Designing at the Crossroads of NGSS and CCSS: Text-Based Investigations for Evidence-Based Argumentation in Science

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READI Science Intervention
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Reading for understanding in science = the capacity to use evidence from multiple information sources to construct, justify, and critique models/explanations of science phenomena

We are working across the adolescent years, grades 6 – 12

We are designing:

– Text-Based Investigation Modules
– Learning progressions advancing literacy and inquiry practices
– Assessment tools
– Ongoing professional learning for science teachers
Mapping the Literacy and Inquiry Practices of Science

Reading to Investigate, Explain, Model
- Attention to evidence, counter evidence
- Attention to mechanisms, interactions, impacts, scale, magnitude
- Attention to prior conceptions, science frameworks
- Interactive argumentation, meaning making

Multiple forms of text & means of representation
- Graphs, diagrams, models, exposition

Valued reasoning processes, stances
- Skepticism
- Conceptual change, knowledge development
- Argument re: best explanation of evidence
The State of Secondary Science Teaching

- Very little authentic science inquiry occurs (*Taking Science to School, Inside the Classroom, NRC*)
- Little reading for science understanding occurs
- Text resources are limited in scope (overwhelmingly textbook only, for content delivery)
- Students rarely develop and justify their own explanations based on evidence (scientific argumentation)
- Pedagogies (discussion, modeling, collaboration, literacy) necessary to enable [text-based] inquiry largely missing
Engaging in Teaching Literacy as Science Practice is a Major Shift

The Challenge
To simultaneously develop students’:

• Science knowledge
• Interest and engagement in science learning
• Participation in inquiry practices
• Ability to make meaning of science texts for scientific purposes
• Reading for understanding in science
Engaging in Teaching Literacy as Science Practice is a Major Shift

The Challenge

To develop science *teachers*: 
- Understanding of inquiry practices
- Understanding of literacy practices
- Understanding of texts – varied forms, structures, and challenges
- Pedagogical repertoire
Emerging Misconceptions of CCSS and NGSS

• Assigning ELA teachers to take on literacy in science and technical subjects
• Argumentation units promoting policy debates about science topics rather than science learning
• Treating literacy practices as adjunct rather than fundamental to science practices
• Using science texts solely to deliver science content rather than as catalysts for inquiry
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<th><strong>Engage in close reading of a range of science representations</strong>; Identify, analyze and interpret scientific evidence in texts/sources including graphs, diagrams, models, exposition</th>
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<td><strong>Synthesize evidence and information across multiple sources</strong> including graphs, diagrams, models, exposition</td>
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<td>3</td>
<td><strong>Construct, justify, and critique explanations and explanatory models</strong> of science phenomena from scientific evidence drawn from multiple sources and using science principles, frameworks, and enduring understandings</td>
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<td><strong>Demonstrate understanding of the epistemology of science</strong> through inquiry dispositions and conceptual change awareness/orientation, seeking “best understandings giving the evidence.”</td>
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Text-Based Investigation Example: Methicillin-Resistant Staph *Aureus*

• Over the next few weeks, we are going to be studying about a serious public health issue, an infection called MRSA. This infection has been studied by scientists for many years. The bad news is the infection can be deadly. The good news is it is almost entirely preventable IF you understand the science.

• Your job, over the course of this unit, is to make sense of the science, determine the best steps to prevent the spread of the infection, and share what you have learned with your community. Your knowledge may be your community’s best defense. Let’s get to work!
Multiple Opportunities for Explanatory Models and Argumentation

• MRSA Transmission and Infection
• MRSA Spread
• MRSA Evolution
• Managing the Public Health Challenge of MRSA
MRSA Text Set/Sequence

- Connie’s Story: A Nurse’s Personal Story with MRSA (video) http://webmm.ahrq.gov/perspective.aspx?perspectiveID=58
- Kansas City Teen Gets MRSA From Attempted Lip Piercing, Almost Dies http://www.foxnews.com/story/0,2933,354696,00.html#ixzz1m0Zj9t9b
- MRSA History http://mrsa-research-center.bsd.uchicago.edu/timeline.html
- Contagion movie trailer
- Superbug, Super-fast Evolution (excerpt) University of California Museum of Paleontology
- Battling Bacterial Evolution: The Work of Carl Bergstrom
- Natural Selection and Antibiotic Resistance (excerpt) Battling bacterial evolution: The work of Carl Bergstrom
- Modification by Natural Selection (excerpt) MODERN BIOLOGY by Holt, page 287
- Growth and Reproduction http://www.biologyreference.com/Ar-Bi/Bacterial-Cell.html#ixzz1RG7ByBLw
- The Success of Evolutionary Engineering Adapted from www.sciencemag.org SCIENCE VOL 293 7 SEPTEMBER 2001
Multiple Representations of Science

Resistance to the antibiotic Vancomycin rose dramatically over the 1990s in US hospital intensive care units.

