READI for Science – Yes They Can!
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Science Texts are Varied and Complex

(C) Comparison of estimated deaths in the United States in 2005 due to individual infectious agents or other causes. Data are CDC estimates from National Vital Statistics Reports (12) and Klevens et al. (11). Deaths associated with MRSA infection are based on the estimated number of in-hospital deaths rather than attributable mortality, whereas data for all other causes of mortality are based on US Standard Certificate of Death. Note also that mortality due to MSSA is not included, and thus estimated mortality associated with all S. aureus infections is not shown.
Designing an Approach to Reading Science as Doing and Learning Science

Goal: 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
# NGSS Practices and READI Science Student Learning Goals

<table>
<thead>
<tr>
<th>READI Science Learning Goals</th>
<th>NGSS STEM Practices</th>
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<tbody>
<tr>
<td>1. Engage in close reading of a range of science representations</td>
<td>1. Asking questions and defining problems</td>
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<tr>
<td>2. Synthesize evidence and information across multiple sources</td>
<td>2. Developing and using models</td>
</tr>
<tr>
<td>3. Construct, justify, and critique explanations and explanatory models</td>
<td>3. Planning and carrying out investigations</td>
</tr>
<tr>
<td>4. Demonstrate understanding of the epistemology of science</td>
<td>4. Analyzing and interpreting data</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
<td>5. Using mathematics and computational thinking</td>
</tr>
<tr>
<td>6. Developing explanations and designing solutions</td>
<td>6. Developing explanations and designing solutions</td>
</tr>
<tr>
<td>7. Engaging in argument from evidence</td>
<td>8. Obtaining, evaluating, and communicating information</td>
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</tbody>
</table>
Text-Based Investigation Modules

Middle School

• Human Impact on Water Resources module and Human Impact on Carbon Cycle Pre/Post Assessment – Earth Science
• Reading Models Mini-Unit
• MRSA Module and Pesticide-Resistant Head Lice Pre/post assessment – Life Science
• Teacher developed modules
Text-Based Investigation Modules

High School

- Methicillin Resistant Staph Aureus module and Malaria Pre/post assessment – Life Science
- Reading Models Mini-Unit, Life Science
- Homeostasis – Life Science
- Cell Theory Text Set – Life
- Teacher developed modules
Building Science Teacher Capacity to Teach Literacy as Science Inquiry Practice

Goal: to develop science teachers’

- understanding of inquiry practices – constructing and critiquing explanatory models
- understanding of science literacy practices – close reading and sensemaking to model and explain
- understanding of texts – varied forms, structures, and challenges
- pedagogical repertoire – metacognitive routines, text-based discussion, formative assessment
Models of Professional Learning to Tap and Build Teacher Expertise

Discourse Routines

Metacognitive routines

Reading in Science

Inquiry learning culture

Science literacy practices

Instructional Strategies & Decisions
READI for 9th Grade Biology: Yes They Can

Teachers mediate students’ opportunities to learn. Teachers need opportunities to engage with the knowledge, skills, and practices they will facilitate for their students.

11-day professional development series

Winter 2014
Spring 2014
Summer 2014
Fall 2014
Winter 2015

READI RCT Professional Development: Integrating Reading Apprenticeship and READI Learning Goals

READI Science RCT PD Design

Days 1-4
Building classroom routines to support science literacy

Days 5-9
Building science literacy and discourse: Reading for modeling, explanation and argumentation. Planning modules into the semester

Days 10-11
Deepening science literacy and discourse: modules as educative curricula, formative assessment & responsive instruction

READI Science Learning Goals

- Engage in close reading of a range of science representations; identify, analyze and interpret scientific evidence in texts/sources including graphs, diagrams, models, exposition
- Synthesize evidence and information across multiple sources including graphs, diagrams, models, exposition
- Construct, justify, and critique explanations and explanatory models of scientific phenomena from scientific evidence drawn from multiple sources and using science principles, frameworks, and enduring understandings
- Demonstrate understanding of the epistemology of science through inquiry dispositions and conceptual change awareness/orientation; generate inquiry questions, monitor their changing conceptions through multiple encounters with text, tolerate ambiguity, seek “best understandings given the evidence.”

