
Updated Design Rationale, Learning Goals, and Hypothesized Progressions for Text-Based Investigations in Middle and High School Science Class

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Cynthia Greenleaf, Willard Brown, Monica Ko,
Gina Hale, Ursula Sexton, Katie James, and
MariAnne George

PROJECT **READi**



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Please send us comments, questions, etc.: info.projectreadi@gmail.com

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Project READI operated as a multi-institution collaboration among the Learning Sciences Research Institute, University of Illinois at Chicago; Northern Illinois University; Northwestern University; WestEd’s Strategic Literacy Initiative; and Inquirium, LLC. Project READI developed and researched interventions in collaboration with classroom teachers that were designed to improve reading comprehension through argumentation from multiple sources in literature, history, and the sciences appropriate for adolescent learners. Curriculum materials in the READI modules were developed based on enacted instruction and are intended as case examples of the READI approach to deep and meaningful disciplinary literacy and learning.

Introduction

The Science Design work within Project READI focuses on the development of text-based science investigations, work that promises to make a unique contribution to the fields of science and literacy education. As defined in our Year 2 report (IES-rfu Project READI Annual Report, March 2012), READI text-based investigations for science focus on explanation/model building (NRC, 2012) about science phenomena from multiple documents and scientific representations. The READI Science Design Team worked across sites and with teacher design partners to implement two interventions during the spring of 2012: The first of the READI Science modules, on Methycillan-Resistant Staphylococcus Aureus, or MRSA, was implemented in a 10th grade biology and 11th grade physiology classroom.

In addition, based on lessons learned from the first iteration modules and their implementations, the Science Design Team developed a mini-module focused on Reading Models to introduce students to the role of modeling in science, which was implemented in two middle school science classrooms. A middle school module on MRSA was designed and will be implemented this spring, along with a new pre/post assessment on a parallel evolutionary topic, pesticide resistant head lice (see Appendix A, B). Revision of the MRSA module for high school is currently underway, with plans to implement the unit this spring. Finally, a high school life science version of the Reading Models in science module is also in progress. These modules share a common architecture based on the 14 design principles developed by the larger Project READI team and are designed to address the Project-developed core constructs of knowledge for science.

For elaboration of the design and implementation of the science modules, see Project READI Curriculum Module Technical Reports: (www.projectreadi.org)

- *CM #26-Earth Science: How are Humans Impacting Water, Middle School, 8th Grade, Spring 2013*
- *CM #24-Life Sciences: The Spread of MRSA, Middle School, 6th Grade, Spring 2013.*
- *CM #27-Life Sciences: The Spread of MRSA, High School, 9th Grade, RCT, Fall 2014.*
- *CM #29-Reading Science Models, High School, 9th Grade*
- *CM #30-Reading Science Models, Middle School, 6th Grade*

Design Rationale

Reading for understanding in science requires that students build a robust internal model of science phenomena from evidence and ideas in source materials. READI science modules aim to place sense-making with texts in the hands of students to see to what extent the model of instruction and architecture of the unit support students in learning the science from their intellectual work with these sources, rather than from lecture, demonstrations, or textbooks that are designed “deliver content” to students (Alozie, Moje & Krajcik, 2010; Cervetti & Barber, 2008; Chiappetta & Fillman, 2007; McNeill, 2009; Myers, 1992; 1997). We hypothesize that due to the nature of science textbooks (compendia of well-established science facts and theories) and the way the goal of science instruction is often framed (as knowing correct answers to questions the teacher poses), students will be socialized to scanning science texts for information rather

than to engaging intellectually with texts to construct deep understanding or to using texts as sources for inquiry (Evagorou & Avraamidou, 2011; Berland & Hammer, 2012; Norris & Phillips, 2003). An explicit goal of the text-based investigation modules, then, is to re-socialize students to actively construct meaning with science texts and to reposition science texts as resources for science inquiry learning (Pearson, Moje, & Greenleaf, 2010).

Toward these ends, these modules offer abundant social and material support for active sense-making and a focus on explanation/model building (Gotwals, Songer & Bullard, 2012; NRC, 2012; Pluta, Chinn & Duncan, 2011; Schwarz et al., 2012). While unit materials are designed to be both compelling and supportive of the active sense-making goals of the project, we know both teachers and students will benefit from the strong social and pedagogical supports for such active intellectual engagement that were built into the units. Students' work with the module materials has been designed to mirror the work of scientists – as text-based inquiry. Pedagogical routines therefore focus students on asking questions, identifying and accumulating data to answer inquiry questions, developing explanations and models, and critiquing how well their models hold up – the practices of science – rather than solely on acquiring specified content. At the same time, module materials focus on important crosscutting concepts (cause and effect, mechanism and explanation, systems and interactions) and core ideas central to life and Earth science domains (structures and processes, interactions, variation of traits, biological evolution, matter and energy). By using the literacy practices of science to inquire into real world topics of interest, we hypothesize that students will simultaneously learn about the content as well as literacy practices of science.

Since March 1, 2012, the READI science team has validated the initial designs of text-based investigations around these principles by conducting a thorough literature review on the topic of science argumentation. Argumentation in science results from the development of models and explanations for phenomena (Cavagnetto, 2010; Osborne & Patterson, 2011). As scientists communicate the results of their experiments or observations in the form of models and/or explanations, they must argue for the viability of their understandings by demonstrating how well their explanatory models fit the data, by drawing on and connecting their results to the existing body of science principles, and by considering alternative explanations and showing why they are less accurate, powerful, useful, or parsimonious (Bricker & Bell, 2008). Studies of science argumentation show that students as early as elementary grades can productively engage in making claims about scientific phenomena and finding evidence to support those claims (Chin & Osborne, 2012; Ryu & Sandoval, 2012; Sampson & Clark, 2008).

This research also shows that younger students have more difficulty linking claims and evidence than do older students, and thus need more support to make explicit the grounds for their explanations and understandings (Berland & Reiser, 2009; Manz, 2012; McNeill & Krajcik, 2011; Windschitl, Thompson, Braaten, & Stroupe, 2012). Looking across the research base convinces us that we are operating in the right design space for the development of E-B A interventions for middle and high school science. Science education reform projects focused on supporting students to develop explanatory models have approached this important project by providing students with frameworks for explanation, modeling, and argumentation, using datasets or hands on investigations as stimuli for modeling and explanation tasks (Berland &

Reiser, 2009; Chin & Osborne, 2012; Passmore & Svoboda, 2012; McNeill & Krajcik, 2011). Very little of the work on modeling and explanation has been carried out in the context of science reading. Ford (2012) reports that simulating interactions between science authors and reviewers for a scientific journal can support scientific sense-making discourse, and Norris and colleagues (Norris, Stelnicki, & de Vries, 2012; Phillips & Norris, 2009) have shown that using adapted primary literature resembling scientific writing increases the use of critical thinking skills with writing. However, argumentation studies have focused almost exclusively on hands-on investigations.

To develop students' proficiency in science-specific *reading for understanding*, we have developed and refined text-based investigations in science to promote science literacy and argumentation, working in a design research tradition (Brown, 1992; Cobb, et al., 2004; Reinking & Bradley, 2008). Text-based investigations must allow students to build enough knowledge of a phenomenon from texts to enable them to model and explain it. We reason that by engaging students in building their understandings from close reading of high quality science texts, students will examine and critique their own and others' models and explanations through the course of the science modules, thereby engaging in arguing to learn while at the same time learning to argue scientifically (Von Aufschnaiter, Erduran, Osborne & Simon, 2008). At the same time, such an approach engages students in the literacy practices of science as core scientific inquiry practices, as newly highlighted in the Next Generation Science Standards (NGSS, 2013).

