Texts as Tools:

Engaging Students in Reading to Complement Hands-On Activities

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Abstract

Texts can and should be used as tools to support students as they engage in science. This is part of both the Next Generation Science Standards and the Common Core State Standards for English Language Arts. In order to use texts effectively, teachers need to (1) carefully choose texts that their students will be able to comprehend. Such texts are cohesive, do not contain distracting details, and have clearly labeled images. Teachers also need to (2) use texts as part of other activities to build knowledge and support engagement, because knowledge and interest are related to better comprehension. When using texts, teachers need to (3) support their students with: complex vocabulary, reading multiple texts, integrating the words and images, and general reading strategies. Taken together, these three instructional guidelines will allow teachers to engage students with texts in ways that can enhance their science learning and prepare them for the texts they will encounter in adulthood.

Keywords: Reading in Science, NGSS, Life Science

In her seventh-grade science class, Mrs. Williams is using an article and the textbook along with investigations to support her students in the three-dimensional sense-making called for by the Next Generation Science Standards (NGSS; NGSS Lead States, 2013) and to meet the informational text standards of the Common Core State Standards for English Language Arts (CCSS ELA; National Governors Association Center for Best Practices and Council of Chief State School Officers [NGAC and CCSSO], 2010). The students have conducted an investigation to determine where the mass of a plant comes from (See Image 1). They also read about the process of photosynthesis in their science textbook and read a news article about a plant that turns blue for survival (See Resources). The students are now collaboratively writing explanations about how plants grow.

Image 1: Plant Growth Investigation; Photo Credit: Sarah Bodbyl Roels

The classroom is alive with conversation as the students discuss the results of the investigation and the information from both readings. They are debating if most of the dry mass of a plant comes from soil or air. They analyze how the information from each of the information sources is similar and different from the others. They also consider what they want to include in

their explanations as they complete a graphic organizer (See Figure 1). Here three students discuss the information sources:

Ezra: Both readings talk about photosynthesis.

Jada: We also got evidence of photosynthesis in our light experiment. The plants in light took in carbon dioxide.

Kyle: I think we should include both information from the article about plant structures and that evidence, Jada, in our explanations.

	Text 1:	Text 2:
Main Ideas		
Evidence		
Similarities		
Differences		

Figure 1: Blank Graphic Organizer for Comparing Two Texts

It is important for students to have experiences, such as Mrs. Williams provided, to prepare them for the texts they will encounter in adulthood. They will need to interpret information from many sources, such as science-related news articles with political spins, and medical information from their doctor and online to make medical decisions. These and other situations require that students are able to use science texts as tools for multiple purposes.

Learning how to interpret texts should start early and continue through school. The obtaining, evaluating, and communicating information practice of the NGSS emphasizes the need for middle school students to be able to read texts, understand diagrams and photographs, synthesize across multiple texts, and evaluate the information in texts (NGSS Lead States, 2013). Likewise, the CCSS ELA require that middle school students evaluate the argument in a text, determine the purpose of a text, and analyze how the text makes connections across ideas, among other things (NGAC and CCSSO, 2010).

So how can teachers support students in using texts in these various ways? What texts should teachers use and how should they incorporate them into what they are already doing? I answer these questions about science texts in the rest of this article. I provide evidence from research conducted in middle school classrooms about how students read science texts and offer suggestions on how to use texts, including examples from Mrs. Williams' class.

Selecting Texts

Not all science texts are equal. For this reason, teachers need to carefully review the texts they are using. When choosing texts, teachers should consider three things: level of cohesiveness, any distracting details, and the included diagrams.

One criterion in text selection is the cohesiveness of the text (Hall et al., 2015). More cohesive texts have stronger connections between ideas which helps student understanding. A cohesive text will use nouns instead of pronouns to describe things and will have connecting words, such as "because" and "but." It is the difference between saying: “Plants need sunlight, water, and air. Plants do photosynthesis.” And saying: “Plants need sunlight, water, and air in order to do photosynthesis.” Notice that the second example is more cohesive, but that the sentence length is longer. Cohesive texts may have higher reading levels, because of longer

sentences, but will likely be more understandable to students. Teachers should look for texts that are highly cohesive using the indicators of nouns instead of pronouns and connecting words.

