Leveraging Literacy in Science

Grades 9-12

Participant Handouts

ARKANSAS DEPARTMENT OF EDUCATION

Charlotte Danielson's FRAMEWORK FOR TEACHING

DOMAIN 1: Planning and Preparation

1a Demonstrating Knowledge of Content and Pedagogy
- Content knowledge • Prerequisite relationships • Content pedagogy

1b Demonstrating Knowledge of Students
- Child development • Learning process • Special needs
- Student skills, knowledge, and proficiency
- Interests and cultural heritage

1c Setting Instructional Outcomes
- Value, sequence, and alignment • Clarity • Balance
- Suitability for diverse learners

1d Demonstrating Knowledge of Resources
- For classroom • To extend content knowledge • For students

1e Designing Coherent Instruction
- Learning activities • Instructional materials and resources
- Instructional groups • Lesson and unit structure

1f Designing Student Assessments
- Congruence with outcomes • Criteria and standards
- Formative assessments • Use for planning

DOMAIN 2: The Classroom Environment

2a Creating an Environment of Respect and Rapport
- Teacher interaction with students • Student interaction with students

2b Establishing a Culture for Learning
- Importance of content • Expectations for learning and achievement
- Student pride in work

2c Managing Classroom Procedures
- Instructional groups • Transitions
- Materials and supplies • Non-instructional duties
- Supervision of volunteers and paraprofessionals

2d Managing Student Behavior
- Expectations • Monitoring behavior • Response to misbehavior

2e Organizing Physical Space
- Safety and accessibility • Arrangement of furniture and resources

DOMAIN 4: Professional Responsibilities

4a Reflecting on Teaching
- Accuracy • Use in future teaching

4b Maintaining Accurate Records
- Student completion of assignments
- Student progress in learning • Non-instructional records

4c Communicating with Families
- About instructional program • About individual students
- Engagement of families in instructional program

4d Participating in a Professional Community
- Relationships with colleagues • Participation in school projects
- Involvement in culture of professional inquiry • Service to school

4e Growing and Developing Professionally
- Enhancement of content knowledge and pedagogical skill
- Receptivity to feedback from colleagues • Service to the profession

4f Showing Professionalism
- Integrity/ethical conduct • Service to students • Advocacy
- Decision-making • Compliance with school/district regulations

DOMAIN 3: Instruction

3a Communicating With Students
- Expectations for learning • Directions and procedures
- Explanations of content • Use of oral and written language

3b Using Questioning and Discussion Techniques
- Quality of questions • Discussion techniques • Student participation

3c Engaging Students in Learning
- Activities and assignments • Student groups
- Instructional materials and resources • Structure and pacing

3d Using Assessment in Instruction
- Assessment criteria • Monitoring of student learning
- Feedback to students • Student self-assessment and monitoring

3e Demonstrating Flexibility and Responsiveness
- Lesson adjustment • Response to students • Persistence

DL 6-8 Tectonic Plate Simulations

Record observations

Organize observations

Write your explanation of the science phenomena based on your observations

Vocabulary Self-Awareness Chart

Vocabulary Term	Know Definition	Know Example	Don’t Know Either Yet	Definition	Example(s)

Affixes and Word Parts Commonly Seen in Scientific Words			
anthr-/andr- (man)	**ecto-** (outer)	**macro-** (large)	**post-** (after)
****aqu-** (water)	**-ed** (past)	**meta-** (change)	**pre-** (before)
astr- (star)	**electro-** (electricity)	**mar-** (sea)	**pro-** (forward)
auto- (self)	**endo-** (within)	**-mania** (madness)	**proto-** (first)
****bi-** (two)	**eu-** (well, good)	**mis-** (wrong)	**pseudo-** (false)
biblio- (book)	****ex-** (out or away from)	**micro-** (small)	**psycho-** (mind)
bio- (life)	****-flect/flex-** (bend)	****-meter** (measure)	**quad-** (four)
		****mono-** (one, alone)	
cardio- (heart)	**-form** (shape)	**multi-** (many)	****re-** (again, back)
chemo- (chemical)	**frag-/fract-** (break)	**-ology** (study of)	**scop-** (see)
chlor- (green)	****geo-** (earth)	**ortho-** (straight)	**-scribe** (write)
		****para-, par-** (beside, alongside, related to; disordered, sideways, wrong, contrary to, different (from)	

chron- (time)	**hydro-** (water)	**paleo-** (old, ancient)	**-sect (cut)
-cide (kill)	**hyper-** (too much)	**-ped/-pod** (foot)	****sub-** (under)
****-cline-** **(lean, slope)**			
****co-** (with)	**hypo-** (not enough)	**-phobia** (fear)	**super-** (above)
-cycle (repeating event)	**-ify/-ize** (make)	**phono-** (sound)	**tele-** (far away)
****Con-** (together, with)	****in-, il-, im-, ir** (not, toward, into, very, thoroughly)		
****de-** (down or removal of)	**-ing** (action, process)	**photo-** (light)	****trans-** (across and through)
****di-** (two)	**-iosis** (disorder)	**poly-** (many)	**tri-** (three)
****dis-** (away from)	****kine-** (move)		
	****litho-** (stone, rock)		
eco- (habitat)	**-ology** (science, body of knowledge)	**port-** (carry)	**uni-** (one)
			****vect-** (carry or convey)
			****vi-, vis-** (force,

			violence)

Grades 6-8 Sniglet Activity

Participants create 'sniglets' with the following:

mar-
bi-
ex-
-fect
-flex
-form
mono-
re-
geo-
-cline
co-
-sect
sub-
de-
trans-
di-
dis-
kine-
litho-
vi-
-vect

Core Actions for K-12 Science

Text taken/adapted from: 1) Student Achievement Partners, CCSS Instructional Practice Guide for ELA and 2) Pearson, Moje, and Greenleaf (2010).

CORE ACTION 2: Develop disciplinary literacy in science by employing lessons focused on high quality texts, as well as questions, tasks, and dialogues that are evidence-based.

(Teacher Rubric Strands: I-A-1. Subject Matter Knowledge; I-A-4. Well-Structured Lessons; II-A-1. Quality of Effort and Work; II-A-2. Student Engagement)

The teacher:

A. scaffolds student learning with discipline specific strategies and makes their use explicit to students.
B. provides opportunities for students to conduct research, drawing appropriate and sufficient evidence from informational texts, observational studies, investigations, and design solutions, to justify arguments and develop explanations.
C. creates the conditions for conversations where students listen carefully to construct, understand and critique ideas.
D. uses explicit strategies to support students' acquisition and transferability of academic and domain specific vocabulary.
E. provides regular opportunities for and feedback on students' writing, including their use of Standard English grammar and science domain conventions.
F. uses science notebooks each day as a learning resource to record and reflect upon science lessons.
G. uses curriculum embedded performance tasks to inform and assess instruction (e.g., CWAs, PBTs, etc.).
H. uses non-fiction science texts(s) that are: at or above the complexity level expected for the grade and time in the school year; content-rich and designed to build knowledge and enable rigorous evidence based discussions and engagement.
I. embeds *close reading* questions that are sequenced to guide students to delve deeper into the text to identify key ideas and details.
J. conceptualizes reading in science as a form of scientific inquiry by setting purposes, asking questions, clarifying ambiguities, drawing inferences from incomplete evidence, and making evidence-based arguments.