Student Learning Goals for Evidence-Based Argumentation in Science

To inform the ongoing work of module development and focus for assessment, including formative assessment while teaching E-B AIMS in science, the science design team met in Chicago in May 2012 as a part of two days devoted to further defining the Project READI Intervention. The group brainstormed a set of learning goals based on the ongoing design work. Subsequently, a subgroup met to discuss and explore the learning objectives and how to measure them. The result of this work is the following list. As we work on modules and document classroom implementation, we plan to test whether these objectives need further articulation and refinement.

Student Science Learning Objectives

1. Engage in close reading of science information to construct domain knowledge-including multiple representations characteristic of the discipline and language learning strategies.
2. Synthesize science information from multiple text sources
3. Construct explanations of science phenomena (explanatory models) using science principles, frameworks and enduring understandings (big ideas) and scientific evidence.

4. Justify explanations using science principles, frameworks and enduring understandings (big ideas) and scientific evidence.
5. Critique explanations using science principles, frameworks and enduring understandings (big ideas) and scientific evidence.
6. Demonstrate understanding of epistemology of science through inquiry dispositions and conceptual change awareness/orientation (intentionally building and refining key concepts through multiple encounters with text); seeing science as a means to solve problems and address authentic questions about scientific problems, tolerating ambiguity and seeking “best understandings given the evidence”, considering significance, relevance, magnitude and feasibility of inquiry.

The Role of Text-Based Investigation Modules in the READI Intervention for Science

Ultimately, the READI intervention is envisioned as ongoing professional development accompanied by material supports and worked examples to support teacher uptake and implementation of the approach across the science curriculum. An impact study is being designed for which teachers will enact Evidence-Based Argument instruction to promote construction and critique of science explanations and models from multiple science texts in units spread across a full semester to test the impact of such instruction on student learning. The designed modules provide material resources for instruction as well as models to guide teachers’ instructional decisions in the interstices between modules.

Draft Learning Progression for Text-Based Investigation

As we build modules, we are endeavoring to be deliberate in progressive sequencing to build a set of skills and dispositions for student science learners. Modules thus are intended to deliberately provide “spotlights” on needed classroom instructional routines to build needed skills and dispositions and progress them over time in the classroom. Based on observations from the iterative design and implementation process, the science team has drafted and will continue to refine a progression to guide module development and instructional sequencing.

Progression Development. The READI Science Design Team convened a series of meetings to construct a progression of learning for students’ advancement of scientific literacy processes and dispositions for evidence-based argumentation. The progressions were intended as tools to guide teacher implementation of the science learning goals. Early meetings explored the possible scope of the progression. What kinds of learning needs to be included with a progression -- non-cognitive, cognitive, metacognitive? Should it include student learning only, or the teacher learning progression necessary to support student progress as well?

The first draft of the READI science progression posited an evolving scope of reading growing from single text to multi text, from engagement with text to practice of processes to performance of argumentation tasks. It also indicated the requisite teacher learning associated with instruction

that would support students in these tasks. The draft progression was anchored in the developed science modules. Observation of READI inquiry network teacher implementation of the designed modules had indicated the kinds of requisite learning experiences students would need to prepare them to engage productively in prolonged text-based investigations such as the MRSA or Water Purity science module. One finding from these observations was that students need to learn discourse norms and routines for text based, metacognitive conversations that support sense-making, building knowledge of science, and building meta-knowledge for science reading. Another finding from classroom observations was that students needed to learn about the warrants for argument in science. These same findings had already led to the construction of the Reading Models module as described above. The progression draft attempted to build in these threads as aspects of science literacy practice that would build over time.

Subsequent discussion by the Science Design team elucidated the necessity for greater specificity in the progression with respect to the READI science student learning goals. The resulting second draft narrowed the focus to student learning only, faded the prominence of existing READI science modules and shifted the framing to the READI science learning goals. The new draft explicated how each of the science learning goals progressed over a semester of instruction, supporting purposeful advancement of each READI science goal across time. Alignment of the progression along the science learning goals also facilitated cross comparisons among the disciplines, since other design teams were developing similar progressions.

Progression Description. The READI science progression is a framework for ‘on-boarding’ novice science readers into science reading practices, culminating in reading multiple science texts for evidenced based argumentation. The progression supports teachers who having completed READI teacher professional development are implementing instructional approaches that develop student science reading, specifically the READI science modules. The READI science progression is organized into six strands of learning, one for each READI science learning goal:

- Close Reading
- Multi-text Synthesis
- Construct explanations of science phenomena
- Justify explanations of science phenomena
- Critique explanations of science phenomena
- Science Epistemology and Inquiry

In the progression, each learning goal progresses over four learning phases, forming 24 specific learning goal phases populated by multiple incremental science learning goals:

- Building Classroom Routines To Support Science Literacy and Meaning Making
- Building a Repertoire of Science Literacy and Discourse Processes
- Deepening Scientific Literacy And Discourse Practices For Reasoned Sensemaking
- Utilizing Scientific Literacy And Discourse Practices For Disciplinary Knowledge Building

The READI science progressions are grounded in multiple evidences and guided by READI core constructs and design principals:

- READI network teacher interviews and reflections
- READI network teacher designs (lessons, curricular units, scope and sequences for developing student science reading their own classes)
- READI network teacher classroom observations of READi Modules and science reading lessons
- READI Baseline observations

In the 2013-14 school year multiple middle school and high school teachers in the READI science network are instantiating the READI science progressions in their specific science curricula to generate grade level specific instructional examples to instantiate the progressions as well as to provide feedback on the progression itself.

READI Science Progressions (for instances)

	Building Classroom Routines To Support Science Literacy and Meaning Making	Building a Repertoire of Science Literacy and Discourse Processes	Deepening Scientific Literacy And Discourse Practices For Reasoned Sensemaking	Utilizing Scientific Literacy And Discourse Practices For Disciplinary Knowledge Building
SLG -1: Close Reading	<p>Setting a purpose for reading in science and science learning.</p> <p>Introducing Annotation as persistent close reading practice</p> <p>Introducing Discussion of meta-comprehension in context of sense making</p> <p>Introducing Language for describing reading and reasoning processes.</p>	<p>Building confidence and range with science genre, text types and text structures (including scientific models).</p> <p>Previewing to set reading purpose and process based on topic, genre, text type, level of interest and level of challenge.</p> <p>Identifying and Handling Roadblocks while reading.</p>	<p>Set reading purpose based on text-based indicators of reliability and scope of content.</p> <p>Nascent Modeling Reading processes: attending to and clarifying/inquiring into the Science, phenomena, elements and relationships thereof, and model generation.</p> <p>Multi-text synthesis</p>	<p>Attending to scientific principles (theories such as mass-energy conservation, Hardy-Weinberg model) and Unifying Concepts of science (paradigms such as Evolution, Scale, Equilibrium, Matter and Energy, Form and Function, model and explanations, Evidence and representations) while reading.</p>
SLG -2: Multi-text Synthesis	<p>Reading multiple texts on same topic or related topics</p>	<p>Making connections to schema and in-text connections</p> <p>Building knowledge of key concepts across multiple texts</p>	<p>Attending to how multiple texts are connected (i.e. complimentary, additive, or even contradictory) and the affordances of various text types (i.e. personal anecdotes, primary data)</p> <p>Building explanations for</p>	<p>Viewing texts as investigations, setting purpose and inquiry for reading single and multiple texts. Attending to the new information afforded with additional texts and how</p>

			inquiry questions across multiple texts	information provided in those texts addresses the inquiry question
SLG-3: Construct explanations of science phenomena	Developing Norms for Classroom Discourse that holds students accountable to one another's ideas Students begin to increasingly explicate their ideas and make them visible to the classroom and their peers	Making norms for reading, writing, talking, speaking for text based science inquiry / sensemaking discussion routine Increased attention to building off of one another's ideas, attending to the logical coherence of one another's claims. Constructing gists of phenomena from single texts treating the text as an authority (i.e. noticing causal or correlation relationships between elements)	Deepen language, representation and discourse patterns/conventions that attend to disciplinary norms for knowledge building. Attention to evidence, claims, and the links that one puts forth and that others propose within classroom discussion. Developing and making public disciplinary norms for model construction, justification, critique and revision Constructing models based on text evidence	Using disciplinary criteria for knowledge building as students engage in multiple cycles of reading, talking, and writing Constructing multi-text models from larger text sets Using models to predict implications of proposed solutions and answers to authentic science questions
SLG-4: Justify explanations of science phenomena	Citing text in sense making / meta-comprehension discussions. Reasoning and support based on authority (text, teacher, or one's own experience)	Identifying relevant evidence in single text that responds to inquiry questions Increasing attention to the distinction between evidence and inference in both texts and classroom talk	Identifying relevant evidence that informs the model while reading single and multiple texts Specifying how evidence informs the model Developing criteria for scientific models and explanations (write large and for particular systems)	Justifying explanations by appealing to scientific principles or unifying concepts of science. Refining explanatory models and explanations through careful attention to claims, evidence and

