solve problems involving force, mass, and
horizontal velocity with no ini
P3.4f Calculate the changes in velocity of a thro
P3.4g Explain how the time of impact can affect
P3.5x Momentum
A moving object has a quantity of motio
between objects, the total momentum
P3.5a Apply conservation of momentum to solv

Michigan Force and Motion High School Content Expectations

Shifts in Practice for NGSS

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

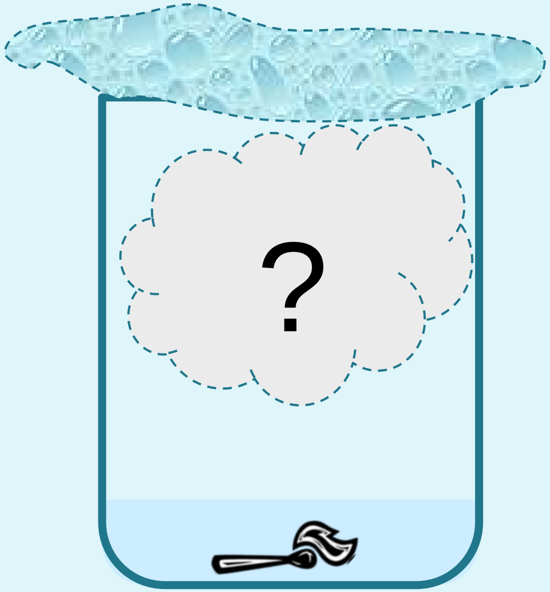
- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
- Forces at a distance are explained by fields (gravitational, electrostatic, and magnetic) permeating 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

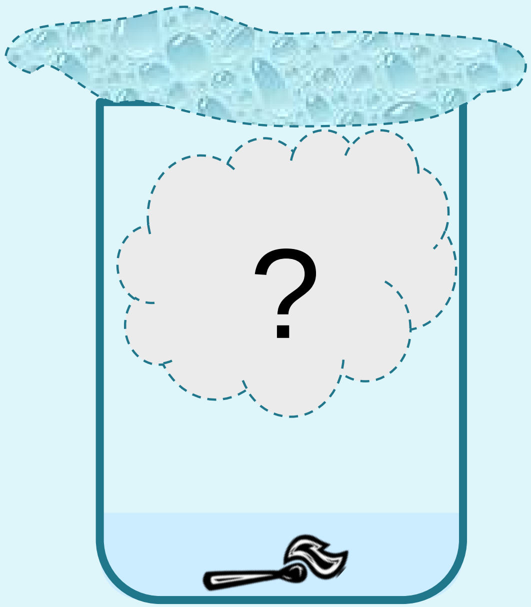
Students read the text to learn vocabulary and background information about clouds.