Another criterion in text selection is the presence of distracting details included (Wang, 2016). Texts that include details that are unrelated to the main ideas can be distracting and reduce comprehension. A tidbit about the real-world or a narrative element in a text may be interesting, but can make the reading harder to understand for some students. This is particularly important for struggling readers. When choosing texts, teachers should avoid texts with distracting details.

A third criterion in text selection is the images. Texts should also have clear labeled images that focus on the main ideas (Ge, Unsworth, & Wang, 2017). Such images can improve comprehension. The captions allow students to make connections between the words and the images. Teachers should select texts with images that convey the main ideas of the text and are captioned.

Mrs. Williams used two different carefully-chosen texts with her students. The text in the science textbook on photosynthesis is clearly written, does not contain any off-topic details, and has diagrams that are clear and labeled. The article, "A Rainforest Plant Shows its True Colors (Blue) When in Survival Mode," is highly cohesive, does not contain unnecessary details, and has a captioned picture. It is written at a higher reading level than the textbook, but its other features make it comprehensible for Mrs. Williams' students.

Texts that meet these guidelines include excerpts from science textbooks, news articles, like those from newsela.com, and trade books, like those on the National Science Teachers Association Outstanding Science Trade Books for Students K-12 list. Wherever a text is found it

should be screened with these three criteria: cohesiveness, no distracting details, and clear diagrams.

Building Knowledge and Interest

There is a relationship between a student's knowledge about and interest in a topic and their ability to comprehend a text on that topic. Because of this, teachers should not use texts in isolation from knowledge- and interest-building activities.

Multiple studies have concluded that the more a student knows about a topic the better they will comprehend a reading on that topic (Cervetti & Wright, in press; Davis, Huang, & Yi, 2017). For example, if a student knows a lot about plants, they will have better comprehension of a text about plants than one about birds. Research has also shown that the more students are interested in science the higher their comprehension (Hall et al., 2015). This means if students enjoy science this may improve their comprehension of science texts.

To build knowledge and interest, texts should be used as part of other classroom activities, such as investigations and discussions. Teachers can choose texts that complement and enhance the activities they are already using. For example, if a teacher facilitates an investigation about what plants need to grow, the students can read an excerpt from the textbook on photosynthesis as they are analyzing their data. The information from the textbook can be compared to the results of the investigation.

Additionally, discussions can center around texts. After students read excerpts from the textbook on cellular respiration and photosynthesis, the teacher could lead a class discussion about how the information on plants relates to what they have already learned about animals. They could discuss questions including:

- How do plants move and how is that alike and different from how animals move?

- How do plants get energy and how is that alike and different from how animals get energy?
- What evidence from the texts supports your answer?

These and other questions will support students in making sense of the text and integrating the information in the text with previous learning.

Mrs. Williams did not just give her students two readings about plants. She generated interest and built their background knowledge through an investigation, and kept their interest by engaging them in discussions about what they were figuring out.

Supporting Comprehension

Students cannot be expected to read science texts without instruction, so teachers should provide scaffolding to improve their students' comprehension of texts. Science texts differ from texts in other subject areas. They have challenging vocabulary, ideas conveyed in multiple ways, and disciplinary norms for how ideas are supported with evidence (Lemke, 1998; McNamara, Graesser, & Louwerse, 2012). Given these differences, students require instruction in making connections across texts, integrating words and images in a text, and making sense of complex vocabulary (Botsas, 2017; Davis et al., 2017; Ge et al., 2017; Mason, Tornatora, & Pluchino, 2015).

Students have difficulty combining information from images and words in a text (Ge et al., 2017; Mason et al., 2015). In science texts, the images often contain information not found in the words, so a reader needs to make sense of the words and texts together. Students who do this have better comprehension (Mason et al., 2015). Teachers can model how to look across the images and the words. While displaying the text, the teacher would read then look at the images and back at the text. The teacher would ask herself aloud and discuss her thought process:

- What information do the words provide?
- How is the diagram showing what the words are saying?
- How is the diagram adding to what the words are saying?