			Justifying models based on criteria for scientific models and reliability of text sources	reasoning
SLG-5: Critique explanations of science phenomena	Offering and tolerating alternative explanations, viewpoints, opinions in class discussions.	Disagreeing and offering evidence/rationale for it, Asking probing questions of each other in class discussions. Questioning while reading (to clarify, challenge or build knowledge). Increased attention to how the ideas presented in text “fit with” one’s prior knowledge and other texts.	Offering alternative explanations in response to the explanations of others Using criteria for scientific models and explanations (writ large and for particular systems) as basis for critique (I think that part of the model may be wrong because) and consensus building. Critique models and explanations based on the purpose of the model (the question it is trying to answer). Compare multiple, alternative models for single phenomena.	Critique the reliability of models and explanations based on the quality of evidentiary support (convergence, corroboration) Critique the scope of the model based on appeals to scientific principals and unifying concepts of science.

<p>SLG-6: Science Epistemology and Inquiry</p>	<p>Promoting the understanding that scientific findings have both practical and theoretical implications for science and society Taking inquiry stance as a basis for interacting with text</p>	<p>Viewing science findings as limited and tentative, based on available evidence Tolerating ambiguity and seeking the best understanding, given the evidence, while reading</p>	<p>Recognize that science knowledge is socially constructed by peer critique and public dissemination (advancing and challenging explanations/models) to create scientific explanations that meet certain criteria (based on sound empirical data, parsimonious and logically cohesive) as a basis for co-construction of knowledge while reading.</p>	<p>Recognize that science knowledge building is shaped by (and shapes) scientific principles (theories) and Unifying Concepts of science (paradigms) as a basis for building knowledge of these and using them as a basis for constructing, justifying and critiquing models while reading.</p>
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Draft READI Science Module Progressions Overview

Module #	Texts/Time	Most Consequential Tasks	Metacognitive Conversation Focus	Primary Literacy Learning Goals for Students	Primary Potential Requisite Teacher Learning	Continuing/ongoing Routines to be practiced between modules
Module 1: Founding a Science Reading Learning Community (proposed)	1 text related to current curriculum topic 1 day	Read one text Practice one routine for making their metacognition visible (think aloud or talking to the text) Instantiate and practice norms for reading and metacognitive conversation. Begin the Science Reading Strategy List Poster	Students practice noticing, writing about and talking about their own about science reading processes. Students practice norms for silent reading/writing, pair/small group talk and whole class talk.	To notice their own science reading processes. To learn language for describing science read processes. To learn processes for engaging in pair and whole class metacognitive conversations, and processes for hold other accountable for the doing same. Students learn that reading is a processes	To notice their own reading processes To read with student in mind To model their thinking processes using think aloud. To model, mentor and hold student accountable in taking up the practices needed for pair and whole class metacognitive conversation. To elicit student thinking	Routines and practices for reading and metacognitive conversation repeated with individual texts in multiple lessons. Update Science Reading Strategy List
Module 2: Focusing MC on particular science reading processes (proposed)	1 text related to current curriculum topic 1 day	Read one text Update Science Reading Strategy List Practice new particular science reading practices.	Above plus ... MC now foregrounds particular Close Science* Reading Processes pertinent for reading the text	To acquire and refine particular science reading practices (visualizing for clarifying and consolidation might be high leverage seeing that we are headed that way with the modeling work)	To orchestrate inquiry about particular science reading processes To enact a reciprocal model of particular science reading processes To read with students in mind to prepare an the recip. Model To support student to build and respond to peers comments in whole group	Routines and practices for reading and 'focused' metacognitive conversation repeated with individual texts in multiple lessons. Update Science Reading Strategy list

Sequence	Texts/Time	Most Consequential Tasks	Metacognitive Conversation Focus	Primary Literacy Learning Goals for Students	Potential Requisite Teacher Learning	Continuing/ongoing Routines
Module 3: Models Module (existing draft)	1 text about science models Multiple visual texts, include visual representations of science models. ___ days (?)	Read multiple science texts Begin a science Models criteria List Update the Science Reading Strategy List Poster	Above and ... How do you make sense of visual texts, including models? How do you distinguish whether a visual texts is a model, picture, or other genre?	To draw on prior knowledge and reading to acquire additional uses for specialized language: model. To learn the purpose and criteria of science models To build knowledge of genre of visual science texts, especially visual representations of model. To agree/disagree with peers (teacher) based on criteria.	To facilitate pair and whole class metacognitive conversations supporting disciplinary reading learning goals. (i.e. using the medium of metacognitive conversation to advance students reading practices.)	Above plus ... MC about visual science texts, including models
Module 4: Reading with Modeling and science argumentation (proposed)	1 text explaining a casual model for a phenomena – containing only a few elements and links, maybe a cycle – not visual provided ___ 3 days	Read 1 science text Develop a visual representation of Explanatory Model	Above and ... How to notice and analyze a science explanation while reading How to form and update own mental model while reading How to draw on criteria for a good model to assess own mental model.	*how to form and sketch their mental models How to identify evidence in text for model construction and critique How to discuss what their mental model has accounted for and what it hasn't How to note confusions? Questions they still need to resolve	to support student to give criteria based feedback on peers mental model to argue for/against particular model 'constructions' based the warrants of criteria for science models and drawing on texts for evidence.	Above plus ... Identification and interpretation of evidence for model construction and critique. Text-based construction and critique of science models.

Sequence	Texts/Time	Most Consequential Tasks	Metacognitive Conversation Focus	Primary Literacy Learning Goals for Students	Potential Requisite Teacher Learning	Continuing/ongoing Routines
Module 5: Water Module (existing draft)	___ days	Develop a visual representation of Explanatory Model for how humans impact water Propose and argue for a course of action based on the science model	How to notice and analyze a science explanation while reading How to form and update own mental model while reading How to synthesize cross text information into a coherent science model? How to draw on criteria for a good model to assess own mental model.	Cross text synthesis	To support students in cross text synthesis of evidence into science model construction	Above plus multi text synthesis.
Module 6: Middle School MRSA (existing draft)	___ days	Develop a visual representation of Explanatory Model for how SA became MRSA Propose and argue for a course of action based on the science model	Same as above	Same as above	Same as above	Same as above

Ongoing Teacher Inquiry Network Contributions and Participation in READI Design Teams

In California, there are middle and high school science teachers in the Teacher Inquiry Network working on implementation and documentation of group-designed modules, as well as in working to implement the design principles for science E-BA across the school year in the topics they study. These teachers submitted an argumentation unit from their Winter/early Spring instruction of 2012 at the last Inquiry Network meeting of 2011-2012. Several of the submitted units demonstrated key aspects of the design principles. For example: 1) a unit on earthquakes generated by a student's inquiry question, "Should we be concerned that California has many small earthquakes every day?" for which students read multiple sources and used data from the USGS to respond to this question with their own explanation; 2) a unit on genetics responding to the question, "What living terrestrial animal is the closest relative to whales?" based on examination of the evolutionary records, gene mapping, and readings of multiple texts; 3) a unit a partnering teacher designed after implementing the MRSA unit on the causes, risk factors, and potential ways to reduce risk for diabetes.