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

Shifting Instructional Practice: **Experimentation**

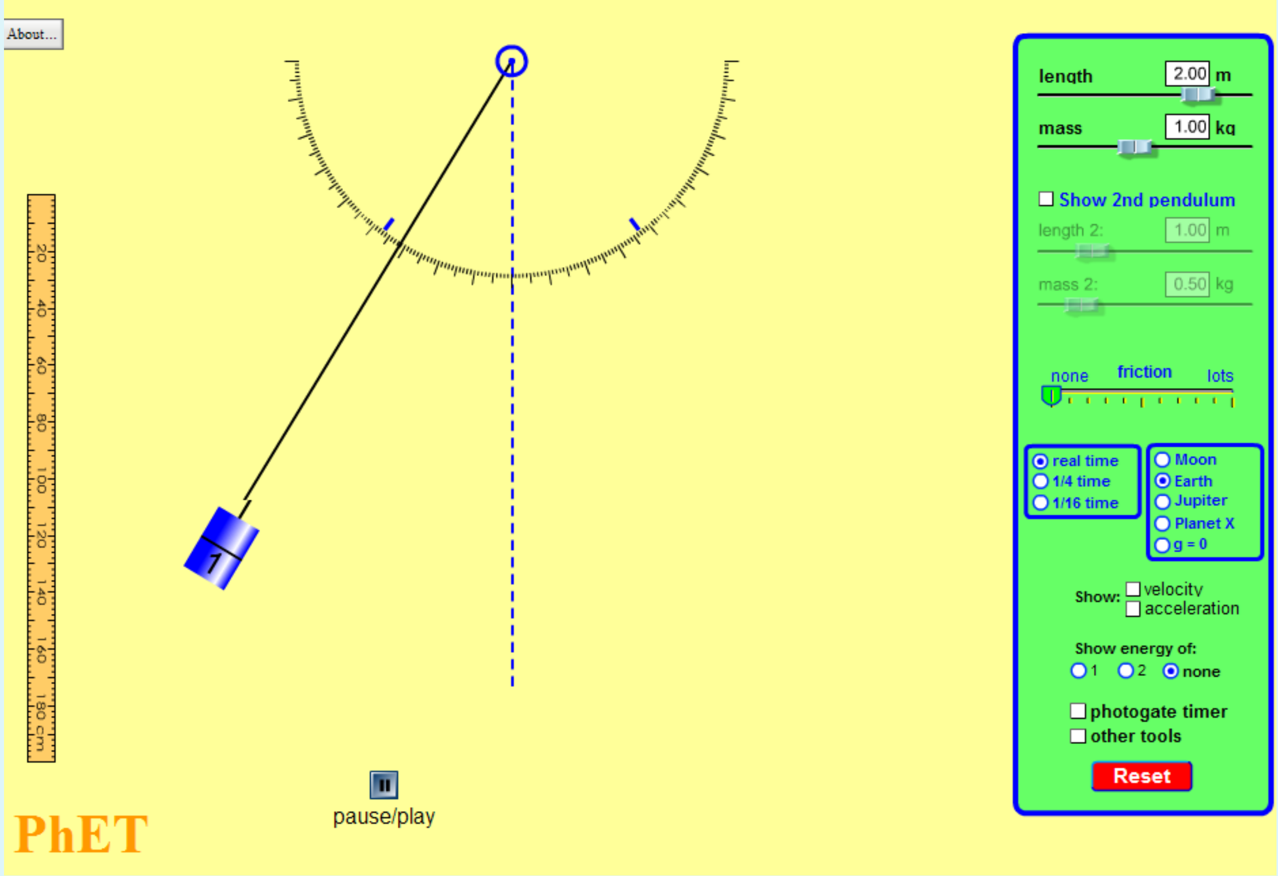
Shifts in Practice for NGSS



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**



Shifting Instructional Practice: **Experimentation**

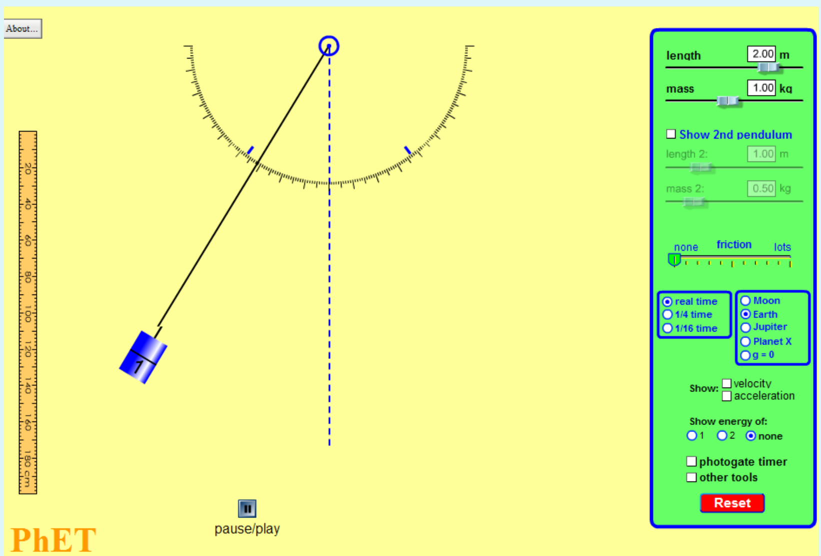
Conventional Science Instruction

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^o 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^o, 30^o and so on down to 10^o
- 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**

