What Do Teachers Need to Know about the Language of Science Text ?

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SCIENCE TEXTS

"Science texts are a good example of the challenging text to which the framers of the CCSS refer. These texts often present information that is conceptually rich, but also conceptually dense and abstract; they use terminology that is unfamiliar to many students; and they present explanations using language in ways that students do not encounter in their everyday uses of language or in their reading of fictional and narrative text" (Palincsar, 2013).

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THE THEORY INFORMING THE ANALYSIS

- Systemic Functional Linguistics (SFL) (Halliday, 1978; 1994)
- Connecting language form and meaning with social context
- Providing a functional grammar for seeing meaning in the language of text and discourse
- Enabling us to see variation in texts by discipline, genre, and context

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SOME SCIENCE GENRES

Genre	Purpose
Description	To define something or tell what it is like
Explanation	To tell how or why something works or is as it is
Recount/Procedure	To tell about what happened or what someone did
Argument	To persuade that something should be done

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READING AN EXPLANATION

- Key language features
  - Technicality
  - Density of information
  - Development of information from clause to clause as the text evolves
  - Connections that present time, cause, condition, contrast, or other linkages
  - Author perspective

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TECHNICALITY

Protons, neutrons and electrons are very different from each other. Each has its own properties, or characteristics. One of these properties is called an electrical charge. Protons have what we call a "positive" (+) charge. Electrons have a "negative" (-) charge. Neutrons have no charge. They are neutral. The protons and neutrons in the nucleus are held together very tightly. But the electrons in some materials are not held tightly; in fact, they can move pretty freely. When a material has electrons that are able to move very freely, it conducts electricity. We call it a conductor. Most metals are good conductors. When a material holds its electrons tightly and the electrons do not move, it does not conduct electricity. We call it an insulator. Plastic, cloth, and glass are insulators.

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EXPLORING DEFINITIONS IN EXPLANATIONS

Protons, neutrons and electrons are very different from each other. Each has its own properties, or characteristics. One of these properties is called an electrical charge. Protons have what we call a "positive" (+) charge. Electrons have a "negative" (-) charge. Neutrons have no charge. They are neutral. The protons and neutrons in the nucleus are held together very tightly. But the electrons in some materials are not held tightly; in fact, they can move pretty freely. When a material has electrons that are able to move very freely, it conducts electricity. We call it a conductor. Most metals are good conductors. When a material holds its electrons tightly and the electrons do not move, it does not conduct electricity. We call it an insulator. Plastic, cloth, and glass are insulators.

Note that *being* and *having* **processes** occur frequently: This signals that definitions and/or descriptions are being presented. In this case key words are being defined.

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IDENTIFYING DEFINITIONS

Protons, neutrons and electrons are very different from each other. Each has its own properties, **or** characteristics. One of these properties **is called** an electrical charge. Protons have what we call a "positive" (+) charge. Electrons have a "negative" (-) charge. Neutrons have no charge. They are neutral. The protons and neutrons in the nucleus are held together very tightly. But the electrons in some materials are not held tightly; in fact, they can move pretty freely. **When a material has electrons that are able to move very freely, it conducts electricity. We call it** a conductor. Most metals are good conductors. **When a material holds its electrons tightly and the electrons do not move, it does not conduct electricity. We call it** an insulator. Plastic, cloth, and glass are insulators.

EXPLORING EXPLANATION SEQUENCES

The electric current provides energy that makes things run. The electrons flow through wires that are made of metal (conductors) and covered in plastic (an insulator). The wires lead into things like motors or light bulbs (resistors), where the electric current carries energy that does work. The energy of the electrons is converted to heat or light as the electrons make resistors run. The electricity forms a circuit as the electrons push their way through the resistor and more wires carry it back to the battery.

Note that explanations use *doing* processes to tell how something works or happens.

WORKING WITH *PROCESSES* AND THEIR *PARTICIPANTS*

- The energy of the electrons is converted to heat or light…

- *What's the process?*

WORKING WITH *PROCESSES* AND THEIR *PARTICIPANTS*

- The energy of the electrons is converted to heat or light…

- *What's the process?* is converted
- *What is the **participant** that is converted?*

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WORKING WITH *PROCESSES* AND THEIR *PARTICIPANTS*

- The energy of the electrons is converted to heat or light…
- *What's the process?* is converted
- *What is the participant that is converted?*
  - The energy of the electrons

WORKING WITH *PROCESSES* AND THEIR *PARTICIPANTS*

- The energy of the electrons is converted to heat or light…

- *What's the process?* is converted
- *What is the participant that is converted?*
  - The energy of the electrons

Identifying whole meaningful constituents and not just individual words, and seeing their meaning in context

RECOGNIZING HOW INFORMATION FLOWS IN AN EXPLANATION

The electrons *flow* through wires that are made of metal (conductors) and covered in plastic (an insulator).