Teachers in the Inquiry Network thus demonstrated their understanding of the intervention in their independent module development. To further identify teachers for close documentation among the California science participants, Project READI team members have conducted classroom visits to observe the pedagogical routines teachers have established in their classrooms, the culture for learning in place, and the role given reading in the science curriculum. From these observations, the team selected a few teachers to observe more closely as they implement science team-designed modules as well as across the year as they implement E-B A instruction in their curricula.

As a result of this selection process, there are two groups of teachers participating in the science design work drawn from California Inquiry Network participants: a middle school group focused on Earth science, and a high school group focused on life sciences including Biology and Physiology. In a participating middle school, two Inquiry Network teachers are developing modules for the entire year across the grade levels and we are not only documenting their design work but also are in their classrooms to observe and film frequently.

In addition, the science teachers meet as a sub group during the Teacher Inquiry Network sessions. This year, the team has been pursuing the development of explanatory models of science phenomena, and how to support students in constructing and critiquing models, both from text and from hands on investigations. They have been conducting inquiries themselves, pushing to model phenomena and see what they do as science readers and thinkers to do so. Stepping back from this inquiry, they have focused on designing instructional routines to support their students. These instructional routines constitute a resource for the ongoing module development and enactment of the READI science team.

In Chicago, science teachers have met for part of the day during the day-long sessions as a disciplinary group. The theme for the year has been assessment, based on defining learning goals for each disciplinary group. Initially, the focus of the work in the science group was to define

what we mean by scientific argumentation. The group of science teachers worked together to draw out what they think science argument is about -- that it involves making claims and a critical analysis of the sources you use to back up that claim. In this discussion teachers were questioning what part of this process of generating claims is actually argumentative -- and that without opposition, it is difficult to describe this activity as argument (rather than something like interpretation from evidence). Some teachers talked about argument as struggle, while others thought it could be just about the process of building knowledge. Out of this conversation the group generated a model of science argumentation on the white board and then also pointed out that norms need to be established in order to engage in these conversations. The group also began to draft a conceptual definition of science argument together as a group.

Subsequently, science teachers focused in network meetings on generating a progression, from grades 6-12, of what evidence-based argument might look like over time. Based on CCSS for the grade bands, the science group identified overarching 'themes' or strands of development in evidence-based argumentation, and then mapped backwards to define what these strands might look like at grades 6-8, 9-10 and 11-12. We worked in small groups and then convened together to talk about the different themes and progressions we generated in two small groups, and then consolidated this into one large conceptual definition with grade level specifications.

Some of the participating science teachers in the Chicago Teacher Network are also working with the READI design team to design and implement modules in middle and high school science classes, as in California. To the extent possible, the design teams attempt to engage teachers from across the sites in design collaboratives and conversations.

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date _____

name _____

teacher _____

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

1. Read the texts on the following pages and make notes in the margins about your reading, thinking and problem solving processes.
2. After you have read the texts, respond to the following, using information from your reading:
 - A. Use the information in texts two, three and four 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.

SPACE WILL BE PROVIDED AT THE END FOR YOU TO COMPLETE YOUR RESPONSES.

TEXT ONE

Introduction: The Malaria Problem

Malaria causes fever, joint pain, vomiting, seizures and can lead to brain damage and death, especially in children. On World Malaria Day in 2009, former President Clinton explained that “malaria was eliminated in the United States over a half a century ago, yet more than 1 million people around the world still die from the disease each year, making it one of the most pressing health challenges the world faces today.”¹ According to the World Health Organization’s 2011 report, there were 216 million cases of malaria and an estimated 655,000 deaths in 2010.² Most deaths occur among children living in Africa where a child dies every minute of malaria and the disease accounts for approximately 22% of all childhood deaths. The Clinton Foundation states, “despite ... attention from the global community in recent years, the majority of African families are not benefitting from the tools necessary to stop malaria, such as bed nets and effective medicines, because of a lack of access or efficient use.”³

1. April 24, 2009 | New York, Address given by Bill Clinton on *World Malaria Day*

2. http://www.who.int/malaria/world_malaria_report_2011/en/

3. 2. <http://www.clintonfoundation.org/what-we-do/clinton-health-access-initiative/our-approach/access-programs/malaria>

TEXT TWO

How is malaria spread?

Malaria is caused by *Plasmodium* bacterium. These parasites infect successively two different hosts: humans and female *Anopheles* mosquitoes.

The parasites are transmitted to people who are bitten by infected female *Anopheles* mosquitoes. In humans, *Plasmodium* multiplies in the liver and then invades the red blood cells. Successive generations of parasites grow inside the red cells and destroy them, releasing daughter parasites that continue the cycle by invading other red blood cells. These blood-stage parasites, called “gametocytes” (G. gamete + kytos, cell) cause the symptoms of malaria, which begin 6-10 days after infection.

When a female *Anopheles* mosquito bites an infected human, she takes the person’s infected blood for a meal. During this meal, if gametocytes are picked up by the female mosquito, they may start another, different cycle of growth in the mosquito’s gut. After 10-18 days, the parasites develop the infectious stage, called “sporozoites” (G. *sporos*, seed + *zōon*, animal), which reproduce in the mosquito's salivary glands.

When this infected *Anopheles* mosquito bites another human, the sporozoites are injected into the human’s blood along with the mosquito's saliva. Thus the mosquito acts as a vector, transmitting the disease-causing parasite from one human to another.

Adapted from <http://www.cdc.gov/malaria/about/biology/index.html> and <http://www.who.int/mediacentre/factsheets/fs094/en/>

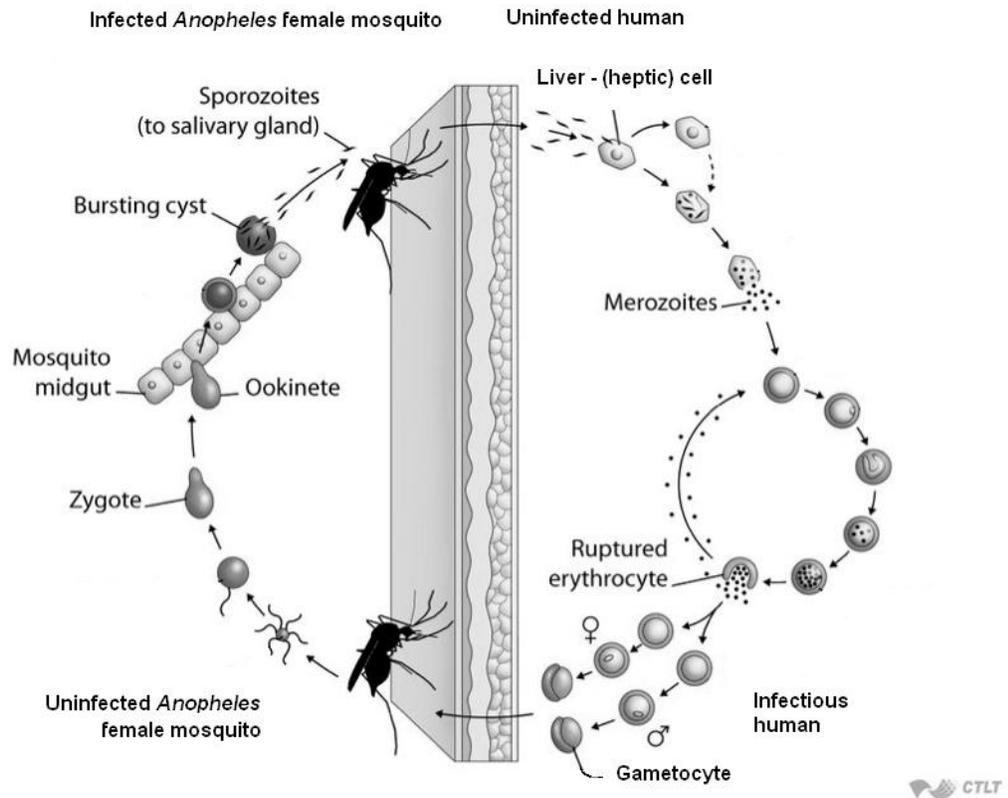
TEXT THREE

Ecology of Malaria

For malaria transmission to occur, three conditions must exist:

- Female *Anopheles* mosquitoes must be present, which are in contact with humans, and in which the parasites can complete half of their life cycle
- Humans must be present, who are in contact with the *Anopheles* mosquitoes, and in whom the malaria parasites can complete half of their life cycle
- Malaria parasites must be present.

TEXT FOUR



Life Cycle of Malaria parasite – Adapted from: <http://ocw.jhsph.edu>

2A. Use the information in texts two, three and four 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).

2B. 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.

Date _____

Name _____

Teacher _____

Introduction

Science is about understanding changes in the natural world and developing solutions to challenges. In this learning experience you will do both. The topic is about how head lice are becoming pesticide resistant.

Task

1. Read the texts on the following pages. Make notes in the margins about your reading, thinking and problem solving processes.
2. Construct a scientific model that explains how head lice have, over time, become commonly pesticide resistant. Use the information in the texts. Use both visuals and words in the model.
3. Explain why the scientific model you constructed is a good model.

Space is provided after the texts for you to complete your responses.

Text 1

Head Lice: Treating Parasites That Go to Your Head

If simply the thought of head lice makes you feel a little itchy, imagine how those affected by a head lice infestation feel when they learn what has been creeping around them and causing symptoms such as intense itching or irritated scalps. Even less comforting is the fact that lice parasitic infestations are on the rise.

According to the Centers for Disease Control and Prevention (CDC), 6 million to 12 million people a year suffer from head lice infestation, and it is estimated that more than \$100 million is spent annually to combat this problem. Head lice tend to affect younger, school-aged children, but teens also can get them; and girls tend to get head lice more than boys due to their longer hairstyles.

Upon close examination, the most common signs of head lice include: an itchy scalp, red bumps, small skin tears and evidence of the egg casings (or nits) attached to the hair shafts, as well as live lice. The nits hatch within seven to 10 days and live about 30 days, during which they reproduce to spread the infestation.

Common, over-the-counter, topical treatments for head lice include chemical pesticides, such as permethrin and synthetic pyrethroids. However, resistance to standard pyrethroid treatments has become widespread and is well documented in the United States, the United Kingdom, Israel and the Czech Republic. In one study, patients using both permethrin and synthetic pyrethroids for 10 minutes and then washing it out (the standard treatment), only killed 5 to 7 percent of the head lice.

To help children avoid head lice, they should not share combs, brushes, hats, barrettes or any other personal care items with anyone else, regardless of whether they have lice or not. Also, it's important to examine everyone in the household when there is a case of head lice, just to be sure that the bugs have not been transmitted.

Sources: Adapted from: American Academy of Dermatology (Academy)
<http://www.news-medical.net/news/20100305/Dermatologist-addresses-common-parasitic-infestations-and-latest-treatment-options-at-Academy-Annual-Meeting.asp>

Excerpts from: <http://www.news-medical.net/health/What-is-head-lice.aspx>.

Text 2

Head Lice Resistance to Pesticides

Pharmacists and doctors have relied on chemical pesticides to kill head lice. Some of the chemical pesticides are over the counter products, and others are prescriptions. Their purpose is to affect the nervous system of the lice, to disrupt their ability to move and eat, or to kill bacteria that lives in their gut, which provides nutrients to them. If the bacteria die, the lice die. However, these may now be unwise choices for treatment, in light of potential lice resistance to these chemicals.

Resistance is the development of mechanisms to survive potentially deadly onslaughts. Many organisms that can cause disease have become resistant to many antibiotics. It should be no surprise that rapidly reproducing insects, such as head lice are developing resistance to the pesticides used to kill them.

Resistance has become a ‘growing problem’ since the 1970’s, as patients resort to using multiple treatments of chemical pesticides, which can also potentially and needlessly expose children to toxic chemicals. By 1999, several of the chemical pesticides were reported as virtually useless in England, while, in the U.S. 81% of patients using pyrethrin against head lice could not get rid of the lice. Also, more than 58% of people in the U.S. who treat against lice without success the first time have treated themselves with higher doses of chemical pesticides and have done it more frequently. Resistance seems to be affected by:

- how large is the spread of infestation,
- the type of chemical pesticides used,
- the variety of mechanisms by which lice resist chemical pesticides, and
- the pattern of use of chemical pesticides in different countries.

Scientists hypothesize that there are various resistance mechanisms that head lice develop, such as changes that take place in the amino acids of cells in the nervous system of the lice, so the chemical pesticides’ purpose is no longer effective; or by slowing down the absorption and metabolism of the pesticides into their bodies, allowing lice to live longer and to lay eggs; and by successful mutations in their DNA being passed on to succeeding generations for survival.

Sources:

Pray, W., Head Lice: New Approaches May Help Overcome Pediculicide Resistance, *US Pharm.* 2010; 35(3):10-15. Retrieved from:
<http://www.uspharmacist.com/content/c/19874/>
<http://www.ncbi.nlm.nih.gov/pubmed/14651472>

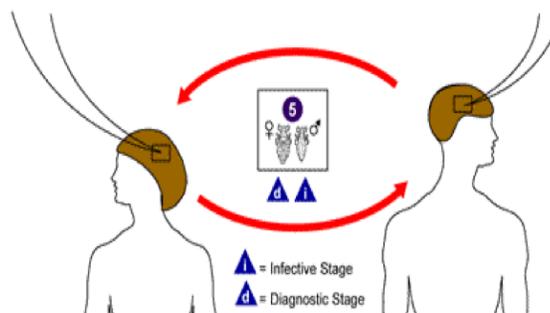
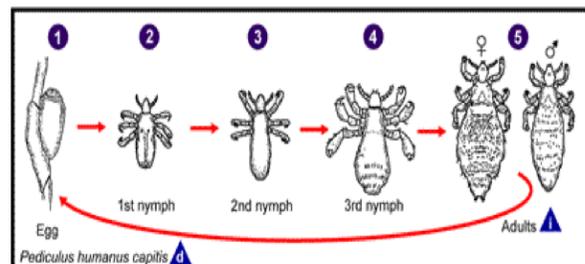
Text 3

Head Lice Life Cycle

Pediculus humanus capitis, the head louse, is an insect parasite that lives only on the outside of human hosts, particularly on hair close to the scalp (1 mm).

The adult female lice lay around 7 to 10 eggs a day and attach them to the hair using a glue-like, water-insoluble substance. Most eggs are laid at night and can survive for more than 2 weeks. The common site for these eggs or nits is the back of the head or back of the ears. The heat and the moisture of the human head help to incubate the eggs. Because people have a constant body temperature, female lice reproduce continuously throughout the year.

Each adult louse lives for around 30 days. Within 7 to 10 days the nymph emerges from the eggs and feeds on blood from the scalp. Another 7 to 10 days and three moulting stages makes the nymphs adult lice. New adult females start laying eggs soon after day 10. Consequently, the total life span of a head louse from egg through adult averages about 25 days.