Scaffolds and Supports for English Language Learners and Students with Disabilities

Provide opportunities for students to process and produce language at the discourse, sentence, and word/phrase level.	Include sensory, graphic and/or interactive instructional supports (e.g., digital media, graphic organizers, word walls, and anchor charts).	Explicitly link prior learning and new concepts (e.g., through complex text, critical reading discussion, digital media, etc.).
Use WIDA standards and integrate language domains (e.g., reading, writing, speaking, and listening) to develop language targets and objectives that are appropriate for students' language proficiency and instructional levels.	Enable rigorous evidence-based discussions and engagement by providing language structures (e.g., sentence stems) and using protocols (e.g., turn-and-talks, retelling, summarizing and synthesizing the main points, and collaborative learning structures).	Explicitly teach relevant Tier 2 vocabulary words to build the academic language necessary for students to read, write, and/or discuss texts and tasks. Tier 3 vocabulary should be embedded within the context of the lesson rather than at the start of the lesson.
Model annotation (e.g., through shared and interactive reading and writing) of high-quality grade level text at the word, phrase, or sentence level.	Create authentic and meaningful assessments in conjunction with timely and targeted feedback on a consistent basis.	Select an essential complex aspect of the text in which to delve deeper (e.g., close read) with questioning and academic language instruction.

New Learning	Surprising Information	I Need to Know More About.......

STUDENTS' CLOSE READING OF SCIENCE TEXTS

What's Now? What's Next?

Diane Lapp ▪ Maria Grant ▪ Barbara Moss ▪ Kelly Johnson

Are you wondering how to weave together the Common Core State Standards and the new Next Generation Science Standards as you support students closely reading science texts? This article offers a few very practical suggestions for making this your classroom reality.

Gearing up for changes in curriculum as the Common Core State Standards (Common Core State Standards [CCSS] Initiative, 2010) weave their way into schools, teachers experience a multitude of emotions—fear of change, a desire to embrace change, and for some, confusion about how to proceed. Although coming to grips with the specifics of the CCSS is challenging, supporting students' growth from *below* and *far below basic* achievement levels to levels at which they can closely read, discuss, and write about complex informational text is daunting. Through a "what's now, what's next" perspective, we explore instructional moves supportive of ascending performance as students closely read science texts, a genre often fraught with difficulty for many underperforming students.

Balancing Narrative and Informational Text Reading

What's Now?

Informational *text*, a specific form of nonnarrative text communicating information (National Assessment Governing Board, 2008), is defined by the CCSS (2010, p. 31) as including the following:

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- Biographies and autobiographies
- Books about history, social studies, science, and the arts
- Technical texts, including directions, forms, and information displayed in graphs, charts, or maps
- Digital sources on a range of topics

Primary and elementary students lack exposure to reading informational texts because teachers emphasize story (Duke, 2000; Hoffman, Roser, & Battle, 1993; Ness, 2011; Swanson, Wexler, and Vaughn, 2009) over informational texts and often read aloud narratives (Yopp & Yopp, 2006) rather than support independent reading of informational texts either in class or as homework (Wade & Moje, 2000). When science is taught, inquiry-based instruction through hands-on experiences often minimizes textbooks (Pearson, Moje, & Greenleaf 2010). Furthermore, since the testing requirements for No Child Left Behind were enacted, 71% of elementary school districts nationwide have reduced time spent on subjects other than reading and mathematics (Jennings & Rentner, 2006); in many California schools, students receive little or no social studies or science instruction (Wineburg, 2006).

"Reading science texts can help students learn more about the social, biological, and physical realms of our world, and connect to real world issues."

What's Next?

We assume that the CCSS assessments will mirror the 50/50 narrative/informational text balance suggested for fourth graders on national assessments (National Governing Board, 2008). Students will still read stories, but they will also read informational texts for 50% of the school day across all content areas. Findings from the 2009 National Assessment of Educational Progress confirm the need for more informational text in reading science; only 34% of fourth graders, 30% of eighth graders, and 21% of 12th graders performed at or above the "proficient" level in science.

Exposure to a range of informational text types is essential if students are to develop facility with this genre (Dreher & Voelker, 2004) because discourse forms differ within specific disciplines. The ability to read exposition, argumentation, persuasive, and procedural texts and documents require different skills (Shanahan & Shanahan, 2008), but all are critical to reading and understanding science (Saul, 2006). Informational science texts expose students to the genre and linguistic registers characteristic of scientific discourse (Varelas & Pappas, 2006). As noted by Maloch and Bomer (2013), classroom instruction should provide detailed insights about differences associated with reading informational and narrative texts.

Science educators view reading as an important aspect of scientific inquiry (Douglas, Klentschy, Worth, & Binder 2006; Yore, Bisaz, & Hand 2003). According to Yore (2004), "good science educators recognize the centrality of literacy to the scientific enterprise" (p. 69). Reading science texts can help students learn more about the social, biological, and physical realms of our world and connect them with real world issues that affect us nationally and internationally. As informed everyday citizens, they will eventually cast intelligent, research-related votes on ballot issues addressing food safety, hazardous materials, energy, water use, and pollution. With developing understandings, some will even become the creators of important ideas and innovations.

Closely Reading Science Texts: Building From a Base of Instructional Knowledge

What's Now?

The CCSS call for students to critically read increasingly complex texts across content areas with the expectation that

Pause and Ponder

- Consider a science lesson in which you might incorporate a close reading.
- During each rereading, what text-dependent questions would you ask to get students to delve more deeply into an identified chunk of the text?
- Contemplate how partner or small-group collaborative conversations provide students opportunities to expand and consolidate their understandings of the author's message through the workings of the text, such as language patterns, structure, and cohesion.
- Think about how your observations of the students' performances during a close reading help you to identify both the science and literacy teaching points.

by high school graduation they will be able to read college or career-related texts. Doing so involves "the mindful, disciplined reading of an object (i.e. text) with the view to a deeper understanding of its meaning" (Brummett, 2010, p. 3). Very close reading involves analyzing the unfolding of all text dimensions, including language, form, argument, and ideologies within texts, emphasizing the particular over the general (Fisher & Frey, 2012; Richards, 1929).

Close reading represents *one type* of classroom reading in which a small or large group of students "have a go" at a text. Student(s) become the primary investigator(s) of the text and its meaning. During a close reading, students explore the deep structures of a text (Adler & Van Doren, 1940/1972), identifying the "bones" of the passage. They return to the text at the word, phrase, sentence, and paragraph levels to fully comprehend how the "important details fit together to support the author's central idea(s)" (Cummins, 2012, p.8). Selectively using the cognitive functions of remembering, understanding, applying, analyzing, evaluating, and creating (Anderson & Krathwohl, 2001), the reader draws on prior and immediate knowledge to support integrating new text information within existing information. "In reality, none of these cognitive functions or strategies is used in isolation, but instead, depending on what comprehension needs are triggered by the text, a proficient reader draws from his or her bank of familiar strategies to support meaning making" (Fisher, Frey, & Lapp, 2012, p. 20).

What's Next?

Science texts are especially suited for close reading because of their density and level of challenge. The language used in some science texts far exceeds the experience and reading abilities of many students (Chui & Yong, 2010; Merzyn, 1987); furthermore, learning the language of science poses a major challenge to pupils (Wellington & Osbourne, 2001), because science has its own language. Closely reading scientific texts demands deep engagement with the text to understand its content (Pearson and Raphael, 1990), requiring students to assess the validity of text claims, infer meanings, and use text structures to facilitate comprehension.

Close text reading requires students to read a passage without in-depth preteaching or frontloading by the teacher. This differs from instructional practice in which teachers do so much frontloading that students never get a chance to "dig deeply" on their own. This does not mean that preteaching is never warranted if the teacher determines that some context is needed to support comprehension (Jago, 2012). In fact, as noted by Sandler and Hammond (2012/2013), the CCSS do not ban prior knowledge; teachers can accelerate student mastery of analytical reading by prompting, providing cues, and so forth to help students use prior knowledge during text reading, rather than frontloading. Through more of a back-filling rather than a frontloading process, teachers give students the initial opportunity to apply their bases of knowledge to text reading, just as they must do when reading independently.

