2015 Workshop & Exhibition: “Empowering the 21st Century Student”

Changes in Curriculum, Instruction & Assessment with the NGSS

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About the Speaker

- Thomas Misiak
- 6-12 Content Supervisor Mathematics, Science, World Languages, Business & Technology
- Former High School Science Teacher
  - Physical Science Cert.
  - Taught Chemistry, Physics, Geophysical Science & Environmental Science
- Background with NGSS
  - Participant/Presenter at Rider & Princeton Universities on AAAS Science Atlases
  - Presenter 2013, 2014 & 2015 at NJ Science Convention on NGSS
  - Member 19 District Consortium on NGSS
    - Currently working in grade level teams to develop model lessons
Agenda

- Quick Over of NGSS
- Changes in Content/Courses
  - Grade/Level Structure
  - Course Sequencing
- Changes in Labs
  - Instruction
  - Assessment
- Revising Curricula
  - Model Template
  - Data & Experiences
- Resources
Agenda Item 1: Overview NGSS
Two Main Areas:

1) Standards Themselves
   - Viewable 3 Ways
     - I prefer DCIs (disciplinary core ideas)
   - Arranged in Grade Bands
     - K-5 (elementary)
     - 6-8 (middle school)
     - 9-12 (high school)
   - Can search by grade or DCI

Performance Expectations by Topic
Click on a topic to view associated performance expectations.
Searching the NGSS

In the example search I selected:

❖ DCI for PS1A: Structure & Properties of Matter

❖ Limited to the Middle School (grades 6-8)
  • Response yielded two topics:
    • MS: Structure & Properties of Matter
    • MS: Chemical Reactions
# Looking at Topics in NGSS

## MS. Structure and Properties of Matter

How to read the standards »
Go back to search results
Related Content »

Views: Disable Popups / Black and white / Practices and Core Ideas / Practices and Crosscutting Concepts / PDF

<table>
<thead>
<tr>
<th>Students who demonstrate understanding can:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MS-PS1-1.</strong> Develop models to describe the atomic composition of simple molecules and extended structures.**</td>
</tr>
<tr>
<td><strong>Clarification Statement:</strong> Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms. <strong>Assessment Boundary:</strong> Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.</td>
</tr>
</tbody>
</table>

| **MS-PS1-3.** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. **Clarification Statement:** Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels. **Assessment Boundary:** Assessment is limited to qualitative information. |

| **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. **Clarification Statement:** Emphasis is on 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 until a change of state occurs. Examples of models could include drawing and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium. |

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

**Science and Engineering Practices**

- Developing and Using Models
- Obtaining, Evaluating, and Communicating Information

**Disciplinary Core Ideas**

  - Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
  - Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to

**Crosscutting Concepts**

- Cause and Effect
  - Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4)

- Scale, Proportion, and Quantity
  - Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1)
Most Important Part: Performance Expectations (white)

- Defines what students should know/should be capable of demonstrating

- The Science & Engineering Practices, DCIs, and Crosscutting Concepts all relate back to the Performance Expectations
Breakdown (cont.)

No aspect of the NGSS was designed as a stand-alone

• Practices- define what types of things the students should be doing

• DCIs- comparable to enduring understandings

• Crosscutting Concepts- explain how this topic is connected to previous grades/other science courses
Worth noting:

• The Common Core for LAL and Math are linked to the NGSS
• NGSS are not the Common Core
  • Overlap is noted to help with cross-curricular initiatives
2) Appendices

- Most Notable:
  - E: DCIs
  - F: Science & Engineering Practices
  - G: Crosscutting Concepts
  - K- Model Course Sequencing
Focus Ahead on Curriculum

Need to understand NGSS to revise science curricula

❖ To understand NGSS:
  ❖ Understand the arrangement of the standards
  ❖ Appendices E, F & G
  ❖ NRC Framework for K-12 Science Education
    ❖ Immensely helpful read for those writing the curriculum, those teaching the curriculum, and those evaluating the instructors
Agenda Item 2: Changes in Content & Courses
WARNING

NGSS is not a Curriculum

Topics are not Units
Breakdown

Three main focus areas:

❖ Elementary: Grades K-5
❖ Middle School: Grades 6-8
❖ High School: Grades 9-12

*The NGSS do not dictate the structure of your buildings/district BUT as far as aligning instruction teachers do need to be mindful of the organization noted above
Important Deadlines