READI Practices × Content

- Building classroom routines to support science literacy and meaning making
- Building a repertoire of science literacy and discourse practices
- Deepening scientific literacy and discourse practices for reasoned sensemaking
- Utilizing scientific literacy and literacy practices for knowledge building

Study Design

SAMPLE
- Stratified random sample at school level
- 6 strata based on prior school level achievement
- 12 schools assigned to READI intervention and 12 to comparison

PARTICIPANTS
- 24 teachers per school
- Teacher evaluation: 24 comparison – business as usual

TREATMENT
- Collaborative reading in science
- Metacognition routines
- Science literacy practices

ASSESSMENTS PRE AND POST
- TEACHERS: Survey, classroom observation early, late in semester
- STUDENTS: Comprehension (pre; GISA at post), explanation, epistemology

TEACHERS: READI and comparison teachers did not differ on survey responses prior to PD. There were significant differences between the two on all constructs related to practices at the conclusion of the intervention, with READI teachers showing significantly higher ratings.

Teacher Practice Survey (post)

- Science reading opportunities: learning structure
- Science metacognition
- Metacognitive inquiry: teacher modeling
- Metacognitive inquiry: student practice
- Negotiation success: instruction

Teacher Practice Observations (late)

- Collaboration
- Science argumentation
- Science modeling
- Science reading routines, tools & strategies
- Metacognitive inquiry into science reading and thinking
- Support for science reading
- Science reading opportunities

Results

STUDENTS: READI and comparison students did not differ on comprehension at pre. Post intervention READI students outperformed comparison students on the ETS-developed GISA multiple source comprehension assessment.

Student Learning Outcomes

<table>
<thead>
<tr>
<th></th>
<th>READI n = 672</th>
<th>Comparison n = 539</th>
</tr>
</thead>
<tbody>
<tr>
<td>GISA (post)***</td>
<td>58.76% (16.14)</td>
<td>54.85% (17.36)</td>
</tr>
<tr>
<td>Science epistemology 1: Corroboration using multiple sources**</td>
<td>4.86 (0.69)</td>
<td>4.74 (0.75)</td>
</tr>
<tr>
<td>Science epistemology 2: Science is tentative and complex, not simple and certain</td>
<td>2.94 (0.83)</td>
<td>2.92 (0.82)</td>
</tr>
<tr>
<td>Self-efficacy/confidence in doing science</td>
<td>3.58 (0.84)</td>
<td>3.53 (0.84)</td>
</tr>
<tr>
<td>Pre RISE</td>
<td>271.33 (13.47)</td>
<td>270.01 (13.95)</td>
</tr>
<tr>
<td>Science epistemology 1: Corroboration using multiple sources</td>
<td>4.81 (0.68)</td>
<td>4.83 (0.72)</td>
</tr>
<tr>
<td>Science epistemology 2: Science is tentative and complex, not simple and certain*</td>
<td>2.76 (0.81)</td>
<td>2.85 (0.81)</td>
</tr>
<tr>
<td>Self-efficacy/confidence in doing science</td>
<td>3.60 (0.81)</td>
<td>3.62 (0.79)</td>
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</table>

Note: * p < .05; ** p < .01; *** p < .001

http://www.projectreadi.org/

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Katherine McIntyre and Students
preK-8 Elementary School
Chicago Public Schools
- neighborhood school
- South side of Chicago
- 430 students

Other Statistics
• Low Income 93.0%
• Diverse Learners 15.3%
• Limited English 1.6%

- Asian American
- African American
- Hispanic
- White
- Other
Literacy Struggles in Urban Classroom With Students of Low SES Backgrounds

- Lacking academic background knowledge
- Gaps in general science knowledge
- Many students not reading on grade level
- Low academic vocabulary knowledge
- Low science specific vocabulary knowledge
My Participation in Project

- Implemented READI modules in 6th grade science classroom
  - Models mini-module
  - Water Module
  - MRSA Module

- Overlaid READI principles onto school-based curriculum to develop:
  - Energy Resources Unit
  - Fossils Unit
  - Dynamic Planet Unit
Putting READI Principles Into Practice in the Classroom

• Essential Question
  – Questions that guide unit that trying to get students to explain

• Annotating Text
  – Explicit instruction via teacher modeling and think aloud

• Engaging with Text through discourse
  – Whole class discussion and peer to peer discussion

• Evidence Gathering

• Consensus Model Building throughout unit

• Iterative Cycle
  – Read text, gather evidence, discourse
How much carbon dioxide (CO₂) is produced when different fuels are burned?