To survive, a newly hatched head louse must have a blood meal within minutes of birth. Each louse takes several meals of blood each day and die if they are removed from the head for more than 2 days.

At any given time a person with an infestation has no more than 10 to 12 live head lice but over a 100 eggs or nits.

Source adapted from: from URL: <http://www.news-medical.net/health/What-is-head-lice.aspx>

Appendix A

2. Construct a scientific model that explains how head lice have, over time, become commonly pesticide resistant. Use the information in the texts. Use both visuals and words in the model.

Appendix A

3. Explain why the scientific model you constructed is a good model.

Date _____

Name _____

Introduction

Scientists have collected data that prove that Earth is warming up. Scientific models and experiments show that increasing amounts of carbon in the atmosphere causes this warming. One of the most important scientific questions today is “How are humans impacting the carbon cycle and what can be done about it?”

In your folder are four texts that will help you understand the carbon cycle and how humans are impacting it.

Your Tasks

1. Read the texts in your folder and write notes in the margins about your reading, thinking and problem solving processes.
2. After you have read the texts, respond to the following:

Use information from the texts to create a detailed model, using visuals (pictures, diagrams, graphs, etc...) and words that explain how humans impact the temperature of the Earth.

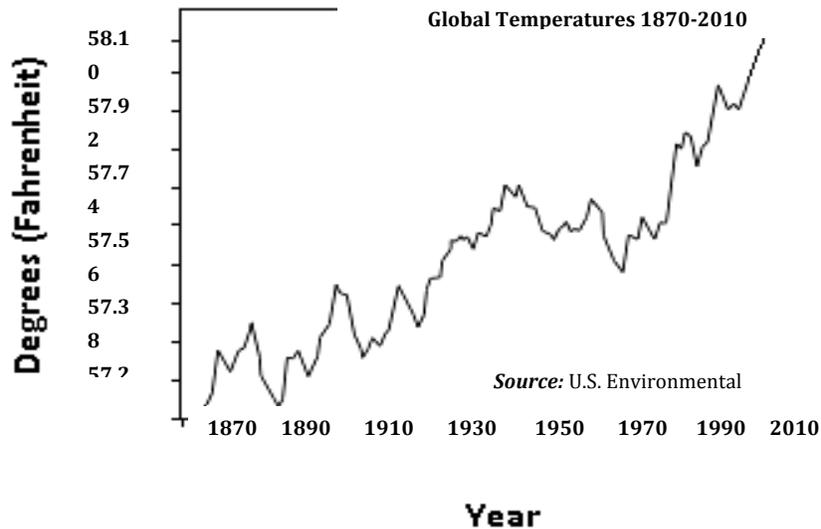
- You can read the texts in any order you wish.
- The information in the texts will help you create your model.
- When you have finished reading and writing notes on the texts take the blank paper that is in your folder and use it to create your model.
- You can look at the texts and your notes when you are creating your model.

Name _____

Changes in Global Temperatures

The temperature of the land and the oceans is measured by weather stations all over the Earth. Scientists have access to all of this temperature information. At the end of the year, they take the average of all of these temperatures. This average is called the global temperature of the Earth. Small changes in the average global temperature create big problems for living things. A recent study by the Royal Society of biological sciences found that warmer temperatures are related to higher extinction rates. *

Scientists have recorded temperatures around the globe since 1880. The graph below is a visual model made using this data. It shows the average global temperature of the Earth from 1880 to 2010.



* doi: 10.1098/rspb.2007.1302 *Proc. R. Soc. B* 7 January 2008 vol. 275 no. 1630 47-53

Name _____

Carbon Balance

Carbon is the backbone of life on Earth. We are made of carbon, we eat carbon, and our economies, our homes, our transportation all use carbon. On Earth, carbon is stored in the ocean, the atmosphere, in living things, and in the earth as rocks, soil, and fossil fuels. We call places that store carbon “sinks.”

Carbon moves between sinks through the carbon cycle. Carbon can be moved out of one sink and into another, but it never gets destroyed or goes away. For example, when people use gasoline in their cars, they are moving carbon from the lithosphere to the atmosphere.

Carbon dioxide is gas made up of one atom of carbon and two atoms of oxygen. Carbon dioxide traps heat in the atmosphere. Without it and other carbon gases, Earth would be a frozen world. When there is more carbon in the atmosphere, the Earth warms.

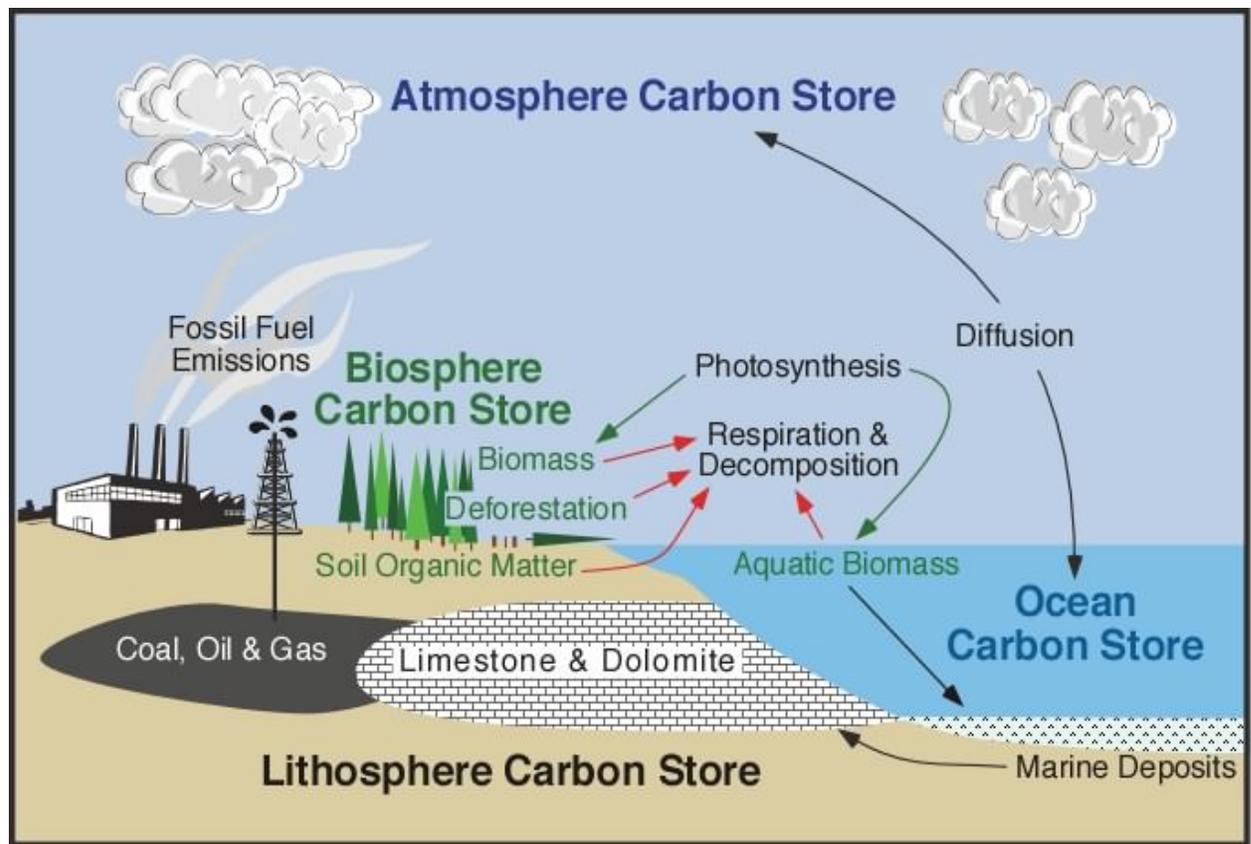
Name _____

Carbon Sinks

The diagram below is a visual model of the major carbon sinks, or “stores”.