Antibiotic/Antimicrobial Resistance

Antibiotics and similar drugs, together called antimicrobial agents, have been used for the last 70 years to treat patients who have infectious diseases. Since the 1940s, these drugs have greatly reduced illness and death from infectious diseases. Antibiotic use has been beneficial and, when prescribed and taken correctly, their value in patient care is enormous. However, these drugs have been used so widely and for so long that the infectious organisms the antibiotics are designed to kill have adapted to them, making the drugs less effective. People infected with antimicrobial-resistant organisms are more likely to have longer, more expensive hospital stays, and may be more likely to die as a result of the infection.

Source: http://www.cdc.gov/drugresistance/index.html
Snapshots of MRSA in MS and HS

Students engage in close reading of science texts to generate inquiry questions and build knowledge.
Students Raise Inquiry Questions to Guide Ongoing Investigation

**PIERCING QUESTIONS & IDEAS**
- How do antibiotics affect MRSA?
- If he had sterilized the needle, would he still have gotten MRSA?
- Why would he pierce his lip if sick?
- 1st: How rare is MRSA?
- 2nd: How common is MRSA?
- How do you get MRSA?
- Should people avoid taking antibiotics to prevent MRSA?
- Is MRSA a more complex version of Staph infection?
- Does MRSA affect joints to the point that they deteriorate?
- Why does he need surgery in knees & hips if the piercing is in lip?
- How did it spread to the leg & hips?

**Connie’s Story Ideas & Qs**
- Pus oozed out of back
- Developed MRSA after surgery
- How does someone’s body make a puddle of pus?
- What did she have in her vertebrae?
- Is MRSA hard to detect?
- How did she contract it?
- Was it MRSA that caused her vertebrae to deteriorate?
- What was pumping out of her back?
Modeling and Practice of Science Reading Strategies

- Annotation routine

  Teacher modeling active reading strategy

  Students annotate on their own with reading strategy list introduced earlier
Documenting and Discussing Text Challenges

• Metacognitive Conversation Routines

Pair share, class share

Discussion of text challenges
Sharing confusions
Identifying challenging vocabulary
Clarifying
Sharing approaches for meaning making
Building Knowledge of MRSA
Transfer, Spread, and Resistance

“How can a person get MRSA? How is it transferred? How does it start? How is it contracted in schools? How does it get into jailhouses? How long does it take to form in your body? Do they know how it’s caught? Is it deadly?”

Why is it nicknamed a “Super bug”? Is it highly contagious? Does it spread quickly? Is it stronger than...

“Is it hard to kill? Is it strong?”

Making connection to prior texts
Constructing Models

Student 1

A person can be infected with MRSA by having an open cut or wound.

MRSA: Binary cells grow by a process called Binary Fission. This starts by one cell dividing into two, then keeps going.

Then the person goes to the doctor for a prescription or a prescription to get an antibiotic for MRSA.

Then the antibiotic starts to kill the MRSA.

Student 2
Discussion of Models Leads to Further Investigation

Students explain their models
Other students asked to weigh in
Further questions arise
This spurs continued investigation and sets purpose for reading
Pre-Post Reading and Modeling Task: Malaria

**Introduction**

Malaria is a serious disease in many parts of the world. It has many “causes” linked in a chain of events. Scientists try to prevent the disease by breaking links in the chain.

**Task**

Read the texts on the following pages and make notes in the margins about your reading, thinking and problem solving processes.

After you have read the texts, respond to the following, using information from your reading:

A. Use the information in the texts to create a model, using visuals and words, that explains how malaria could cause millions of deaths each year in Africa. (You may add to the model in text 4, but yours may also look different).

B. Based on what you know now, explain what might be done at different points to stop the transmission of malaria and use evidence from your reading to explain why these might work.
What We are Learning – Curriculum Challenges

• Tensions between content “coverage” and time students need to learn to read and interpret texts, to identify and use evidence, and to construct models and explanations.

• Promise as “educative curriculum” both for science teachers and students.
  – True science inquiry emerges with text as source material for investigations
  – Students learn science content, practices, and how read science texts
  – Teachers learn to turn the work of sense making over to students
  – Students are highly engaged in text-based investigation
What We are Learning – Pedagogical Challenges

• Enabling pedagogies critical but hard to establish
  – Practices not previously present in classrooms began to emerge
  – Interactive notebooks mediate teacher/student interactions & student/text interactions
  – Teacher and students struggle to adopt new practices

• Teachers need time and support to develop these new pedagogies and stances
  – Curriculum materials, however well designed, will not be enough
What We are Learning – Epistemological Challenges

• Students initially treat modeling as school display vs. tentative representation of ideas to be refined based on new evidence
• Teachers initially understand models as representations or surrogates for the real world vs. causal explanations
• Students AND teachers are profoundly inexperienced at using science texts as sources of wonderment, investigation, and inquiry
BUT

When we engage teachers in doing text-based investigation, inquiring into their own practices as they:

• read and reason with complex science texts,
• synthesize and develop models and explanations across multiple sources, and
• justify and critique their own and their colleagues’ models and explanations,

they gain deeper understandings of science inquiry and literacy practices and ways to engage students in these practices.

• Our observations and assessments show students gaining similarly.
Thank you

Inquiry

Literacy

Science

The literacy and inquiry practices of science can be authentically and effectively engaged simultaneously in the science classroom, making progress on multiple learning goals and CCSS/NGSS standards at once.