Addressing Teachers' Concerns

K–5 teachers at a California school where we were providing professional development expressed concerns about teaching students to read challenging texts, particularly the CCSS text exemplars (see Appendix B of the CCSS). They found many of the texts relatively difficult, especially for English learners and striving readers. Several reluctantly admitted that they didn't know how to teach students to read informational texts. One fourth-grade teacher noted, "It just isn't part of my usual instructional practices and it wasn't a focus of my credential program." A second-grade colleague added, "I've been a teacher for 10 years, and none of my previous professional development efforts included any information about close text reading."

Their thoughts reflected the voices of others who are unclear about the instructional practice of close text reading. Together we created flexible, close reading instructional procedures that allowed teachers to decide how many times and in what ways to push the students back to the text for deepened understandings.

Close Reading Procedures

Teacher

Steps for preparing for close reading are as follows (steps 1 and 2 are interchangeable):

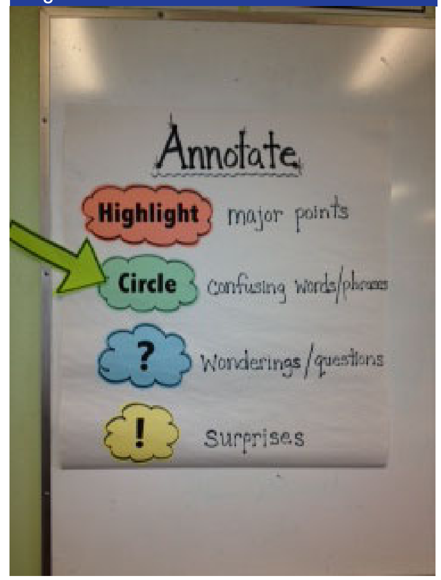
"Close reading represents one type of reading in which students 'have a go' at a text, becoming the primary investigator(s) of its meaning."

1. Select "compact, short, self-contained texts that can be read and reread deliberately and slowly" (Coleman & Pimentel, 2012, p.4).
2. Identify the purpose(s) for the close reading, which may be to understand the gist, note distinctive language, identify key ideas, infer author craft and intention, analyze text structures and organization, or argue a position. Accomplishing the purpose may involve multiple readings; however, during each encounter, the purpose(s) for the investigation should be clear to students and supported by text-dependent questions.
3. Prepare the text for presentation by numbering lines, paragraphs, or stanzas to support ease of reference, focus, and discussion. If children cannot annotate and write in the text, lines can be numbered using small sticky notes. If teachers use shared reading with emerging readers, they should point to the section being read, identify where students should focus, and clarify how much of the passage should be read or listened to at a time.
4. Teach children how to annotate the text sparingly, because too much highlighting can cause children to lose focus. Students can annotate keywords or phrases, confusing concepts, inferences, main ideas, and so on, all related to the lesson purpose. They can highlight each in a different color, using colored highlighters or pencils. Pencils can also be used to circle and underline keywords or phrases that relate to the identified purpose (see Figure 1 as an example of an annotating chart).
5. Write text-dependent questions and prompts that will continually push the students back into the text for deeper analysis. Questions should "be answered by careful scrutiny of the text… and do not require information or evidence from outside the text or texts" (Coleman & Pimentel, 2012, p. 5). Questions should require children to search, synthesize, infer, and make text-supported judgments.

Students and Teacher

1. First reading—Teacher shares purpose and process. Students engage in the first reading and annotating, prompted by a posed question (e.g., What is the general information the author is sharing about...?).
2. Chatting and charting—Students share responses and annotations with a partner. If students cannot write in the text, annotations and information can be written on sticky notes or a graphic organizer.
3. Reading again—Based on insights from the conversation, the teacher asks additional text-dependent questions that return students to the text multiple times to accomplish the lesson purpose.
4. Chatting and charting—Conversation occurs after each return to the text. Responses should deepen after each reading and conversation.
5. Independence—At the conclusion of the reading, students, independently or with others, engage in a task illustrating their understanding of the text (e.g.. writing text- supported arguments, a multimedia project, an opinion paper that uses text-based evidence, a collaborative poster, etc.).

Figure 1 Annotation Chart



Reflecting on the Procedures

After teaching students to closely read informational texts, these teachers were very pleased with the results, noting that they were in "awe of the deep thinking their students shared." Several stated that students loved the experience and wanted to "do it again, even though it made their brains tired. They surprised themselves with how much they were learning, even after their first reading."

"After teaching students to closely read informational texts, teachers noted that they were in 'awe of the deep thinking their students shared.'"

Implementing the Procedures

The following examples illustrate a flexible implementation of these procedures by a first, and a fifth grade teacher as they teach students to closely read science texts.

First Graders Closely Read *Starfish*

Preparing for Close Reading

Before beginning the lesson based on the book *Starfish* (Hurd, 2000), a K–1 CCSS text exemplar, Ms. Weller read the text carefully while thinking about her students and the lesson purpose, which was to understand key features of starfish and address CCSS RI.1.2 ("Identify the main topic and retell key details of a text"). She identified language, ideas, and text features she needed to address and prepared text-dependent prompts/questions to push children back to the text to continually scaffold their understandings.

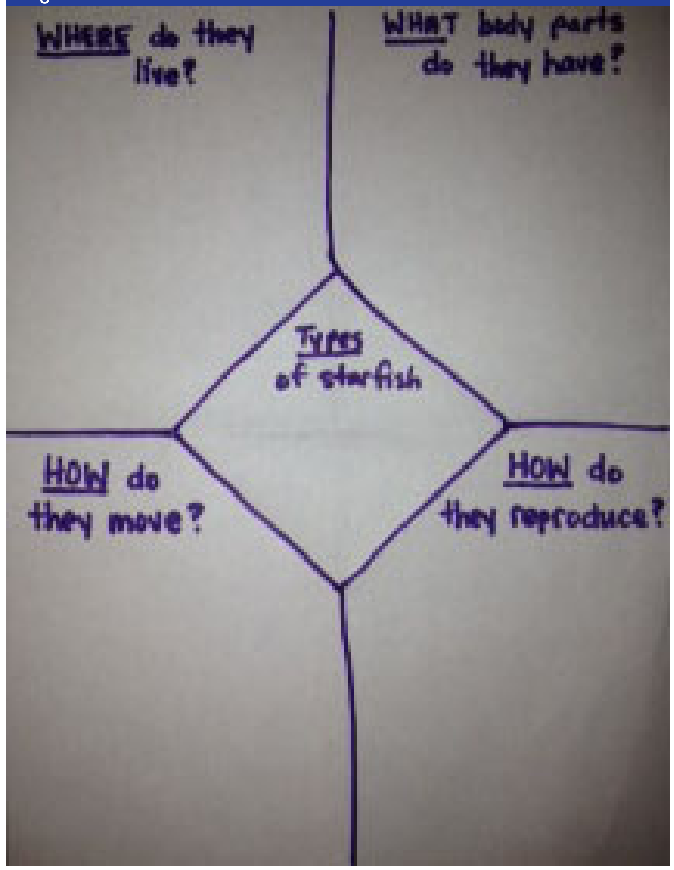
She also prepared a Foldable (Figure 2) that included these questions: Where do they live? What types of starfish are there? What body parts, do they have? How do they move? How do they reproduce? She had previously shown students how to "read with a pencil," demonstrating how she annotates using sticky notes when she wants to notice key vocabulary, record information, or question the text.

First Close Reading, Annotating, and Chatting

Ms. Weller began her the close, shared reading by explaining to students that they would be learning about key features of starfish. She displayed the book under the document camera so all could see the print and illustrations. She prompted the children to closely listen for information that identified what a starfish is, where starfish live, types of starfish, their body parts, how they move, and how starfish reproduce. She provided students with a Foldable (Figure 2) containing each of these questions.