Carbon is found

- (1) in living things in the *biosphere*;
- (2) as the gas in the *atmosphere*;
- (3) in soils in the *geosphere*;
- (4) as fossil fuels and rock in the *lithosphere*
- (5) in the oceans, or *hydrosphere*.



<http://www.physicalgeography.net/fundamentals/9r.html>

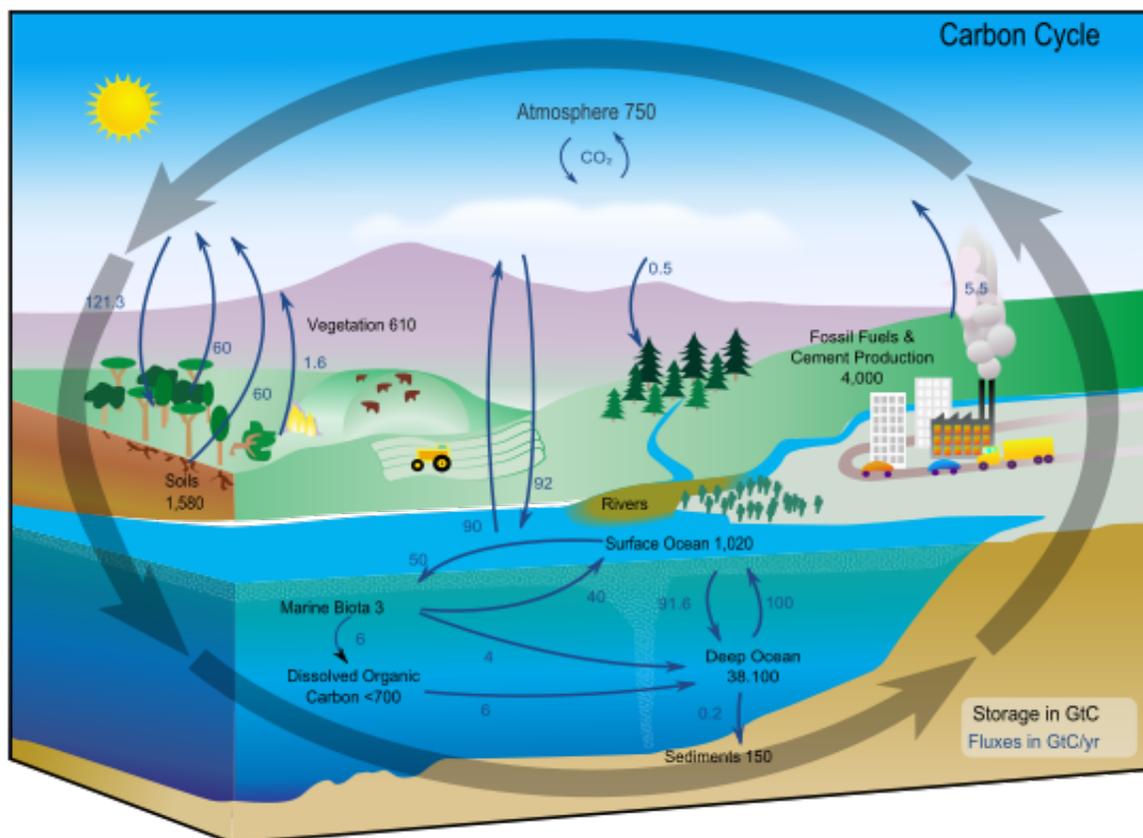
Name _____

The Carbon Cycle

The carbon cycle exchanges carbon among the biosphere, lithosphere, geosphere, hydrosphere, and atmosphere of the Earth. It is one of the most important cycles of the Earth and allows for carbon to be recycled and reused by all living things.

Over billions of years, the carbon cycle seems to maintain a balance between the atmosphere and the other four sinks. This balance has kept Earth's temperature relatively stable and capable of supporting life, unlike any other planet in our solar system. But the ways humans use carbon has moved carbon from a few sinks into the atmosphere. This is changing the balance between sinks and impacting Earth's temperature.

Visual Model of the Carbon Cycle



The black numbers show how much carbon is stored in different sinks, in billions of tons ("GtC" stands for gigatons of carbon).

The grey numbers indicate how much carbon moves between reservoirs each year.

http://en.wikipedia.org/wiki/File:Carbon_cycle-cute_diagram.svg

Appendix B

Annotations Code Book: Developing Assessments of Students' Science Reading Processes and Explanatory Models to Measure Learning Outcomes from Instruction with Text-Based Investigation Modules

Code	Definitions	Guidelines
Type 1: Type of Annotation		
Marks	Use for each type of mark - these are exclusive of one another: underlines, highlights, circling/boxings	<ul style="list-style-type: none"> *If the underline reaches to the end of one row of text and resumes on the beginning of the next, count it as one mark. *If the line stops for a punctuation mark, count it as one mark. *If the underline stops skips a word and then resumes, count them as distinct underlines. *If a string of words are each underlined whether or not there is a gap in the underlines, the string is counted as one mark.
Connecting mark	Between two or more places in the text; between text and annotation; between marked text and annotation; between annotation and annotation; between any two or more lines of text; between any two parts of text or between other marks or writing	These marks may be long or short. Can include arrows between text, brackets, carots, parentheses
Symbols	Symbols associated/near a text. Can be floating punctuation or other non alpha numeric items	<ul style="list-style-type: none"> *Code punctuation marks that are not attached to words also other non alphanumeric characters, such as stars, asterisk and other scientific symbols *Do Not Code doodles or pictures unrelated to topic in the margins
Comments (all writing in the margins should get one of the codes below)		
Single Words	May include a single word, a single word and a punctuation, or a short list of single words separated by slashes or commas	an article + word (a lot, the __) and two words connected by a hyphen are considered one word.
Sentences and sentence fragments	Sentences or sentence fragments making an assertion	Score an assertion followed by a ... 'right?' ... or 'correct?' as a statement. Albeit a tentative statement. (a wondering thought connected to the statement)
Questions	Sentence or sentence fragment posing a question MUST BE co-coded with either Single Word, or Sentence code	May be signaled by interrogatives, verb structure, or question mark.
Combinations of Comments Paired with Marks	Use this code to indicate instances where it is clear that the writing in the margin is associated with marks in the text and therefore should be understood together when deciding how to apply type 4 & 5 codes	<ul style="list-style-type: none"> Code if: *Comment is directly attached (by a connecting mark to marked text) *Comment has a clear referent to a specific sentence or phrase that is marked in the text. *Comment is directly attached by a connecting mark to unmarked text AND has a clear referent to a specific sentence or phrase. Referents could be a replicated word, summary, or synonym to the proximal text *Use low inference as to how the writing is connected to the marked text

Appendix B

Type 2: Association of Annotations

Associated with text	Annotations made on, linked to or nearby verbal text	
Associated with visuals/diagrams	Annotations made on, linked to or nearby visuals/diagrams or the verbal elements associated with the visual. Including any on captions, legends, labels etc.	