❖ Middle School & High School (Grades 6-12)
  ❖ New curriculum approved prior to Sept. 1 2016
❖ Elementary School (Grades K-5)
  ❖ New curriculum approved prior to Sept. 1 2017

NJ ASK Science Grades 4 & 8 and NJ BCT will reflect NGSS following these adoption dates
Elementary

K-5
Elementary K-5

Standards are written to dictate which topics fall into which grades

Elementary can be subdivided:

• K-2: Three topics per grade
• 3-5: Four topics per grade
Elementary Elephants in the Room

❖ Teachers are not necessarily content experts
❖ Science is not tested annually like Math and LAL
  ❖ In many schools:
    ❖ LAL Every Day
    ❖ Math Every Day
    ❖ Science, Social Studies & “Specials” rotate
What to Do

❖ Teachers will need Support & Training
  ❖ Use 6-12 content certified staff to turnkey lessons & labs
  ❖ Invest in Curricular Materials & Resources
    ❖ An NGSS sticker does not make a resource aligned
      ❖ It will be difficult to find a “curriculum in a box” program 100% aligned to NGSS
    ❖ Recommend use of a “textbook adoption” form to be filled out by instructor
  ❖ Some districts considering/using the “science on a cart” content certified teacher K-5
Example “Adoption Form”

Name of Proposed Resource: ________________
Vendor / Manufacturer: ________________
Quantity per Student: __________ |
Quote per item: ______ |
Cost Per Pupil: _____ |
Grade Level(s): _____ |
Topics noted in NGSS for Corresponding Grade Level(s):
_____________________________________________________________

Does this resource address all topic identified by the NGSS (y/n): ______
If no- does this resource address a single topic identified by the NGSS (y/n): ___
LAL and Math dominate the schedule K-5.

How does science fit?

• Curricula need to be written to reflect time available
  • NGSS does not mandate science every day BUT starting an activity and visiting it once every so often for a month is not effective
  • Connect science lessons/units to reading program
    • LAL introduces topic
    • Science lesson/activity extends beyond
    • Possible to even circle science into Math

Revision deadline is 9/2017 for this reason- it gives time to research a best fit based on district needs
Middle School

6-8
Middle School 6-8

Taken from Appendix K of NGSS

Note: despite topical arrangement of Physical Science, Life Science & Earth and Space Science- significant research recommends a spiral approach
Appendix K expanded

- Course 1: Grade 6
- Course 2: Grade 7
- Course 3: Grade 8

- The boxes are not units- they are DCIs
## Compare Appendix K & NJ DOE Model Curriculum

<table>
<thead>
<tr>
<th>Grade</th>
<th>NGSS Appendix K</th>
<th>NJDOE Model Curriculum</th>
</tr>
</thead>
</table>
| Grade 6 | ![Course 1](#) | Unit 1: Waves and Electromagnetic Radiation  
Unit 2: Weather and Climate  
Unit 3: Space Systems  
Unit 4: Structure, Function, and Information Processing  
Unit 5: Growth, Development, and Reproduction of Organisms |
| Grade 7 | ![Course 2](#) | Unit 1: Waves and Electromagnetic Radiation  
Unit 2: Weather and Climate  
Unit 3: Space Systems  
Unit 4: Structure, Function, and Information Processing  
Unit 5: Growth, Development, and Reproduction of Organisms |
| Grade 8 | ![Course 3](#) | Unit 1: Waves and Electromagnetic Radiation  
Unit 2: Weather and Climate  
Unit 3: Space Systems  
Unit 4: Structure, Function, and Information Processing  
Unit 5: Growth, Development, and Reproduction of Organisms |
Middle School Summary

NGSS do not require the spiral approach but:

• Significant research went into the sequencing as presented by the NGSS

• NJ DOE Model Curriculum- a guide not a stand alone curriculum- adopted this same approach due to the supporting research
High School

9-12
NJ DOE Model High School Curriculum

- Appendix K (NGSS) does note a model sequence 9-12
  - It does not work in NJ due to certification issues
- Most Courses Remain:
  - Biology
  - Chemistry
  - Physics
- Concern:
  - Earth Science & Environmental Science- previously two courses- appear to be merging
The Issue:

❖ NGSS Topics:
  ❖ Life Science- Biology; portions of Environmental Science
  ❖ Physical Science- Chemistry; Physics
  ❖ Earth & Space- Earth Science; portions of Environmental Science
  ❖ With shifting focal points Environmental Science is seemingly be absorbed by two other courses
Course Sequencing

Different Schools, Many options

9th —> 10th —> 11th —> 12th

• Environmental Science —> Biology —> Chemistry —> Physics
• Biology —> Chemistry —> Physics —> AP Electives
• Physics —> Chemistry —> Biology —> AP Electives
• Earth Science —> Biology —> Chemistry —> Physics
• Geophysics —> Biology —> Chemistry —> Physics

And these options/variations go on and on…
What to Do

❖ We are restricted by certifications
❖ Previously:
  ❖ Revised “Earth Science” to be a combination of Earth & Physical Science- “Geophysical Science”
❖ With a Better Understanding Considering:
  ❖ Eliminating Geophysics
  ❖ Adding “Environmental & Space Science”
    ❖ NJDOE Model curriculum: 5 units
      ❖ First 4 the same
        ❖ 5a makes course Earth Science
        ❖ 5b makes course Environmental Science
          ❖ 6 unit course with both = Environmental & Space Science
❖ Districts will need to assess staffing and develop a case-by-case plan to address NGSS, meet district goals & best serve students
Agenda Item 3: Changes in Labs
Science is Inquiry Based

• Exploration of Phenomena Leads Instruction

• Essential Question(s) linked to a phenomenon that launches the unit before any new content is provided

• This initial activity connected to this phenomenon becomes the unifying theme for all subsequent discussion, lab work, and projects in a given unit
Why “Phenomena”

- What are “Phenomenon?”
  - Observable experience based upon fact
  - Can be duplicated / manipulated / explored
- “Labs” could be considered the exploration / attempt to explain “phenomena”
  - Students have come to identified being graded on labs
  - Many teachers have come to wanting to provide grades for all labs
Assessing Labs

• Completing a handout does not signify that learning has occurred
• Instructional style will vary but:
  • The initial phenomenon (tied to Essential Questions) is not directly graded
    • Lab procedure is not just given 6-12. Rather, there is discussion around a “problem” to set up the lab.
    • K-5 procedure is handed out with discussion as to why certain data is being measured/collection/recorded
  • Conclusion Questions tied to the initial lab are used to launch class notes/discussion
    • Students do complete pre & post lab questions but do not turn in a handout for a grade
Assessing Labs (cont.)

What the sequence looks like:

1) Topic/unit is introduced with a phenomenon that will be thematic/reflects essential question(s) (referred to as EQs)

2) Students reflect on the phenomenon and discuss how that problem could be studied/resolved. In this discussion students note for a:

   - Study: data that must be collected
   - Resolution: criteria that will be tested to determine success

3) The lab pertaining to the phenomenon (reflecting EQs) is conducted
4) Students use the lab experience to complete conclusion questions

Instructor has options here:

• Students work solo
• Students work in groups
• Entire class works together

In all cases this work is NOT graded
Assessing Labs (cont.)

5) Following the lab: ample discussion & follow up over multiple class periods which may include:

- Extension do nows, homework, and exit slips that reflect lab activity
  - Calculations using boxed data & analysis of said data to draw conclusions
  - Design a lab to conduct a similar study / resolve a similar problem
    - Students should be collaborating and reporting / explaining there "solutions" to their peers
- Lecture
  - Yes it still exists but in extreme moderation. The notes / information delivered in lecture are in direct response to clarify experiences the students had during lab.
- Additional Labs
  - The guiding, thematic lab may require supplemental experiments to help students master the content. Just like with the initial lab the handout / conclusion questions launch discussion - they are not graded
Side-Step: ASCD Homework Tree

Homework Decision Tree

This flowchart helps teachers determine whether to grade a homework assignment.
So how does a lab show up in a grade book/student’s average?