She read aloud chunks of the text, moving slowly, showing the illustrations on each two-page spread. Stopping every few pages, she asked children to annotate by writing or drawing on their Foldable what they remembered about each question. After students analyzed content independently, they partner-shared their Foldables with one another, noting what details they remembered.

Figure 2 Foldable



Second Close Reading: Annotating, Chatting, and Expanding Understanding

Next children listened to the teacher read aloud pages one through three, which revealed where starfish live. They were then instructed to review their drawings and add details or write words they learned from these pages. Ms. Weller again invited partner talk, during which students shared their details. She continued chunking the text as children listened for more information about each question and added details onto the Foldable. As they did so, she listened in to support, assess understanding, and determine next instructional steps.

Finding that most students could articulate where starfish live but were having trouble identifying their body parts, she prompted them to "return to the text to identify a body part that a starfish would have that we also have." Once they identified a feature such as eyes, she pushed them back into the text with the text-dependent question, "What is a feature or characteristic of a starfish that we don't have, but we use for the same purpose?" As they shared responses such as *arm* (*ray*), she helped them show and share where they located this information by approaching the document camera and using their hands to encircle the appropriate text sections. She reminded them of the importance of returning to the

"A close reading need not involve three return visits to the text. The number depends on the lesson purpose and student performance."

text for evidence. Using their Foldables as a foundation, they formalized their thoughts through collaborative academic conversations about the text content and added new ideas to their Foldables.

Next Close Reading

Once students understood the features of starfish, Ms. Weller wanted them to focus on the craft of the text, emphasizing the author's descriptive language. To address CCSS RI.1.4 ("Ask and answer questions to help determine or clarify the meaning of words and phrases in a text"), she prompted, "What words does the author use to describe the starfish?" Again chunking the text, she invited student responses. She also asked questions about the author's word choices. For example, on page 10, she asked, "What two rhyming words does the author use to tell us how starfish move on their feet?"

After children identified *slide* and *glide*, she asked them to say the words to a partner and modeled her thinking: "Hmm, What does it mean to glide and slide? When I glide, I move without making noise. When I slide, I move smoothly, like sliding down a hill on the ice. Let's use our bodies to show what it means to glide and slide." She asked them to write *slide* and *glide* and illustrate these words on their Foldables under the section labeled *How do they move?*

After experiencing the text multiple times, Ms. Weller introduced additional, challenging, text-dependent questions (Figure 3) designed to help students think more deeply about the text. The answer to one question (How do starfish find food and feed themselves?), which addressed CCSS RI.1.3 ("Describe the connection between two individuals, events, ideas, or pieces of information in a text"), required students to infer that they needed to locate answers to a single question on different pages of the text. She invited individuals to come to the document camera and point to the sections that had helped them infer this textual evidence. They discussed clues they found to answer the question.

Reading and Talking Transition to Writing

Once students understood the features of starfish, Ms. Weller asked, "What did the author want us to know at the end of this book?" Answering this question, which focused on CCSS W1.2 ("Write informative/explanatory texts, in which they name a topic, supply some facts about the topic, and provide some sense of closure"), required students to support their inferred understandings with text-based information.

Ms. Weller asked students to listen (or chorally read with her if they were able to) as she read the entire text once more. She provided sentence frames to use for partner talk about the author's intent and their new information. She reminded them to look for ideas from the text to support their thinking about the starfish and also the author's intent.

- The author wrote this book to tell us that ___________________.
- After reading this book, I know that _________________.

At the culmination of the close reading, the children used their Foldables and the sentence strips to write a report sharing what they had learned about starfish and what they were still wondering (Figure 4A and 4B).

Throughout the readings, Ms. Weller's observations of students' listening, thinking, reading, and writing made obvious their strengths and needs. In essence, observing their close text reading and chatting provided a formative assessment of the next instructional steps needed to support developing their independence

Figure 3 Text-Dependent Questions for *Starfish* (Hurd, 2000)

What is a starfish? *(general understanding)*

Which body parts do starfish have and not have? (*key details*)

Who is telling us the information, the starfish or a narrator? How do you know? (*author's purpose*)

Why did the author write this book? To entertain or inform? (*author's purpose*)

What words does the author use to describe the starfish? (*vocabulary*)

What two words does the author use to tell us how starfish move on their feet? (*vocabulary*)

How do starfish find food and feed themselves? (*inference*) with the text. A close reading need not involve three return visits to the text. The number of revisits depends on the lesson purpose and student performance in relation to accomplishing the purpose.

Fifth Graders Closely Read *Hurricanes: Earth's Mightiest Storms*

In Mr. King's fifth-grade classroom, students were studying storms. Using an excerpt from *Hurricanes: Earth's Mightiest Storms* (see CCSS, Appendix B), he prepared students to independently read challenging informational texts and to scientifically understand hurricanes. At the onset, Mr. King shared that the purpose for reading the excerpt was to understand how changeable atmosphere creates storms. Here's how this lesson evolved.

First Reading

Students were presented with the text excerpt to read and answer the purpose-driven, text-dependent question, What two parts of the environment work together to create hurricanes? (Figure 5). This question addressed CCSS RI 5.3 ("Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text").

During the first reading, students annotated the text, a skill they had previously learned. They highlighted main ideas, circled confusing words or phrases, identified wonderings with question marks, and indicated surprise using an exclamation point. Because paragraphs in the excerpt were numbered, students in later discussion identified where they found information about how the environment works to create hurricanes and shared difficult

Figure 4 My Starfish Report

(A)

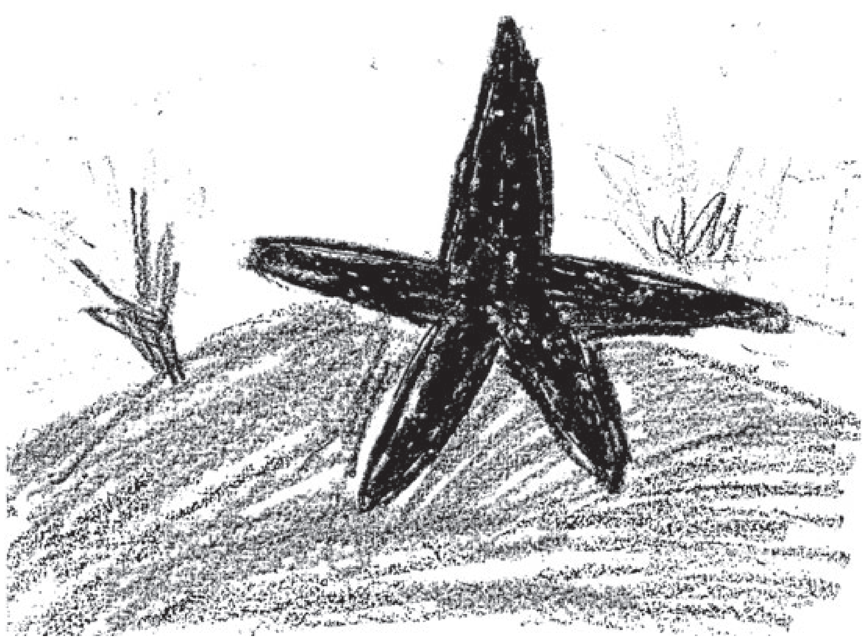
My Starfish Report

I know that Starfish live________. I read about________and________ ________which are different types of Starfish. Starfish have ________and________. They ________and ________to move about in the water. They reproduce by________. The author wrote this book about Starfish because________.

(B)

Ricky's Starfish Report

I know that starfish live in the sea. I read about mud stars and the sunflower starfish which are different types of starfish. Starfish have feet and rays. They slide and glide to move about in the water. They reproduce by laying tiny eggs. The author wrote this book about starfish to give information. I think starfish are important because they're a part of the sea habitat.