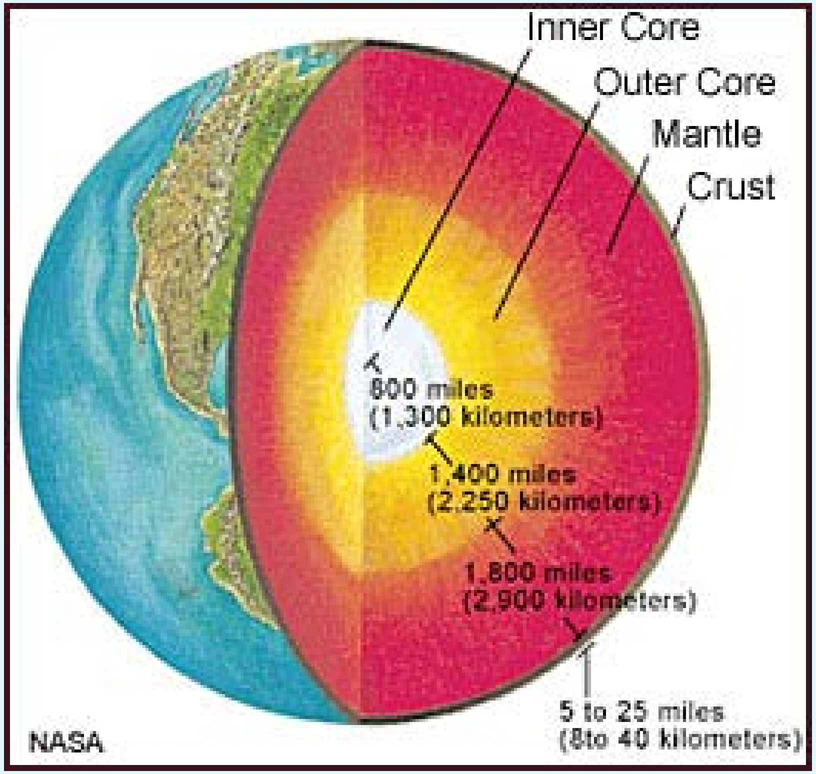
Shifts in Practice for NGSS



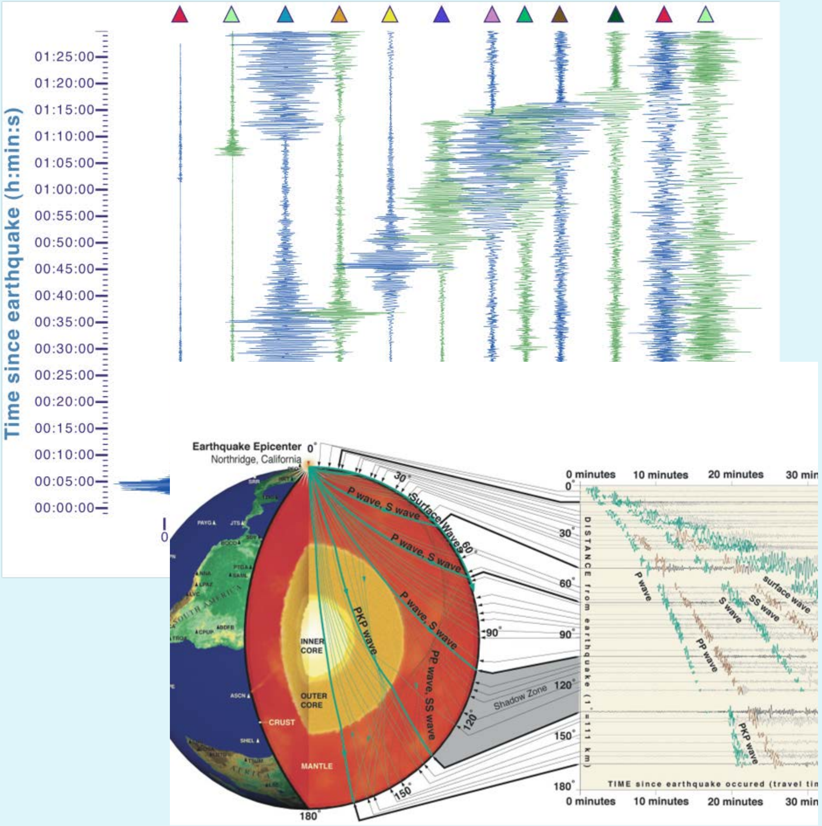
- What questions do you have about the motion of a pendulum?
- How might you use this simulation to answer your questions?
- What kind of models might you develop to represent the motion of the pendulum?

