LIVE INTERACTIVE LEARNING @ YOUR DESKTOP

Engineering Practices in the Next Generation Science Standards

Presented by: Mariel Milano

January 15, 2013
6:30 p.m. – 8:00 p.m. Eastern time
Introducing today’s presenters...

Ted Willard
Director of NSTA’s efforts around NGSS

Mariel Milano
P-SELL and STEM Coordinator
Orange County Public Schools
NSTA’s Role in NGSS
NGSS Second Public Draft released January 8

Unprecedented to have such widespread involvement of so many states and stakeholders—including classroom teachers—involVED in science standards development

NGSS will have a profound influence on curriculum, assessment, and teacher professional development in the years ahead

NSTA encourages all teachers to review the NGSS draft and provide feedback to Achieve by January 29
NSTA role with the NGSS

- One of four partners in a state-led process, including
  - The National Academies of Science (the NRC)
  - Achieve Inc.
  - National Science Teachers Association
  - American Association for the Advancement of Science

- Provided guidance and reviews directly to the National Research Council and Achieve

- Provided names of teachers for writers on the writing teams
NGSS Lead State Partners
NSTA Outreach

- Inform science education community about the NGSS draft
- Encourage science educators to have a voice by engaging in the review process
- Help educators study and learn more about the document
Did you attend last fall’s web seminar series on the practices in NGSS?

A. Yes, I attended 1-4 seminars in the series.
B. Yes, I attended 5-8 seminars in the series.
C. No, I did not attend any seminars in the series.
NSTA Resources on NGSS

www.nsta.org
NSTA Resources on NGSS

www.nsta.org
NSTA Resources on NGSS

www.nsta.org/ngss
For More Information from NSTA

- [www.nsta.org/ngss](http://www.nsta.org/ngss)

- Email: ngss@nsta.org
The Role of Technology and Engineering in the Next Generation Science Standards Science and Engineering Practices

Mariel Milano - NGSS Writing Team Member
Learning Goal

• The participants will be able to understand the role of the engineering practices in NGSS

They will do this by:

• Learning how the framework defines and utilizes engineering and technology
• Comparing and contrasting the science and engineering practices
• Discussing an example of a draft performance expectation in the classroom setting
<table>
<thead>
<tr>
<th>Rating</th>
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</table>
| 4      | I can do all of (1), (2), and (3) as well as  
• explain the role of the engineering practices in the NGSS to a peer using a sample performance task |
| 3      | I can do all of (1) and (2) as well as  
• explain the role of engineering practices in the NGSS  
• explain how engineering presents itself in each of the practices |
| 2      | I can do all of (1) as well as  
• explain how engineering is integrated throughout the NGSS |
| 1      | I can ...  
• define in my own words the terms engineering and technology |
| 0      | • This is my first learning experience dealing with engineering |
The Elephant in the Room

Time

Funding

Change
The Elephant in the Room

Engineering
Segment One - Guiding Questions

- How does engineering influence society and the natural world now?
- What conceptual shifts in NGSS deal with engineering?
- What is technology?
- How are engineering, technology, and innovation related?
- How is engineering integrated into NGSS?
"Scientists investigate that which already is; Engineers create that which has never been."
Conceptual Shifts in the NGSS

1. K–12 Science Education Should Reflect the Real World Interconnections in Science as it is Practiced and Experienced in the Real World.

2. The Next Generation Science Standards are student performance expectations – NOT curriculum.


4. The NGSS Focus on Deeper Understanding of Content as well as Application of Content.

5. Science and Engineering are Integrated in NGSS from K-12.

6. The NGSS and Common Core State Standards (English Language Arts and Mathematics are Aligned) Coordination with Common Core State Standards
Barriers to Interpreting Engineering in NGSS

• Multiple Meaning Words
  – Engineering
  – Technology

• Lack of Concrete Personal Experience Using Engineering in a Science Classroom
What is Technology?

Place clip art under one or more technologies.
What is Technology?

• “...all of the ways that people have modified the natural world to meet their basic needs and to realize their dreams.”