"Listening in on student discussions provides an opportunity for assessment and support."

words and phrases. They indicated where they put question marks beside confusing lines and recorded questions in the text margins. Responses to the first text-dependent question could be answered with a simple, single-sentence response (The two parts are atmosphere and tropical waters.); however, to arrive at this, students had to navigate complicated science ideas bobbing around in a sea of academic and topical vocabulary.

It is precisely through these complex "waters" of informational language that Mr. King wanted his fifth graders to navigate. He later explained why he engages students in closely reading texts:

> I know that I can't be standing over their shoulders when they are at home reading *Scientific American* or in the school library researching for a science fair project. I need to empower them to move through tough science language with the skill and fortitude of a captain expertly moving his ship through uncharted waters. I want students to feel they are limitless when it comes to reading informational text. I don't want them to be held back by language—academic or topical.

Mr. King does not leave students to struggle with challenging vocabulary or confusing concepts. Instead, he strategically listens in as students share responses to initial questions through partner conversations. When students can't provide the expected response, he poses another text-dependent question that helps them home in on the targeted ideas. When Andrew wondered why the text referred to the atmosphere as "the envelope of air that surrounds the earth and presses on its surface," Mr. King asked him to make an intertextual connection by asking, "Remember the description of the atmosphere in our reading on Tuesday and the diagram in the text? How is the atmosphere like an envelope?"

Andrew pondered this and tentatively responded, "Well, an envelope covers a letter—It goes around it. And the air of the atmosphere goes around the Earth. I guess they are both covers for something, and I remember from the reading that air has a little weight. Maybe that's why it presses on Earth." Listening in on student discussions about text-dependent questions provides an opportunity for assessment and support—one that Mr. King intentionally uses as a mechanism for offering differentiated instruction.

Next Reading

The next text-dependent question intentionally focused on key vocabulary. Mr. King asked students to read to answer the question, How are areas of high and low pressure different? As he moved through the room monitoring student's additional annotations, he noted that a few students made comparison charts in the text for the purpose of differentiating between high- and low-pressure systems. Others drew arrows to text sections and labeled them *high* and *low.* After the reading, students talked with partners to see if their ideas differed or were in agreement.

Listening in on one conversation, Mr. King noticed that two students seemed confused about how high and low pressures connected to storms. One student thought that both low- and high-pressure areas were connected to hurricanes. His partner, pointing to the last line of the text, countered, "It says that low-pressure

Figure 5 Text-Dependent Questions for *Hurricanes: Earths Mightiest Storms* (Lauber, 1996)

What two parts of the environment work together to create hurricanes? (*general understanding*)
How is the atmosphere like an envelope? (*vocabulary*)
How are areas of high and low pressure different? (*vocabulary*)
What role might changes in air pressure play in creating a hurricane? (*inference*)
What do scientists look for when they are predicting the formation of a hurricane? (*inference*)
Do you agree with the author that hurricanes are earth's mightiest storms? (*opinions, arguments, intertextual evidence*)
What effect might increased ocean temperatures, due to global warming, have on the development of hurricanes? (*opinions, arguments, intertextual evidence*)

"Students used the text to make connections and to seek evidence to support the notion that hurricanes are formed in part because of changes in air pressure."

areas over warm oceans give birth to hurricanes. I think this means hurricanes are formed where there's low pressure not high." Given this text-based evidence, both partners agreed that low-pressure systems correspond to storm formation. This interaction confirmed for Mr. King that text-based questions push students to deepen their understandings.

Third Reading

This time Mr. King reminded students of a previous lesson in which they discussed the layers of the atmosphere, viewed a demonstration of a soda can crushed by air pressure, and talked about sea and land breezes. He asked, "What role might changes in air pressure play in creating a hurricane?" This is clearly a complex, inferential, text-dependent question that cannot be fully determined from a single, cursory text reading. Students needed to attend to the language used to describe changes in air pressure (high and low pressure) and draw on previously studied understandings of wind and atmosphere by making intertextual connections. This text-dependent question guided their attention to language and prior knowledge to deepen understanding and pushed them toward multilayered thinking, which required students to address CCSS RI.5.8 ("Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]").

He reminded them when annotating to draw arrows showing connections among ideas. Again, using student responses as a formative assessment tool, Mr. King clearly and quickly scanned annotations to see who was documenting appropriate sections of the text in response to the question. Several students highlighted fragments of this sentence from the text: "Other storms may cover a bigger area or have higher winds, but none can match both the size and the fury of hurricanes." In conjunction with this, they noted thoughts that connected hurricanes to strong winds.

Others noted that low-pressure systems are connected with storms, as they highlighted the following line: "There are days when a lot of air is rising and the atmosphere does not press down as hard." During subsequent chatting, he noted that although not every student could answer the question like a veteran meteorologist, all were concentrated on the complex science language and prior knowledge related to air, pressure, and winds. Students referenced the text to note that low-pressure air occurs "when hot air is rising."

Marley emphatically stated, "Hot air rises and cooler air sinks. Remember when we studied how heat moves." Oscar added, "Look at the first paragraph—It says that hurricanes are 'feeding on warm, moist air.' That must be the rising, warm air that makes it low pressure. I wonder if high pressure air is colder and drier?" Students used the text to make connections and to seek evidence to support the notion that hurricanes are formed in part because of changes in air pressure.

Final Reading

For the final reading, Mr. King provided students with a text-dependent question to which they could respond in the form of a news article: "Imagine that you are writing for an online science journal. Your editor asks you to respond to this question in writing: What do scientists look for when they are predicting the formation of a hurricane?" Mr. King assigned students a coauthor with whom they would write a response addressing this standard: "Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably" (CCSS RI.5.9). He asked two additional questions that required students to make inferences, document opinions, and make intertextual connections as they prepared their article.

Students were strategically partnered to share ideas using academic language rooted in text-based information. They first completed an independent next reading of this text, taking notes and jotting down ideas for the article. Then they wrote and conducted further research using a teacher-selected bank of online resources. Mr. King listened in as students discussed key aspects of the text (hurricanes are born in tropical waters; they feed on warm, moist air).

Students reread, examined ideas, and negotiated meaning before coauthoring articles that drew on their combined banks of word knowledge. Referring to academic language templates posted on the classroom wall that offered sentences starters (Even though… In conclusion… According to…), they crafted their responses. Connecting close reading to real-world applications and writing tasks motivated students to review the text with attention to detail, language, and background knowledge.

TAKE ACTION

1. Choose an appropriate informational text—one that seamlessly connects to standards-based content.

2. Plan for students to do the initial reading of the text as they respond to (a) foundational text-dependent question(s). Develop a note-taking guide or protocol for recording information.

3. Provide students with an opportunity to talk with peers about the reading.

4. Offer another deeper level text-dependent question that requires students to return to the text for a second reading. Remind them to use their pencils to note ideas, questions, and areas that need clarification.

5. Monitor student progress and determine whether scaffolds are needed.

6. For additional readings, ask questions that require students to draw on prior knowledge, make connections to learned content, infer ideas, argue a position, and speculate on extensions of the text. Be sure that students have a chance to record deeper thinking in the form of added notes or a written summary.

Conclusion: Scaffolds are Removed as Students Gain the Skill of Closely Reading

Some informational texts require student knowledge of the topic, whereas others do not. Instruction depends on the students and the texts. As is apparent in both examples, the initial student reading helped teachers determine "next steps." Students were permitted to struggle a bit as they negotiated meaning and oriented themselves to the text. Through this effort, students build the capacity to approach challenging texts with a steadfast, determined attitude and develop the capability to find meaning from challenging texts.

Students learned to follow the initial read-through of the text, with a second, third, or fourth read, each time documenting deeper insights and learned concepts through their annotations. Asking text-dependent questions guided and focused student reading; students read with a purpose in mind, drawing on previously read texts and learned information to infer meanings and facilitating interaction with the text—all behaviors of highly proficient readers. They acquired and internalized text knowledge and used it in academic conversations and writing to share fact-supported arguments. As noted by these teachers, closely analyzing a text helped students gain a deeper understanding of the information, the ability to critically communicate the information, and, best of all, enjoy the process.