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**Pounds of CO₂ emitted per million Btu of energy for various fuels:**

- Coal (anthracite): 351.5
- Coal (bituminous): 251.5
- Coal (lignite): 194.3
- Liquefied Petroleum Gas (LPG): 186.7
- Propane: 161.3
- Natural gas: 130.0
- Diesel: 117.0
- Jet fuel: 67.2
- Gasoline: 44.0
- Wood (briquette): 22.0
- Wood (chips and sawdust): 14.0
- Wood (ash, cinders, and sawdust): 8.0

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**Examples**

- **Coal:** Coal has carbon in it. It is non-renewable.
- **Gas:** Natural gas is also a GHG.
- **Pine:** From pine trees, CO₂ is taken up to synthesize cellulose for the tree.
- **Wood:** Wood is also a non-renewable resource.

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**CO₂ Concentration and Surface Temperature**

**The Recent Role of the Greenhouse Effect**

Since the Industrial Revolution began around 1750, human activities have contributed substantially to climate change by adding CO₂ and other heat-trapping gases to the atmosphere. These greenhouse gas emissions have increased the greenhouse effect and caused Earth's surface temperature to rise. The primary human activity affecting the amount and rate of climate change is greenhouse gas emissions from the burning of fossil fuels. The most important GHGs directly emitted by humans include CO₂, methane, nitrous oxide, and several others. Humans, through their daily activities, are contributing to global warming.

Carbon dioxide is the primary greenhouse gas that is contributing to recent climate change. CO₂ is absorbed and emitted naturally as part of the carbon cycle, through animal and plant respiration, volcanic eruptions, and ocean-atmosphere exchange. Human activities, such as the burning of fossil fuels and changes in land use, release large amounts of carbon to the atmosphere, causing CO₂ concentrations in the atmosphere to rise.

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**Project READi inquirium**

Northern Illinois University

Northwestern University

University of Illinois at Chicago
Instructional Tools

Essential Question: “How does human consumption of energy resources affect the Earth?”

Scientists draw on texts, both written and visual models, as well as experiments and existing models, to help them understand the world around them. One important way is to identify evidence in texts, experiments, and models that help them address their inquiry questions.

Below, identify the evidence that helps you better answer the essential question. Then, make interpretations from evidence and ask yourself what else you need to understand in order to help you address the essential question.

<table>
<thead>
<tr>
<th>Text</th>
<th>Evidence</th>
<th>Interpretation</th>
<th>What else do we need to know?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Plant Using Fossil Fuels Diagram</td>
<td>The power plant needs fuel.</td>
<td>The fuel is burned to create steam to turn the turbine and generator</td>
<td>Is the smoke and gas coming from the power plant polluting the air?</td>
</tr>
</tbody>
</table>

**FOSSILS: WORDS and TERMS to KNOW**

When you come across a word in a reading that you do not know, write it down. Use context clues in your readings, try to define what the word means in your own words.

<table>
<thead>
<tr>
<th>Word/Term</th>
<th>What I think it means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
Explanatory Models

• Dynamic Planet Unit (Initial Model and Model Revision)

• MRSA Unit
Changes for Students

Developed reading skills in science content area

Increased abilities to make meaning of texts and from texts

Constructed meaning of texts and phenomena from repeated opportunities for discourse with teacher, class, and peers

Diagrams, charts, graphs, pictures, informational text
Changes for Students

Used learning from reading the texts to build explanatory model(s) of scientific phenomena

Used text-based evidence to increase understanding by citing evidence, making interpretations, and developing next steps
How did it deepen my instructional practice?

• Depth vs. Breadth

• Release of Teacher as purveyor of knowledge vs. students constructing the knowledge

• Better understanding of student ability to read and comprehend variety of texts (written, graph, chart, diagram)

• Understand student misconceptions from text

• More intentional with what wanted students to focus on from a text

• Increased ability as teacher to get students to actively engage with text and read text