[Image of various objects and icons related to technology and nature]
What is Technology?
An object being classified as technology is dependent on time and place it was developed.

Technology is more than “electronics”
Technology Over Time

- Some ancient forms of technology pre-date the formal discipline of engineering and scientific understanding of the technology.
- The NGSS focus on the formal discipline of engineering and its associated practices.
The Technological Trio

Engineering

TECHNOLOGY

Innovation

Invention
1. Central role of science and engineering practices

2. NGSS will require the contextual application of the three dimensions by students
Organization of the NGSS

Currently Organized by Disciplinary Content

- Physical Science
- Life Science
- Earth-Space Science
- Engineering

K-5
- Grade By Grade
  - Engineering practices and content are integrated into performance expectations

6-8
- Grade Banded
  - Engineering practices and content are integrated into performance expectations

9-12
- Grade Banded
  - Engineering practices and content are integrated into performance expectations
## Sample Engineering Integration in NGSS

### Engineering in Grades 6 through 8

<table>
<thead>
<tr>
<th>Grade / Grade-Level</th>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Idea</th>
<th>Cross-Cutting Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>MS-PS1-b.</td>
<td>MS-PS1-b.</td>
<td>MS-PS1-b.</td>
</tr>
<tr>
<td></td>
<td>MS-PS1-g.</td>
<td>MS-PS1-g.</td>
<td>MS-PS1-f.</td>
</tr>
<tr>
<td></td>
<td>MS-PS2-a.</td>
<td>MS-PS2-a.</td>
<td>MS-PS2-a.</td>
</tr>
<tr>
<td></td>
<td>MS-PS2-c.</td>
<td>MS-PS2-c.</td>
<td>MS-PS2-f.</td>
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<tr>
<td></td>
<td>MS-PS3-c.</td>
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</tr>
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<td></td>
<td>MS-PS3-g.</td>
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</tr>
<tr>
<td></td>
<td>MS-PS4-c.</td>
<td>MS-PS4-c.</td>
<td>MS-PS4-c.</td>
</tr>
<tr>
<td></td>
<td>MS-LS1-a.</td>
<td>MS-LS1-a.</td>
<td>MS-LS1-a.</td>
</tr>
<tr>
<td></td>
<td>MS-LS1-d.</td>
<td>MS-LS1-d.</td>
<td>MS-LS1-d.</td>
</tr>
<tr>
<td></td>
<td>MS-LS2-c.</td>
<td>MS-LS2-g.</td>
<td>MS-LS2-g.</td>
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<tr>
<td></td>
<td></td>
<td>MS-LS2-i.</td>
<td>MS-LS2-i.</td>
</tr>
<tr>
<td></td>
<td>MS-LS4-c.</td>
<td>MS-LS4-g.</td>
<td>MS-LS4-i.</td>
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<td></td>
<td>MS-LS4-i.</td>
<td>MS-LS4-j.</td>
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<td>MS-ESS1-d.</td>
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<td></td>
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<td>MS-ESS1-e.</td>
</tr>
<tr>
<td></td>
<td>MS-ESS3-c.</td>
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### Notes:

- MS refers to Middle School.
- The table outlines how specific engineering practices align with disciplinary core ideas and cross-cutting concepts in grades 6 through 8.
- Each cell indicates the specific integration point between the science and engineering practices and the related core ideas and concepts.
<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
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<tbody>
<tr>
<td>Asking Questions and Defining Problems</td>
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Engineering DCI’s

ETS1: Engineering Design
ETS1.A: Defining and Delimiting an Engineering Problem
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution

ETS2: Links Among Engineering, Technology, Science, and Society
ETS2.A: Interdependence of Science, Engineering, and Technology
ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World
1. Interdependence of Science, Engineering, and Technology;

2. Influence of Science, Engineering and Technology on Society and the Natural World

**This is currently treated similar to crosscutting concepts, but are not additional crosscutting concepts as defined by the Framework**
S1. Ask questions & define problems
S2. Develop and use models
S3. Plan & carry out investigations
S4. Analyze & interpret data
S5. Use mathematics & computational thinking
S6: Constructing Explanation and Designing Solutions
S7: Obtaining & Communicating Information