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MORE TO EXPLORE

Books

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- Grant, M., Fisher, D., & Lapp, D. (2014). *Teaching students to think like scientists.* Bloomington, IN: Solution Tree Press.

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- Lapp, D., Moss, B., Johnson, K., & Grant, M. (2012, Fall). Teaching students to closely read texts: How and when. *IRA E-ssentials*. Available at http://www.reading.org/general/Publications/e-ssentials/e8022

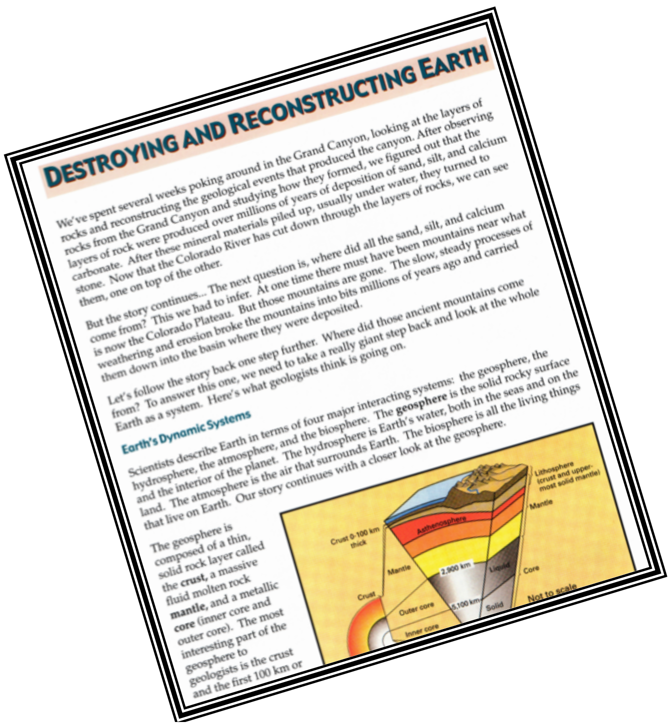
Common Core Informational Videos

- Balancing Informational Text and Literature: www.engageny.org/resource/common-core-in-ela-literacy-shift-1-pk-5-balancing-informational-text-and-literature
- Text-Based Questions: www.engageny.org/resource/common-core-in-ela-literacy-shift-4-text-based-answers

BOSTON Public Schools Focus on Children | Office of Curriculum & Instruction | Department of Science

Close Reading and Text Dependent Questions in Science
Destroying and Reconstructing Earth (Earth History)

The text selection, *Destroying and Reconstructing Earth,* is found in F*OSS Student Resource book*, *Earth History,* pgs. 100-105.


DESTROYING AND RECONSTRUCTING EARTH

We've spent several weeks poking around in the Grand Canyon, looking at the layers of rocks and reconstructing the geological events that produced the canyon. After observing rocks from the Grand Canyon and studying how they formed, we figured out that the layers of rock were produced over millions of years of deposition of sand, silt, and calcium carbonate. After these mineral materials piled up, usually under water, they turned to stone. Now that the Colorado River has cut down through the layers of rocks, we can see them, one on top of the other.

But the story continues... The next question is, where did all the sand, silt, and calcium come from? This we had to infer. At one time there must have been mountains near what is now the Colorado Plateau. But those mountains are gone. The slow, steady processes of weathering and erosion broke the mountains into bits millions of years ago and carried them down into the basin where they were deposited.

Let's follow the story back one step further. Where did those ancient mountains come from? To answer this one, we need to take a really giant step back and look at the whole Earth as a system. Here's what geologists think is going on.

Earth's Dynamic Systems

Scientists describe Earth in terms of four major interacting systems: the geosphere, the hydrosphere, the atmosphere, and the biosphere. The **geosphere** is the solid rocky surface and the interior of the planet. The hydrosphere is Earth's water, both in the seas and on the land. The atmosphere is the air that surrounds Earth. The biosphere is all the living things that live on Earth. Our story continues with a closer look at the geosphere.

The geosphere is composed of a thin, solid rock layer called the **crust,** a massive fluid molten rock **mantle,** and a metallic **core** (inner core and outer core). The most interesting part of the geosphere to geologists is the crust and the first 100 km or

Look in the Student Learning Outcome Document for guidance on when this should be taught.
http://bpscurriculumandinstruction.weebly.com/student-learning-outcomes-by-grade.html

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Destroying and Reconstructing Earth

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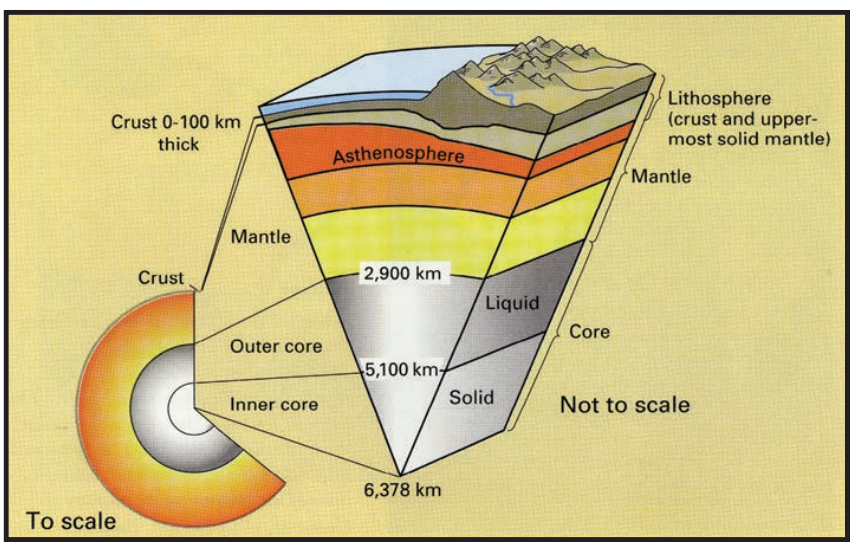
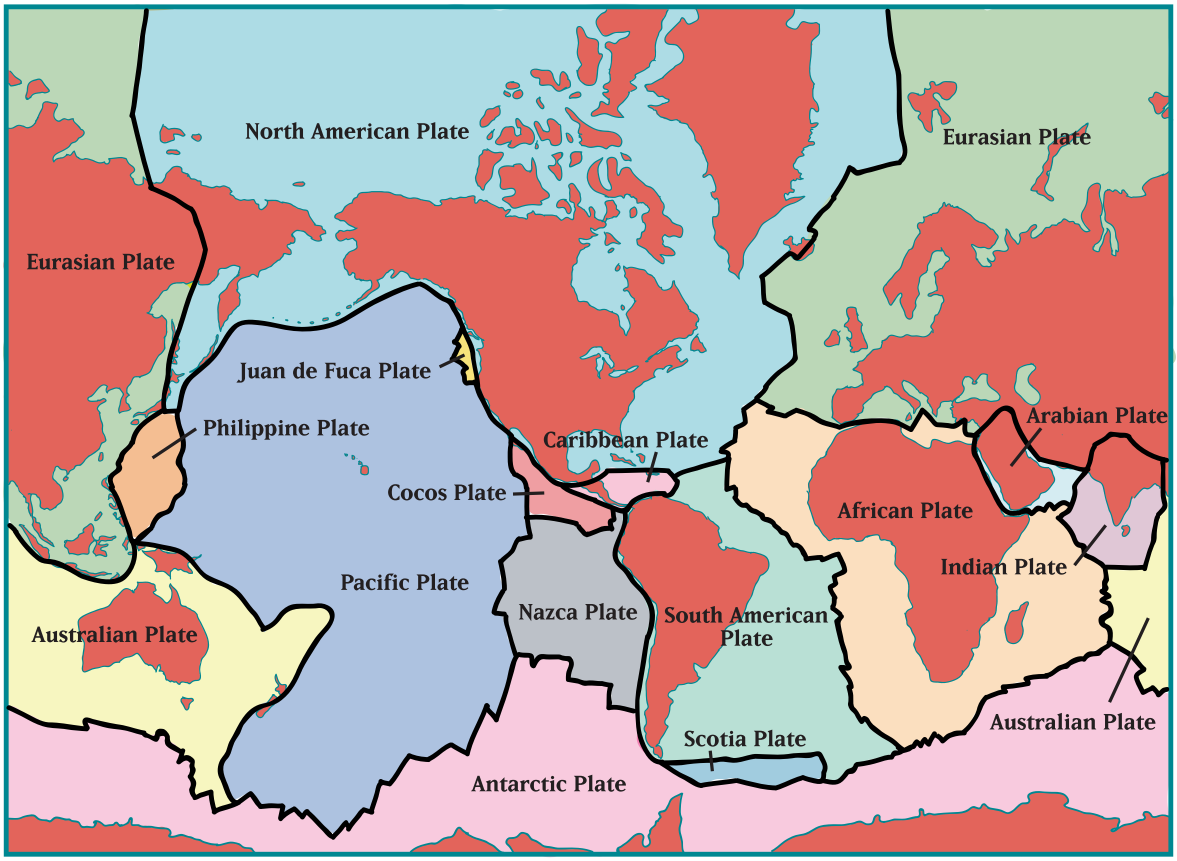
The geosphere is composed of a thin, solid rock layer called the **crust,** a massive fluid molten rock **mantle,** and a metallic **core** (inner core and outer core). The most interesting part of the geosphere to geologists is the crust and the first 100 km or so of the mantle just under it. This region is called the **lithosphere.**