Two things that have been “corner stones” in science education could be looked at as either “extinct” or “extremely evolved”

- Graded handouts that accompany labs
- Formal lab reports

What follows is an example of the aforementioned 5 step process. It is taken from our Honors 8th Grade Science Algebra-Based Physics course

I like this example because we use it in our middle school but, being drawn from physics, it is also useful in relating this process to the high school
Essential Question

How can I determine how high into the air I can throw a baseball?
Following the Steps

Step 1- question was posed by teacher. (Phenomena- if I throw a baseball up it will come back down)

   Bonus points if teacher takes class outside and actually throws a ball up and down/ changes the question to a student challenge (who in the class can throw a ball the highest? How will we know?)

Step 2- Students discuss what will be needed to address the question. Instructor will need to use socratic method & scaffolding to keep discussion on task without simply telling the students what is needed

   The setup discussion may take an entire class period.
Following the Steps (cont.)

Step 3: Students conduct the lab and collected the data required

Step 4: As a class, the data is discussed and the instructor supports with using the data to make calculations

This is the first time in the unit that the instructor does anything close to providing notes
Following the Steps (cont.)

Step 5: Over the next several days students will:

- Complete comparable problems on velocity, time, acceleration & distance (known as “kinematics”)
  - Sometimes solo & sometimes in groups but always with students presenting their work back to their peers (instructor never “presents answers and asks for questions”)
- Conduct additional labs on situations pertaining to kinematics
  - Not collected and graded but plenty of opportunity for practice and feedback
Progression of the Essential Question

- How high can I throw a baseball?
- How can time & distance be used to determine velocity?
- How can I manipulate kinematics equations to solve problems?
Time to Assess for a Grade

The content has been reviewed extensively

• Took several days
• There was work that was checked for correctness and feedback was given to the students multiple times

Two components to the assessment:

1. Making calculations and drawing conclusion from provided data
2. Designing a lab
1) Drawing Conclusions

Can be open-ended or multiple choice

Ex: Consider the scenario

Stomp rockets are air-powered missiles launched from the ground when a student jumps onto the launchpad compressing air and propelling the rocket upward.
Stomp Rocket Example

Question 1: A student launches the rocket and 4.3s elapse from the time it leaves the launch pad until the time it lands on the ground. Assuming that the rocket went straight up and down, determine the maximum height that the rocket obtained.

Question 2: Two students each jump on the launchpads of their respective rockets. The rocket from student A is in the air twice as long as the rocket from student B. Which of the following statements is most accurate:

A. Student A’s rocket went twice as high as student B’s rocket
B. Student A’s rocket went more than twice as high as student B’s rocket
C. Student A’s rocket went less than twice as high as student C’s rocket
D. The two rockets reached the same height because acceleration due to gravity is constant
2) Designing A Lab

NASA has just successfully landed a robot on Mars and wants to study the acceleration due to gravity on the planet. Describe an experiment that the robot could conduct noting what data must be collected and how that data will be used.
In Conclusion

The structure of assessments is impacted by the focus of the NGSS

No more stepwise “subtract the value in step 3 from the value in step two” labs that students complete and turn in for a grade

So what about lab reports?

Instructors wishing to incorporate this level of writing should develop assignments with rubrics requiring detailed, typed proposals for a lab experiments citing specific data and how that data will be used in calculations and conclusions
Agenda Item 4: Revising Curricula
# NGSS Curriculum Template (Draft)

<table>
<thead>
<tr>
<th>Unit:</th>
<th>Essential Questions w/ Phenomena</th>
<th>Objectives</th>
<th>Common Assessments</th>
<th>Standards</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1: Intro to NGSS</td>
<td>How can I determine how high I can Throw a baseball?</td>
<td>SSBAT: • Analyze a situation and identify known and unknown variables • Manipulate formulas to solve for a variable • Assess a situation and design an experiment</td>
<td>• Stomp Rocket Scenario • Design a lab on Mars</td>
<td>• HS-PS2-1</td>
<td>• Text pp. 3-5 • Workbook pp. 7-9 • Interactive Website 1 • Interactive Website 2</td>
</tr>
</tbody>
</table>
Up Front:

It may not be possible for science lessons & curriculum guides to 100% follow the same template that is used in other contents.
The Process

1. Training & familiarization with NGSS
2. Determine units for course
3. Introductory “phenomena” for each unit (linked to EQ)
4. Link DCIs to phenomena
5. Complete curriculum template
Challenges

❖ Change in what teachers have traditionally covered
  ❖ New focal points 9-12
    ❖ Some topics out, new ones added
  ❖ Spiral Approach 6-8
  ❖ Topics locked in K-5
    ❖ In both 6-8 and K-5 teachers may “lose favorite unit”
    ❖ In all- “previous lesson plans & materials” will be defunct and need ample revision to align
Challenges (cont.)