ETS1A: Defining and Delimiting an Engineering Problem
ETS1B: Developing Possible Solutions
ETS1C: Optimizing the Design Solution
ETS2A: Independence of Science, Engineering, and Technology
ETS2B: Influence of Engineering, Technology and Science on Society
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|        |  technology |
| 0      | • This is my first learning experience dealing with  
|        |  engineering |
Questions...
Segment Two - Guiding Questions

- Is inquiry the same as practices?
- Does engineering have a role in each practice?
- What does a performance that uses engineering practices look like?
Poll the Audience

Are inquiry and practices the same?

*Place a piece of clip art below your belief.*

Yes  I am unsure  No
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### Shift From Inquiry to Practices

#### Planning and Carrying Out Investigations

<table>
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<tr>
<th>Asking Questions and Defining Problems</th>
<th>Analyzing and Interpreting data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing and Using Models</td>
<td>Using Mathematical and Computational Thinking</td>
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<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>Engaging in Argument from Evidence</td>
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<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
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### Shift From Inquiry to Practices

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<th></th>
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A Balanced Approach

- Literacy and proficiency in inquiry and design *may not* be accomplished by all students through sheer immersion in investigation or invention.

- Targeted performances using specific practice(s) to demonstrate understanding of a specific disciplinary core idea promote accountability to behavior indicative of college and career readiness.
Striking a Balance

Science

Engineering
**MS-P3-c. Design, construct, and test a device that either minimizes or maximizes thermal energy transfer by conduction, convection, and/or radiation.**

*Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup. Care should be taken with devices that concentrate significant amounts of energy. [Assessment Boundary: Quantitative measures of thermal energy transfer are not assessed.]*

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</table>
| **Constructing Explanations and Designing Solutions** | **PS3.A: Definitions of Energy**  
• Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-P3-c), (MS-P3-d) | **Energy and Matter**  
• Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-P3-c), (MS-P3-e), (MS-P3-g) |
| | **PS3.B: Conservation of Energy and Energy Transfer**  
• Energy is transferred out of hotter regions or objects and into colder ones by the processes of conduction, convection, and radiation. (MS-P3-c) | |
Designing a Solar Oven

One example of a performance task from the clarifying statement that, if constructed correctly, would provide students the opportunity to accomplish the performance.

Examples are suggestions - NOT prescriptions!
Engineering DCI’s for this Performance

**ETS1.A: Defining and Delimiting an Engineering Problem**

- The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful.
- Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.

**ETS1.B: Developing Possible Solutions**

- A solution needs to be tested, and then modified on the basis of the test results in order to improve it.
- There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.

**ETS1.C: Optimizing the Design Solution**

- Comparing different designs could involve running them through the same kinds of tests and systematically recording the results to determine which design performs best.
Designing a Solar Oven

This is ONLY a performance outcome - NOT curriculum!

That means that it will be the work of curriculum designers to develop a lesson(s) on the underlying content/concepts that would pre-date this performance in a student’s experience.
Mistaken Identity... or Purpose

• Solar ovens are used all the time in science classrooms already.... So.... *What’s different?!*

• Now, solar ovens are often used in science classrooms to illustrate a phenomena *or* as a vehicle to collect data on temperature

• In this example, the focus is **on the engineering** as means to assess the understanding of both science and engineering
The goal of **science** is the construction of theories that can provide explanatory accounts of features of the world. A theory becomes accepted when it has been shown to be superior to other explanations in the breadth of phenomena it accounts for and in its explanatory coherence and parsimony. Scientific explanations are explicit applications of theory to a specific situation or phenomenon, perhaps with the intermediary of a theory-based model for the system under study. The goal for students is to construct logically coherent explanations of phenomena that incorporate their current understanding of science, or a model that represents it, and are consistent with the available evidence.