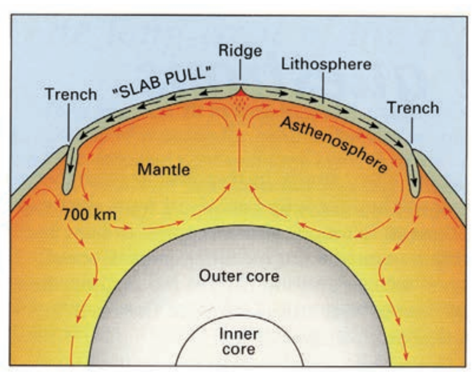
The thin oceanic crust (5 km), the thick continental crust (100 km), and uppermost part of the mantle make up the lithosphere.

The lithosphere (the part that we stand on and that covers the bottom of all the seas) seems like it should be one big, continuous covering on Earth, like the shell on an egg. But it is not. The lithosphere is broken into big slabs, like a hard-boiled egg with a broken shell. That's our picture of Earth today—a planet of molten rock covered with a bunch of solid plates of rock that fit together like puzzle pieces.



Earth's surface is broken into seven major and several more minor lithographic plates that move around slowly on Earth's face.

The lithospheric plates differ from the pieces of shell on a cracked egg in one important way. The lithospheric plates move around on Earth; the pieces of eggshell stay put. One of the larger plates is the North American Plate. All of Canada, most of the United States (except Hawaii, part of Alaska, and a slice of southern California), and most of Mexico wander across the surface of Earth together. Other large plates include the Pacific Plate, which underlies most of the Pacific Ocean, African Plate, Eurasian Plate, Indo-Australian Plate, and South American Plate.



Convection currents, created by hot, rising magma, push plates around.

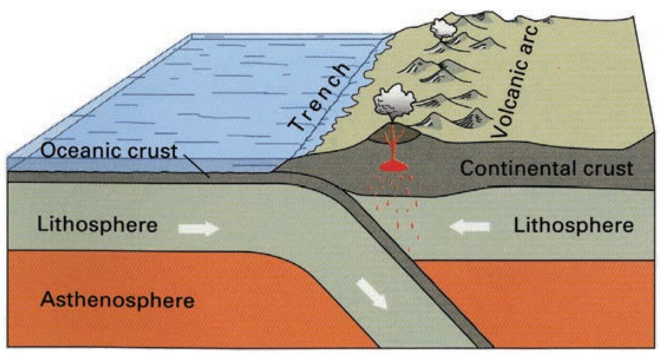
So what makes the plates move around? Geologists think that magma close to the core heats and rises toward the surface. Cooler magma descends to take the place of the heated magma.

This circular movement in the magma, called **convection,** is what pushes the plates around. Scientists call these forces that affect the crust of Earth tectonic forces. Tectonic forces drive some plates away from each other, some plates toward each other, and some plates past each other. The San Andreas Fault on the west coast of the United States marks where the North American Plate and the Pacific Plate are scraping past one another.

The plates don't move very fast by most standards—maybe 1 cm per year. But, as you know, geologists rarely think in time units less than a million years, so in a million years a continent can move 10 km, and in 100 million years 1000 km. Now that's getting somewhere!

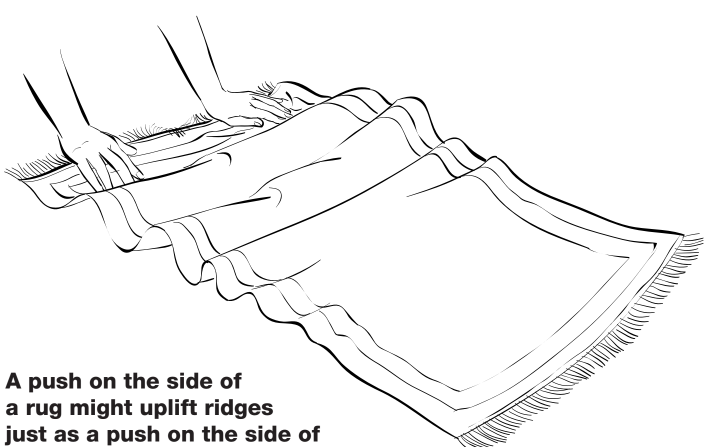
Constructive and Destructive Processes

Now back to the Grand Canyon and those mountains that weathered into the sediments that became the Colorado Plateau. When two plates are driven toward one another and they crash, something has to give. Sometimes one plate slides under another. The part of the plate driven down into the magma melts. This melted material might push up through the crust and onto the surface. When that happens we see a volcano or a lava flow. Places with lots of volcanoes, like the west coast of Mexico and South America, and Washington, Oregon, and California, usually indicate that two plates are colliding. The Cascade Range from Canada to the middle of California is all created by volcanic activity.

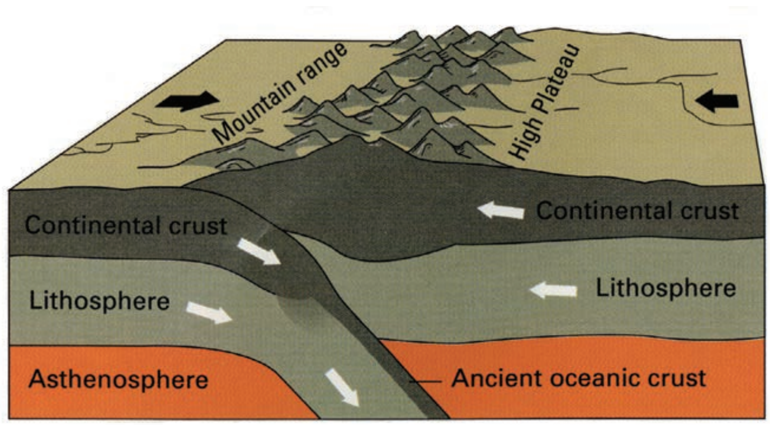


An oceanic plate sliding under a continental plate melts rock that might come up in the form of volcanoes.