**Type 3: Occurrence of student voice in annotation.
CODE FOR ALL COMMENTS**

Verbatim Excerpts / Author's Voice	Verbatim/near verbatim or excerpts from text. "Near verbatim" includes examples where student writes a selection of text but drops words or phrases, adds or drops articles, engages in single synonym word replacement	Include comments that are verbatim/near verbatim excerpts from the text, or condensed from the text - primarily authors words and structure, some words/phrases from text omitted
Comment foregrounding the student's voice/thinking	A comment expressing a students thoughts about the text, contexts or themselves. Mark student voice if a paraphrase/summary of text features at least 25% of words changed or there is a substantial change in sentence structure from the original	Almost all comments not coded as 'Author's voice' can be coded 'student voice.' Strong indicators are words, ideas, phrases in comments that are not in the text. May include use of punctuation marks (?, !) or other symbols.
Inaccurate representation	Comment expresses an idea not substantiated by the text nor our knowledge of the natural world	MUST co-code with Student voice comment

Level 4: Comments Indicating Close Reading Processes

Can be co-coded with either student or author voice
IF coded with type 1, comment & mark associated, use associated text to help assess what code type to apply
Can be multiply coded

Identifying unknown vocabulary	Comment expresses puzzlement regarding a word, term or symbol that is clearly unknown to the student	If comment is simply a "?", do not score as identifying unknown vocabulary because it is ambiguous whether student is expressing curiosity or confusion.
Defining vocabulary	Comment asserts/advances a meaning for an word, term or symbol	*Comment identifies a roadblock and expresses a meaning OR comment explicitly and overtly claims a meaning for a word/term, otherwise score as a paraphrase *May show identifying root words, looking ahead for meaning in the text for a definition, etc.
Paraphrasing and summarizing	Annotation is a paraphrase or summary (beyond the word level)	*Comment explicitly/overtly signals that it is a paraphrase/summary *OR (low bar criteria exception) comment IS an accurate paraphrase or summary. * DO NOT CODE if comment is a verbatim recopying of text- this is not considered a paraphrase nor a summary. Use definition of "verbatim" from type 3.

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<p>Making connections codes caveat: These codes are not meant to describe a student's internal thinking and knowing processes, rather they describe how a student is working with the texts presented. Therefore the aim is to take a very literal read of the text – and if the comment does not contain information within the text set, use Making connections: information outside of text set. This acknowledges that we have no way to know what knowledge the student brought to the text set from prior experiences</p>		
<p>Making Connections: information outside text set</p>	<p>Comment displays student connecting an idea in the text to idea(s) not present in any of the texts in the set</p>	<p>*Low bar *Can Co-code with any other type 4 code except other making connections codes</p>
<p>Making Connections: within text</p>	<p>Comment displays student making connections between two or more ideas present within the text</p>	<p>*Connection must be between ideas in two different sentences *Connecting lines can qualify as connections between ideas in the text*Can Co-code with any other type 4 code except other making connections codes</p>
<p>Making Connections: text to text</p>	<p>Comment displays student making connections between two or more ideas between two or more texts</p>	<p>*Connection must be between ideas in two different texts in the text set *High bar- needs to be clearly from the other text in the set, OTHERWISE code Making connections: outside text set *Can Co-code with any other type 4 code except other making connections codes</p>
<p>Predicting / Inferencing</p>	<p>Comment makes a prediction / hypothesis / inference / tentative claim</p>	<p>*Can be co-coded with paraphrase/summary- i.e.: if an inference is imbedded inside a summary *Must assert an outcome/connection/position/opinion not explicitly described in the text. *Could also be tentative claim. *Must display students expanding on the ideas text in any form (if comment does not extend ideas in text, code for paraphrase/summary)</p>
<p>Inquiry Questioning for knowledge building</p>	<p>Comment poses an inquiry question with the purpose of knowledge building.</p>	<p>*An inquiry question is a question posed that suggests comprehension rather than confusion with the meaning of the text AND asks for information beyond what is given explicitly in the text. *The question can posed in the form of a statement ("I wonder if...") *If comment expresses confusion or implies a misunderstanding, scores are identifying/expressing confusion. *If it simply asks for the meaning of word, code as identifying unknown vocab.</p>
<p>Metacognitive Comment</p>	<p>Comment shows student awareness of their own thinking process, or makes an evaluative statement regarding their own knowledge</p>	<p>* use this code broadly to help define. It would be helpful to me to have more clarity on this construct- metacognitive could include both comments about self-monitoring of understanding as well as other things like self-monitoring of emotions, etc.</p>

Appendix B

Type 5: Indicators of Scientific Reading Processes

<p>Comments on Science in text</p>	<p>Indicates that student displays a SCIENCE reading stance (in addition to close reading stance) or engaged with science in the text that is NOT part of the explanatory model or the phenomena in focus</p>	<p>*Code if comment indicates student is situating themselves as a reader of a science text* Can co- code with type 5 cross cutting concepts or scientific argument arguments* Use for things like paying attention to text features that are science specific, attention to size and quantity that is not at the level of the system or phenomena, *NEVER co-code to other Nascent Modeling codes</p>
<p>Nascent Modeling</p>		
<p>Comments on the phenomena or specific elements of the explanatory model</p>	<p>Indicates student is showing thinking about the topic of the text set. We are using phenomena as a proxy for topic. Indicates student is showing thinking or engagement with a component or of the explanatory or causal model. Not limited to an the understanding of that component as conscribed by the explanatory or causal model design.</p>	<p>*Code if the comment evidences a science reading stance AND is on the text topic *DO NOT code if comment is on an element of the explanatory or causal model (see Type 5 modeling codes)</p>
<p>Comments on the relationships in the explanatory model (relationship between elements)</p>	<p>Indicates student is showing thinking or engagement with the links or relationships between elements in the explanatory model for the phenomena.</p>	<p>*Code for any comment or combination comment/mark that expresses attention to the ways in which two or more elements of the explanatory or causal model are understood to interact in the causal or explanatory model *DOES NOT need to be a causal relationship *Can Co-code with type 5 cross cutting concepts or scientific arguments *NEVER co code with other nascent modeling codes</p>
<p>Modeling</p>		
<p>Generate a course of action based on the explanatory model</p>	<p>Annotation expresses a course of action about the problem and implicitly/explicitly indicates the basis from the explanatory model.</p>	
<p>Identifying Cross-cutting / unifying concepts in science</p>	<p>Annotation expressly note a connection to a cross cutting/ unifying concept in science.</p>	<p>*If evolution is biological evolution, score as schema development, or as science topic knowledge. *Only 3 of the cross cutting concepts are strongly evoked by module and assessments text sets (#3. Cause and Effect, #4 Scale, proportion and quantity, and #7 Stability and Change) Of these #3 and #4 are addressed by the nascent modeling codes. So on Attending to scale is pulled out as a code of its own.</p>

Appendix B

<p>Attending to Scale Proportion and Quantity</p>	<p>A comment about the scale, quantity or proportion of the system and associated with text evidence about the scale, quantity or proportion.</p>	<p>*Must be on a phenomena or system (not “this paragraph has a lot of words”) *Must be about measurable items (e.g., “seriousness” is not measurable) *Comment can be qualitative or quantitative in nature *Text can be qualitative or quantitative, but topic must be measurable</p>
<p>SUPPORTING AN ASSERTION: Annotation offers evidence and/or principled reasoning for own claim)</p>	<p>[Undefined due to lack of sufficient evidence in the data]</p>	<p>This must be double scored for previous argument codes.</p>
<p>Generating a hypothetical/mental Causal Model</p>	<p>[Undefined due to lack of sufficient evidence in the data]</p>	
<p>Stability and change</p>		
<p>Attention to Argument</p>		
<p>Attending to ARGUMENTS: Noting in texts arguments advancing models and explanations (ungrounded in pre/post, no examples yet)</p>	<p>A comment associated with a portion of text that is an aspect of an argument (incl. claim, warrant, backing, etc.).</p>	<p>*If function of the comment is clarifying, score a clarifying arguments. *If function of the comment is evaluative, score as evaluating arguments. *Text associated with comment must be an argument (Claim with kind of support). * If it is a claim without evidence, consider if it is an explanation.</p>
<p>EVALUATING ARGUMENTS Evaluating-questioning of science argument.</p>	<p>Evaluating the model as it is in the text based on own schema (not evaluating the authors argument, if any) Asks questions about the nature of the model/phenomena, its processes and interactions, based on own schema.</p>	<p>*May be related to recommendation/ solution *Annotation reflects a skeptic stance.</p>