**Engineering design**, a systematic process for solving engineering problems, is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technological feasibility, cost, safety, esthetics, and compliance with legal requirements. There is usually no single best solution but rather a range of solutions. Which one is the optimal choice depends on the criteria used for making evaluations.
Connect Example to...
Constructing Explanations and Designing Solutions

MS- PS3.c. *Design, construct* and test a device that either minimizes or maximizes thermal energy transfer by conduction, convection, or radiation.

<table>
<thead>
<tr>
<th>If the focus was on <em>Science Practices</em> students would</th>
<th>The focus is on <em>Engineering Practices</em> so students will</th>
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</thead>
<tbody>
<tr>
<td>• Use the results of what happened in the oven as evidence to construct explanations for energy transfer</td>
<td>• Discuss various solutions based on previous scientific investigations</td>
</tr>
<tr>
<td></td>
<td>• Decide on a design that best meets the criteria and constraints</td>
</tr>
<tr>
<td></td>
<td>• Develop a design blueprint</td>
</tr>
<tr>
<td></td>
<td>• Construct the device</td>
</tr>
<tr>
<td><strong>Science</strong> begins with a question about a phenomenon, such as “Why is the sky blue?” or “What causes cancer?,” and seeks to develop theories that can provide explanatory answers to such questions. A basic practice of the scientist is formulating empirically answerable questions about phenomena, establishing what is already known, and determining what questions have yet to be satisfactorily answered.</td>
<td><strong>Engineering</strong> begins with a problem, need, or desire that suggests an engineering problem that needs to be solved. A societal problem such as reducing the nation’s dependence on fossil fuels may engender a variety of engineering problems, such as designing more efficient transportation systems, or alternative power generation devices such as improved solar cells. Engineers ask questions to define the engineering problem, determine criteria for a successful solution, and identify constraints.</td>
</tr>
</tbody>
</table>
Connect Example to...
Asking Questions and Defining Problems

MS- PS3.c. Design, construct and test a device that either *minimizes or maximizes thermal energy transfer by conduction, convection, or radiation.*

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<tr>
<td>• Use the results of what happened in the oven as evidence to construct explanations for energy transfer</td>
<td>• Ask questions to determine criteria and constraints</td>
</tr>
<tr>
<td></td>
<td>• Design a solar cooker hot enough to make applesauce from apples (<em>criteria</em>)</td>
</tr>
<tr>
<td></td>
<td>• Design a solar cooker that uses a pizza box and only two feet of tin foil (<em>constraints</em>)</td>
</tr>
</tbody>
</table>
Scientific investigation may be conducted in the field or the laboratory. A major practice of scientists is planning and carrying out a systematic investigation, which requires the identification of what is to be recorded and, if applicable, what are to be treated as the dependent and independent variables (control of variables). Observations and data collected from such work are used to test existing theories and explanations or to revise and develop new ones.

Engineers use investigation both to gain data essential for specifying design criteria or parameters and to test their designs. Like scientists, engineers must identify relevant variables, decide how they will be measured, and collect data for analysis. Their investigations help them to identify how effective, efficient, and durable their designs may be under a range of conditions.
Connect Example to...
Planning and Carrying Out Investigations

MS- PS3.c. Design, construct and *test a device* that either minimizes or maximizes thermal energy transfer by conduction, convection, or radiation.

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<tr>
<td>• Test the device and collect data on air, water, or food to measure increase in temperature over time to demonstrate conversion of solar to thermal energy</td>
<td>• Test the device to see if the apples had turned into applesauce</td>
</tr>
<tr>
<td>• Identify and control variables</td>
<td>• If applesauce is not created, identify what could be done to improve it</td>
</tr>
<tr>
<td></td>
<td>• Identify and control variables</td>
</tr>
</tbody>
</table>
Science often involves the construction and use of a wide variety of models and simulations to help develop explanations about natural phenomena. Models make it possible to go beyond observables and imagine a world not yet seen. Models enable predictions of the form “if . . . then . . . therefore” to be made in order to test hypothetical explanations.

Engineering makes use of models and simulations to analyze existing systems so as to see where flaws might occur or to test possible solutions to a new problem. Engineers also call on models of various sorts to test proposed systems and to recognize the strengths and limitations of their designs.
Connect Example to...
Developing and Using Models

MS- PS3.c. Design, construct and test a device that either minimizes or maximizes thermal energy transfer by conduction, convection, or radiation.