Shifting Instructional Practice: **Scientific Models**

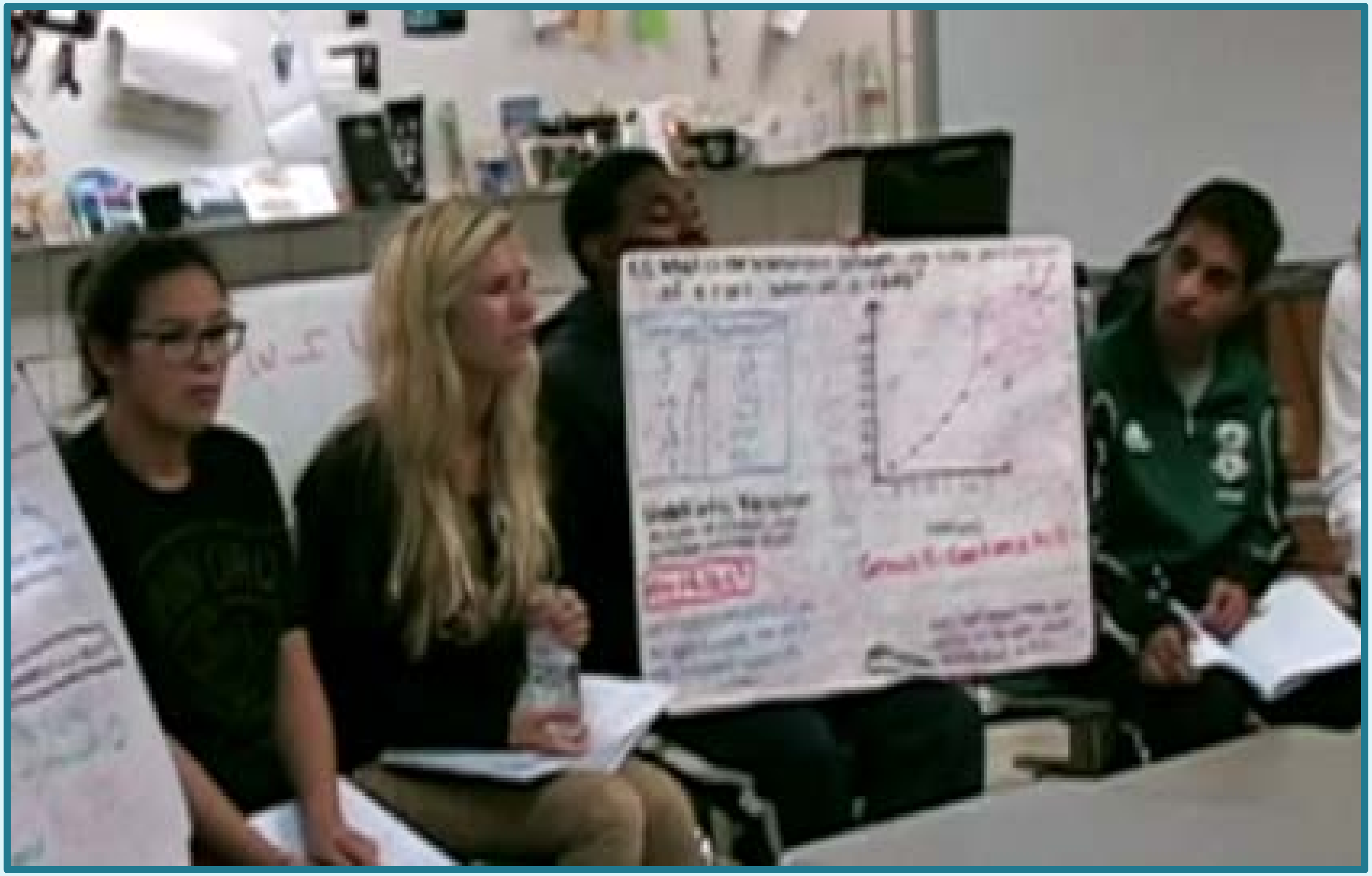
Conventional Science Instruction



Shifts in Practice for NGSS



Shifting Instructional Practice: **Social Interaction**



http://video.oakland.k12.mi.us/show?video=1f51af69ce9a&apg=bff02a13

In summary, it is a shift…

From **telling** our kids the science

TO

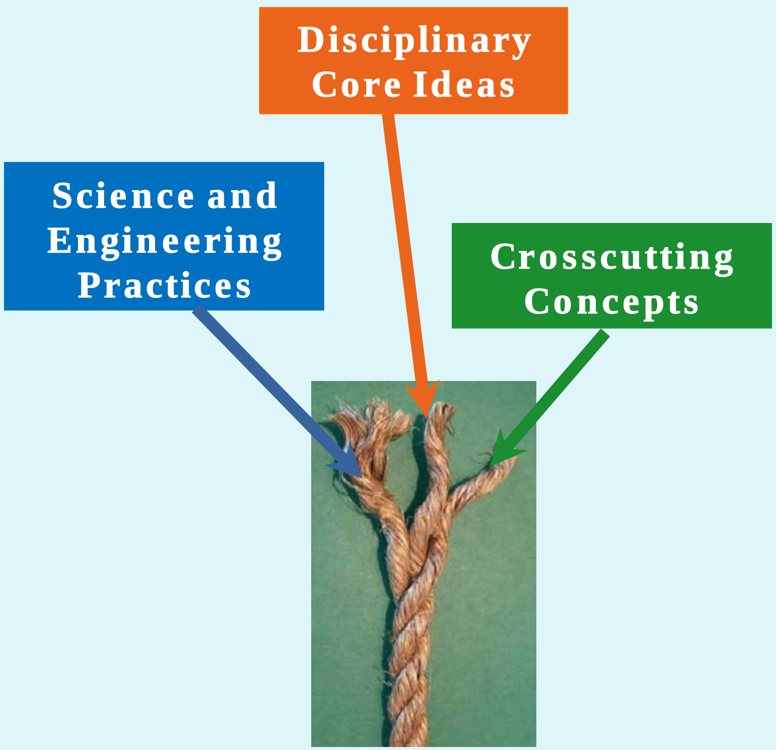
creating learning opportunities that help them **figure out** the science.