Sometimes when two plates collide, the plates get rumpled and folded. The same thing happens when you push on one end of a small rug. The rug has to go someplace, so it forms a bunch of hills and valleys. The same thing can happen when plates collide. We see this happening in Asia today where India is colliding with the Eurasian Plate, rumpling up the landscape to create the Himalayan mountains, which rise higher each year.

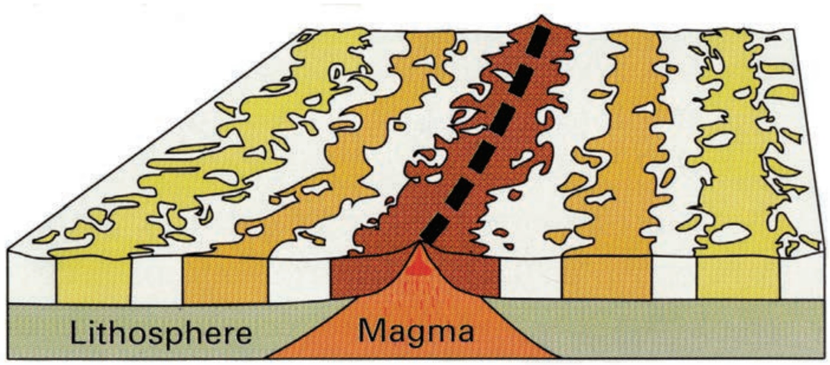

A push on the side of a rug might uplift ridges just as a push on the side of a continent might uplift mountains.

It's possible that millions of years ago something like this happened near what is now the Grand Canyon. A mountain range resulted from a tectonic collision. After that the forces of wind and water broke the mountains down to dust and carried them into the basin to form the sedimentary rocks of the Grand Canyon.



When two continental plates collide, the result might be the uplift of a mountain range.

Earth is constantly recreating its surface and reconstructing its landforms as a result of several processes. The **constructive processes** are mountain building (a result of plate collisions—uplifting and volcanism); new crust formation (where two plates are pulling apart); and sedimentation (resulting from deposition). The **destructive processes** are weathering by gravity, wind, and water (which break rocks apart); erosion (which carries rock away); and tectonic activities (plates sliding under other plates to be consumed by the magma).



New crust is added where magma flows up between two diverging plates.

Fossils in the Kaibab Limestone *Marco Molinaro photo*

The Kaibab Mystery

Now that we have stepped back and taken in the big picture of the constructive and destructive Earth-shaping processes, let's come back down to Earth. Here we are, standing on the Grand Canyon's Kaibab Formation. Right under our feet are fossils—sponges, brachiopods, and crinoids. These fossils are the unmistakable remains of animals that once lived in a tropical sea. How could that be? This Kaibab Formation is more than 8100 feet above sea level!

Two possibilities spring to mind. Either the sea was once 9000 feet deeper than it is today, so that the area where we are standing was under water. Or perhaps millions of years ago the sediments we are standing on were deposited 8100 feet lower in elevation, down below sea level. Let's reason through these two possibilities.

The idea that the seas may have been 9000 feet deeper a few hundred million years ago is too far out of bounds for serious consideration. There is no evidence anywhere else on Earth suggesting that there was ever an incredibly vast additional quantity of water. That leaves the idea that the Kaibab Formation was deposited at or below sea level before being lifted to such a height. Let's see how this idea plays out.

Geologists studied index fossils and other evidence to figure out that the Kaibab Formation was deposited near the end of the Paleozoic era, around 245 million years ago (mya). Furthermore, geologists have found clues that suggest that around the end of the Mesozoic era, about 70 mya, a major geological event caused faulting, folding, and uplifting. What kind of global event might produce these kinds of massive changes in the landforms? Maybe a collision between plates or possibly some extreme magma activity under the North American Plate. The Rocky Mountains started rising at this time, and the area that would become the Colorado Plateau began its "elevator ride" upward.

A **fault** is a place where Earth's crust is broken and the rocks on the two sides of the fault move past one another. The Bright Angel Trail goes down a canyon formed by erosion along the Bright Angel Fault. Geologists know that faults result when extreme force is applied to the crust. When rocks actually break under the strain and slip and slide past one another along a fault, the result is often an earthquake. Today people at Grand Canyon Village on the South Rim occasionally feel small earthquakes that are caused by movements along either the Bright Angel Fault or other faults in the area.

Bright Angel Fault *Marco Molinaro photo*

Folds are another structural feature of the Colorado Plateau that suggest movement of Earth's crust. The Colorado Plateau is well known for its **monoclines**—large sections of rock layers that slope down on one side. At the Grand Canyon, the East Kaibab monocline marks the eastern boundary of the Kaibab Plateau. The existence of this monocline and others suggests a time when portions of the land were compressed and folded during the elevation of the plateau.

The rocks on this monocline are deformed so they slope down to the right side of this picture.

Piecing together the history of the Colorado Plateau is a tough job. Part of the story is still a mystery. Geologists are sure the Kaibab Formation was deposited about 9000 feet lower in elevation than where it stands today. And the faulting and folding throughout the plateau suggest massive uplifting forces. But what primary event or events provided the driving force to lift the Colorado Plateau? It was one of the constructive processes, but just how it happened is still one of those lingering mysteries of the Grand Canyon. That's part of the fun of geology—there's always another mystery to solve.

Destroying and Reconstructing Earth (Earth History)
Student Questions

1. What distinguishes the geosphere from the other three major systems described on page 100?

2. In the text, the lithosphere is described as a region of the geosphere. What is the lithosphere made up of?

3. Using the text and the diagram on page 100, list the layers from innermost layer to the outermost layer of the geosphere. Identify whether the layers are liquid or solid.

4. How does the example of the hard-boiled egg accurately model the Earth's lithosphere as described on page 101, and what are the limitations of the model?

5. After reading pages 101-102, describe the purpose of the red arrows in the diagram on the bottom of page 101. Identify and describe the concept the author was trying to clarify.

6. The author described the lithosphere as, "the most interesting part of the geosphere." Give three examples from the text section, "Constructive and Destructive Processes," that support the author's claim.

Destroying and Reconstructing Earth (Earth History)
Sample Answers

1. **What distinguishes the geosphere from the other three major systems described on page 100?**
   The geosphere is the solid rocky surface and the interior of the planet. The hydrosphere is Earth's water, the atmosphere is the air that surrounds the Earth, and the biosphere is all the living things on Earth.

2. **In the text, the lithosphere is described as a region of the geosphere. What is the lithosphere made up of?**
   The lithosphere is made up of the crust and uppermost mantle.

3. **Using the text and the diagram on page 100, list the layers from innermost layer to the outermost layer of the geosphere. Identify whether the layers are liquid or solid.**
   The first layer is the inner core, it is a solid metallic layer made of solid. The second layer is the outer core, a liquid metallic layer. The third layer is the mantle, which is fluid molten rock. The fourth layer is the crust, which is a solid rock layer.

4. **How does the example of the hard-boiled egg accurately model the Earth's lithosphere as described on page 101, and what are the limitations of the model?**
   A broken eggshell correctly models the solid plates of rock. The biggest difference is that on an eggshell the plates or pieces do not move around, but on the Earth the pieces of the crust do.

5. **After reading pages 101-102, describe the purpose of the red arrows in the diagram on the bottom of page 101. Identify and describe the concept was the author trying to clarify.**
   The red arrows represent the convection currents in the magma. Magma close to the core gets heated and rises to the surface and then cooler magma moves downward.

6. **The author described the lithosphere as, "the most interesting part of the geosphere." Give three examples from the text section, "Constructive and Destructive Processes," that support the author's claim.**
   First, it is interesting because the lithosphere is where the tectonic plates are moving causing volcanoes to form. Second, when two plates collide they can form hills and valleys. Third, there are destructive processes like erosion breaking landforms down.