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<tbody>
<tr>
<td>• Use the model of the solar cooker to test their hypothesis about thermal energy transfer</td>
<td>• Use model of a solar cooker to test how well it maximizes thermal energy</td>
</tr>
<tr>
<td></td>
<td>• Model can be a physical model or a simulation</td>
</tr>
<tr>
<td></td>
<td>• This may be different than the constructed device</td>
</tr>
</tbody>
</table>
**Scientific investigations** produce data that must be analyzed in order to derive meaning. Because data usually do not speak for themselves, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Sources of error are identified and the degree of certainty calculated. Modern technology makes the collection of large data sets much easier, thus providing many secondary sources for analysis.

**Engineers** analyze data collected in the tests of their designs and investigations; this allows them to compare different solutions and determine how well each one meets specific design criteria—that is, which design best solves the problem within the given constraints. Like scientists, engineers require a range of tools to identify the major patterns and interpret the results.
MS- PS3.c. Design, construct and test a *device* that either minimizes or maximizes thermal energy transfer by conduction, convection, or radiation.

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<tbody>
<tr>
<td>• Analyze the data to determine patterns in temperature indicating energy transfer</td>
<td>• Analyze the data from the tests of several models of solar cookers to see which best meets the criteria of maximizing energy transfer and the constraints</td>
</tr>
</tbody>
</table>
In **science**, reasoning and argument are essential for identifying the strengths and weaknesses of a line of reasoning and for finding the best explanation for a natural phenomenon. Scientists must defend their explanations, formulate evidence based on a solid foundation of data, examine their own understanding in light of the evidence and comments offered by others, and collaborate with peers in searching for the best explanation for the phenomenon being investigated.

In **engineering**, reasoning and argument are essential for finding the best possible solution to a problem. Engineers collaborate with their peers throughout the design process, with a critical stage being the selection of the most promising solution among a field of competing ideas. Engineers use systematic methods to compare alternatives, formulate evidence based on test data, make arguments from evidence to defend their conclusions, evaluate critically the ideas of others, and revise their designs in order to achieve the best solution to the problem at hand.
Connect Example to...
Engaging in Argument from Evidence

**MS- PS3.c.** Design, construct and test a device that either minimizes or maximizes thermal energy transfer by conduction, convection, or radiation.

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<td>• Use evidence from test to support or defend a claim about the transfer of energy</td>
<td>• Use evidence from tests to construct an argument for which design best meets the criteria and constraints</td>
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Science cannot advance if scientists are unable to communicate their findings clearly and persuasively or to learn about the findings of others. A major practice of science is thus the communication of ideas and the results of inquiry—orally, in writing, with the use of tables, diagrams, graphs, and equations, and by engaging in extended discussions with scientific peers. Science requires the ability to derive meaning from scientific texts (such as papers, the Internet, symposia, and lectures), to evaluate the scientific validity of the information thus acquired, and to integrate that information.

Engineers cannot produce new or improved technologies if the advantages of their designs are not communicated clearly and persuasively. Engineers need to be able to express their ideas, orally and in writing, with the use of tables, graphs, drawings, or models and by engaging in extended discussions with peers. Moreover, as with scientists, they need to be able to derive meaning from colleagues’ texts, evaluate the information, and apply it usefully. In engineering and science alike, new technologies are now routinely available that extend the possibilities for collaboration and communication.
Connect Example to...
Obtaining, Evaluating, and Communicating Information

MS- PS3.c. Design, construct and test a device that either minimizes or maximizes thermal energy transfer by conduction, convection, or radiation.