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

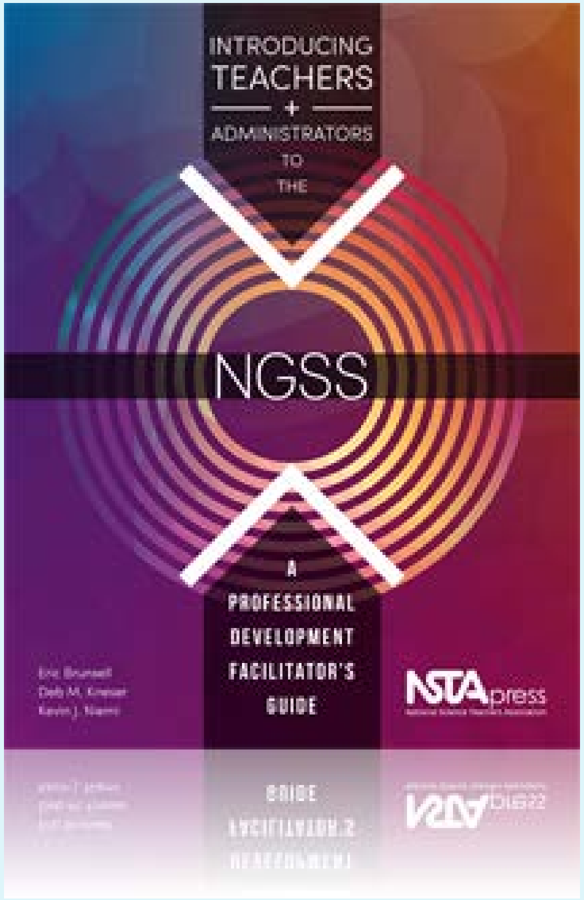
- Where do you put Earth Science…
- Modeling Curriculum
- *Interactions for Physical Science*
- *Model Based Biology*

M-STEP Changes

- 2018 - Pilot test in 5th, 8th and 11th; length is ½ 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

M-Step
Michigan Student Test of Educational Progress

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