❖ Need for New Resources
  ❖ Fiscal burden
  ❖ Teachers need to reestablish comfort

❖ Assessment
  ❖ Communication and support needed to help students & parents adjust to changes
CPHD: Middle School Alignment

Carl H. Kumpf Middle School (awarded Schools to Watch 2013) aligned 6-8 Science Program at start of 14-15 School Year

In looking to adopt a program to assist with alignment we valued the following criteria:

• Topics needed to reflect NGSS Appendix K and NJ DOE Model Curriculum

• Program needed to provide unit scopes, sequence, & pacing
  • Due to drastic change from topical courses to integrated courses this was a must to support the staff

• Bonus: program provides tests, quizzes, labs and other supplements
Progressive Science Initiative (PSI)

The Math Department 6-8 was already using the Progressive Math Initiative.

PSI Program Provided:

- Student Notes
- Teacher Tests, Quizzes & Homework
- Labs w/ material lists for outfitting & restocking
- Pacing, Scope & Sequence

PSI Program Required:

- Smart Boards
- Student Response Systems
PSI Units by Course
6th -> 7th -> 8th

The Universe and Its Stars
Earth and the Solar System
Earth Materials, Systems, and Plate Tectonics
The Roles of Water in Earth’s Surface Processes
Midterm
Weather & Climate and Natural Hazards
Evidence of Common Ancestry and Diversity
Ecosystem Dynamics
Disturbance and Biodiversity
Biodiversity and Humans
Final

Matter and Its Properties
Chemical Reactions and Energy
Structure and Function & Information Processing
Matter & Energy in Everyday Life
Midterm
Growth and Development of Organisms
Inheritance and Variation of Traits
Natural Resources and Human Impact
Global Climate Change
Final

Forces & Motion  Updated!
Types of Interactions
Energy of Objects in Motion  Updated!
Thermal Energy  Updated!
Midterm
Wave Properties
Electromagnetic Radiation
Information Technologies & Instrumentation
Final
Data

6th Grade

X Value: Letter Grades
Y Value: # Students

7th Grade
Data (cont.)

8th Grade
X Value: Letter Grades
Y Value: # Students
Assessment of PSI

What’s Working

• Sequencing / Placement of Units
• Provided Materials- tests, quizzes & labs
  • Raw but a foundation the staff can edit to meet their needs
• Embedded response system to continually assess all students every day

What Isn’t

• No Textbook
  • Electronic Slides Only
• Labs do not fit NGSS
  • Cumulative not introductory
• Lack of use of current events articles / reading comprehension activities
Moving Forward

❖ Using Model Curriculum Template & Resource Adoption Form

❖ Summer 2016

❖ Science 6, Science 7, Science 8, Environmental & Space Science, Biology, Chemistry & Physics

❖ 16-17 School Year

❖ Use department and professional development time to review available data & revise programs as needed

❖ Provide ongoing support & training on NGSS/ lab-based instruction

❖ Essential Question w/ accompanying phenomenon create a theme for a unit that is continually revisited
Moving Forward (cont.)

❖ Summer 2017
❖ 17-18 School Year
  ❖ Establish means of sharing resources within grades/teams
    ❖ Spiraling topics will (somewhat) alleviate supply costs
  ❖ Use department and professional development time to review available data & revise programs as needed
    ❖ Bring in 6-12 content certified staff to assist
  ❖ Provide ongoing support & training on NGSS/ lab-based instruction
Agenda Item 5: Resources
Resources

• NGSS
  • http://www.nextgenscience.org/

• NJ DOE Model Curriculum
  • http://www.state.nj.us/education/modelcurriculum/sci/

• PSI
  • http://www.njctl.org/

• Online Simulations
  • https://phet.colorado.edu/en/simulations/category/new

• Text (Possible) Options
  • Discovery Education “Techbook” series aligned to NGSS
  • Glencoe/McGraw Hill: Integrated iScience Series
  • Pearson: Interactive Science Series
Thank You for Coming

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