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<tr>
<td>• Communicate information about findings from research and investigations</td>
<td>• Communicate in oral, written, or digital form about the most effective design solution</td>
</tr>
<tr>
<td>• Obtain information about energy transfer</td>
<td>• Obtain information about thermal energy considerations in oven design</td>
</tr>
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Check Your Progress 😊

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        • explain the role of engineering practices in the NGSS  
        • explain how engineering presents itself in each of the practices |
| 2      | I can do all of (1) as well as...  
        • explain how engineering is integrated throughout the NGSS |
| 1      | I can ...  
        • define in my own words the terms engineering and technology |
| 0      | • This is my first learning experience dealing with engineering |

64
It's QUESTION TIME!!
### Science and Engineering Practices Matrix

<table>
<thead>
<tr>
<th>Grades K-2</th>
<th>Grades 3-5</th>
<th>Grades 6-8</th>
<th>Grades 9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking questions and defining problems in grades K–2 builds on prior</td>
<td>Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.</td>
<td>Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to formulating and refining empirically</td>
<td>Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating</td>
</tr>
<tr>
<td>experiences and progresses to simple descriptive questions that can be</td>
<td>• Identify scientific (testable) and non-scientific (non-testable) questions. (4th Grade)</td>
<td>testable models to explain phenomena or solve problems.</td>
<td>empirically testable questions and design solutions using models and simulations.</td>
</tr>
<tr>
<td>tested.</td>
<td>• Ask questions based on careful observations of phenomena and information.</td>
<td>• Ask questions that arise from careful observation of phenomena, models, or unexpected results.</td>
<td>• Ask questions that arise from careful observation of phenomena, models, theory, or unexpected results.</td>
</tr>
<tr>
<td>• Ask questions based on observations of the natural and/or designed</td>
<td>• Ask questions to clarify ideas or request evidence.</td>
<td>• Ask questions to clarify or identify evidence and the premise(s) of an argument.</td>
<td>• Ask questions that require relevant empirical evidence to answer.</td>
</tr>
<tr>
<td>world.</td>
<td>• Ask questions that relate one variable to another variable.</td>
<td>• Ask questions to determine relationships between independent and dependent variables.</td>
<td>• Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.</td>
</tr>
<tr>
<td>• Define a simple problem that can be solved through the development of</td>
<td>• Ask questions to clarify the constraints of solutions to a problem.</td>
<td>• Ask questions that challenge the interpretation of a data set.</td>
<td>• Ask and evaluate questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design.</td>
</tr>
<tr>
<td>a new or improved object or tool.</td>
<td>Use prior knowledge to describe problems that can be solved.</td>
<td>• Ask questions to clarify and refine a model, an explanation, or an engineering problem.</td>
<td>• Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may</td>
</tr>
<tr>
<td></td>
<td>Define a simple design problem that can be solved through the development of an object, tool, or process and includes several criteria for</td>
<td>Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and</td>
<td>include social, technical and/or environmental considerations.</td>
</tr>
<tr>
<td></td>
<td>success and constraints on materials, time, or cost.</td>
<td>constraints, including scientific knowledge that may limit possible solutions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.</td>
<td>• Formulate a question that can be investigated within the scope of the classroom, school laboratory, or field with available resources and,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>when appropriate, frame a hypothesis (a possible explanation that predicts a particular and stable outcome) based on a model or theory.</td>
<td></td>
</tr>
</tbody>
</table>
MATH

M1. Make sense of problems & persevere in solving them

M2. Reason abstractly & quantitatively

M3. Construct viable argument & critique reasoning of others

M4. Model with mathematics

M5. Use appropriate tools strategically

M6. Attend to precision

M7. Look for & make use of structure

M8. Look for & express regularity in repeated reasoning

SCIENCE

S1. Ask questions & define problems

S2. Develop and use models

S3. Plan & carry out investigations

S4. Analyze & interpret data

S5. Use mathematics & computational thinking

S6. Construct explanations & design solutions

S7. Engage in argument from evidence

S8. Obtain, evaluate & communicate information

E1. Demonstrate independence

E2. Build strong content knowledge

E3. Respond to the varying demands of audience, talk, purpose, & discipline

E4. Comprehend as well as critique

E5. Value evidence

E6. Use technology & digital media

E7. Come to understand other perspectives & cultures

E8. Obtain, evaluate & communicate information

Source: Working Draft v.4, 12-6-11 by Tina Cheuk, ell.stanford.edu
MATH

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M3. Construct viable argument & critique reasoning of others