The teacher would then repeat the process for the other images. Mrs. Williams modeled this process for her students to support them in doing it on their own.

Students need support in coordinating ideas across multiple texts, because without prompts and specific questions that support them in pulling ideas together, students are unlikely to make these connections (Davis et al., 2017). To help students look across the texts, teachers can provide a graphic organizer. It should allow students to record information they learned in each text and to compare that information. It can be used as a formative assessment to see how students are comprehending and coordinating ideas across texts (See Figure 2). Mrs. Williams had her students read two different types of texts, and then draw information from the texts and classroom experiences to write an explanation of how plants grow.

Jada

	Text 1: A rain forest plant grows its true colors (blue) when in survival mode	Text 2: Photosynthesis
Main Ideas	- Plants make food using photosynthesis. - The peacock begonia has adapted to low levels of light.	- Plants are producers that make their own food.
Evidence	- iridoplasts allow the peacock begonia to collect different wavelengths of light, which makes it appear blue	- with light, $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$ (glucose)
Similarities	Both texts detail how plants use light to do photosynthesis. The light is energy that is converted into stored energy.	
Differences	-Some plants have different structures for photosynthesis	-All energy used by living things comes from photosynthesis. -Chloroplasts are required for photosynthesis.

Figure 2: Completed Graphic Organizer for Formative Assessment

Students will encounter complex vocabulary in science texts (McNamara et al., 2012). This vocabulary contains both science-specific words and polysemous words that have unique meanings in different contexts. An example of a polysemous word is model, which is a representation used to explain in science, but an example to follow in other contexts. Vocabulary instruction that includes active processing of the words within a text can support comprehension of that text (Wright & Cervetti, 2017). Active processing could include giving students opportunities to discuss the vocabulary with their peers and to represent the vocabulary in pictures.

Students with disabilities often require support in using metacognitive strategies when reading science texts (Botsas, 2017). Research has shown that students with disabilities do not have the metacognitive strategies to use when reading science texts. One way to provide metacognitive strategy support for students who need it is to work with the language arts teacher to build on the strategies the students are already being exposed to. Another method is to have students read together. Students can pause and summarize what they have read, relate the text to their background knowledge, or ask questions. Partner reading gives students an opportunity to talk about a text and to practice using strategies with a peer. Mrs. Williams provided support to her students with disabilities by giving them sticky notes to record their questions and ideas, and then an opportunity to share their ideas.

Closing Thoughts

There is a rich range of science texts from news articles to trade books that can and should be used in the classroom. This aligns with both the NGSS and the CCSS ELA for middle school and will prepare students for the texts they will read in adulthood (NGAC and CCSSO, 2010; NGSS Lead States, 2013). Remembering to choose texts carefully, embed texts within

activities, and support students while they read texts, will help science teachers be successful in using science texts as tools in their classroom.

Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013)

• The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.

• The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectations listed below.

MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Standard MS-LS1. From Molecules to Organisms: Structures and Processes https://www.nextgenscience.org/dci-arrangement/ms-ls1-molecules-organisms-structures-and-processes	
Performance Expectation MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	
Dimension	**Classroom Connection**
Science and Engineering Practice Constructing Explanations Obtaining, Evaluating, and Communicating Information	Students use multiple sources to construct an explanation about where most of the mass of a plant comes from. Students obtain and evaluate information from multiple sources on plant growth.
Disciplinary Core Idea LS1.C. Organization for Matter and Energy Flow in Organisms • Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.	Students discover that most of the mass of a plant comes from the air through the process of photosynthesis.
Crosscutting Concept Energy and Matter	Students trace matter and energy as it moves into and through a plant during the process of photosynthesis.

Connections to the *Common Core State Standards* (NGAC and CCSSO 2010)

ELA

CCSS.ELA-LITERACY.RI.6.7: Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Resources

Article: A rainforest plant shows its true colors (blue) when in survival mode-

https://newsela.com/read/blue-leaves/id/23326/

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