S7. Engage in argument from evidence

E1. Demonstrate independence
E3. Respond to the varying demands of audience, talk, purpose, & discipline
E7. Come to understand other perspectives & cultures

ELA

Source: Working Draft v.4, 12-6-11 by Tina Cheuk, ell.stanford.edu
Resources for Continued Exploration

**Current Next Generation Science Standards Draft**
(http://nextgenscience.org/next-generation-science-standards)
- Appendix F: Science and Engineering Practices Matrix
- Appendix I: Engineering, Technology, and the Applications of Science

**Framework for Science Education**
(http://www.nap.edu/catalog.php?record_id=13165)
- Chapter 3: Science and Engineering Practices
- Chapter 8: Engineering, Technology, and the Applications of Science
NSTA Resources
About NGSS
NSTA Resources on NGSS

www.nsta.org
NSTA Resources on NGSS

www.nsta.org/ngss
Below are group forums that you may join. Post to existing topics or start your own! All NSTA resources, personally uploaded resources, and collections may be shared and commented upon within these discussions.

**Pedagogy and Research Forums**

<table>
<thead>
<tr>
<th>Forum</th>
<th>Topics</th>
<th>Posts</th>
<th>Last Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation and Assessment</td>
<td>35</td>
<td>401</td>
<td>by Susan German, Wed Sep 12, 2012 10:25 PM Science Lessons for Inclusion Students</td>
</tr>
<tr>
<td>New Teachers</td>
<td>11</td>
<td>145</td>
<td>by Mary Bigelow, Thu Sep 13, 2012 6:20 PM New Teacher Question</td>
</tr>
<tr>
<td><strong>Next Generation Science Standards</strong></td>
<td>5</td>
<td>22</td>
<td>by Wendy Ruchti, Today, 10:33 AM CCSS and NGSS</td>
</tr>
<tr>
<td>Professional Development</td>
<td>67</td>
<td>754</td>
<td>by Adah Stock, Wed Sep 12, 2012 4:33 PM WestEd New Series &quot;Making Sense of Science&quot;</td>
</tr>
</tbody>
</table>
NSTA Print Resources

NSTA Reader’s Guide to the Framework

NSTA Journal Articles about the Framework and the Standards
NSTA National Conference

San Antonio, Texas
April 11-14
Upcoming NSTA Web Seminars about NGSS

- **Engineering Practices in the NGSS**
  Mariel Milano, Orange County Public Schools & NGSS Writer
  6:30-8:00, on Tuesday, January 15\(^{th}\)

- **Using the NGSS Practices in the Elementary Grades**
  Heidi Schweingruber, National Research Council
  and Deborah Smith, Pennsylvania State University
  6:30-8:00, on Tuesday, January 29\(^{th}\)

- **Connections between the Practices in NGSS, Common Core Math, and Common Core ELA**
  Sarah Michaels, Clark University and author of *Ready, Set, Science*
  6:30-8:00, on Tuesday, February 12\(^{th}\)
on Crosscutting Concepts

Feb. 19: Patterns
March 5: Cause and effect: Mechanism and explanation
March 19: Scale, proportion, and quantity
April 2: Systems and system models
April 16: Energy and matter: Flows, cycles, and conservation
April 30: Structure and function
May 14: Stability and change

All sessions will take place from 6:30-8:00 on Tuesdays

Also, archives of last fall’s web seminars about the Scientific and Engineering Practices are available
The End
Thanks to today’s presenters…

Ted Willard
Director of NSTA’s efforts around NGSS

Mariel Milano
P-SELL and STEM Coordinator
Orange County Public Schools
Thank you to the sponsor of today’s web seminar:

This web seminar contains information about programs, products, and services offered by third parties, as well as links to third-party websites. The presence of a listing or such information does not constitute an endorsement by NSTA of a particular company or organization, or its programs, products, or services.
NSTA Web Seminars

Brynn Slate, Manager
Jeff Layman, Technical Coordinator