The wires *lead into* things like motors or light bulbs (resistors),

where the electric current *carries* energy that does work.

The energy of the electrons *is converted* to heat or light as the electrons *make* resistors *run*.

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FOCUS ON CONJUNCTIONS AND THEIR MEANING IN THE TEXT

The energy of the electrons is converted to heat or light **as** the electrons make resisters run. The electricity forms a circuit **as** the electrons push their way through the resister and more wires carry it back to the battery.

as presents the processes as occurring simultaneously

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AUTHOR'S PERSPECTIVE: HOW SURE? HOW LIKELY?

- Scientists' conclusions or predictions are not always certain.
- They often use language that indicates degrees of certainty or likelihood
- Students can learn about the language scientists use to make claims and introduce evidence

EXPLORING THE AUTHOR'S PERSPECTIVE

- Identify words that present *likelihood* (*may, could, perhaps, sometimes,* etc.)
- Identify words that present *attitudes* (*unfortunately, surprisingly*, etc.)
- Identify connecting words that show a perspective (*but, although, in fact,* etc.)

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ANALYZING LANGUAGE IN AN EXPLANATION

- Identify the genre and its purpose.
- Identify technical terms and how they are presented and defined in the text (look for processes of *being* and *having*)
- Identify what is explained and how:
  - Look for processes of *doing* and the *participants* in those processes (ask “what is doing something?” and “what is it doing?”). Be sure you identify the whole meaningful ‘chunk.’
  - Look at how information flows from sentence to sentence (pay attention to the ends of sentences and how the next sentence begins)
  - Look for conjunctions and connecting words and phrases and explore their meaning in context
- Explore the author’s perspective and attitude

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TRANSLATING *SFL* INTO CURRICULUM AND INSTRUCTION: *FUNCTIONAL GRAMMAR ANALYSIS*

- Our goal is to help children focus on authors' language choices and what those choices mean
- Our curriculum includes:
  - Interactive reading and discussion of text
  - First-hand investigations
  - Demonstrations of phenomena
  - Support for writing about the phenomena

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THE PARTICIPANTS IN OUR DESIGN-BASED RESEARCH

- 26 teachers from grades 2 through 5; 12 coaches/resource teachers
- Dearborn, MI schools: home to the largest population of Arab Americans in the U.S.
- Over 90% of children are bilingual; a high proportion are classified as English learners, and over 90% of the schools qualify for free and reduced-cost lunch

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CONCEPTUAL FRAMEWORK

- Systemic Functional Linguistic theory (Halliday, 1994; Schleppegrell, 2001; 2004)
- Linguistic theory applied to reading (August & Shanahan, 2008; García & Cuellar, 2006; Goldman & Rakestraw, 2000; Graesser, McNamara, & Louwerse, 2003; Snow & Sweet, 2003)
- Sociocultural theory regarding inter-personal to intra-personal development (Vygotsky, 1986)
- Situated nature of teacher learning: teachers' own classrooms are powerful contexts for their learning (Putnam & Borko, 2000)

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4TH-GRADE CASE STUDY OF FGA: THE TEXT (1,313 WORDS)

The content	The functional grammar
How a simple circuit works	The *participants* in the text present technical content like the parts of an atom
The difference between an insulator and conductor	The *participants* in the text play different roles in the *processes* that explain how electricity works (sometimes *being,* sometimes *doing)*
The history of discovery/invention of electricity	*Connectors* signal surprising information about the invention of electricity
	Author's attitude is infused throughout the text

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EXCERPT FROM THE TEXT

Count Alessandro Volta, who lived in Italy, invented the first battery in the 18th century. He called it a “voltaic pile.” It consisted of a pile of zinc and silver or copper discs (do you notice that these are all metals?) separated by pads in an acid solution. The acid allowed the electrons in the metals to travel even more freely, creating an **electric current**. An electric current is the flow of electricity through a conductor.

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Ss: [reading] The acid allowed the electrons in the metals to travel even more freely
T: What are the participants? What is doing the work? What is involved?
S: Acid
T: The acid is a participant.
S: The electrons.
T: The electrons.
T: What else?
S: The metal?
T: The metal. Okay. What is the process here?
Ss: Allow
T: Allow…so, let's read… The acid is doing what?
Ss: Allow
T: Allowing what?
Ss: Electrons! To travel even more freely.
T: Continue reading.
Ss: [reading] creating an **electric current**
T: and what did we learn about informational text. You are reading and you find these bold, dark, big words. Why?
S: It's a new word.
T: It's a new word. So, what do we need to pay attention to?
S: What it means.
T: Let's continue reading and see if the author provides that.
Ss and T: [reading] "An electric current is the flow of electricity through a conductor."
T: Did the author provide the definition of a current?
Ss: YES!
T: Where is it? Say it out loud.
Ss: An electric current is the flow of electricity through a conductor.
T: Are you ready to draw the battery? Let's see.

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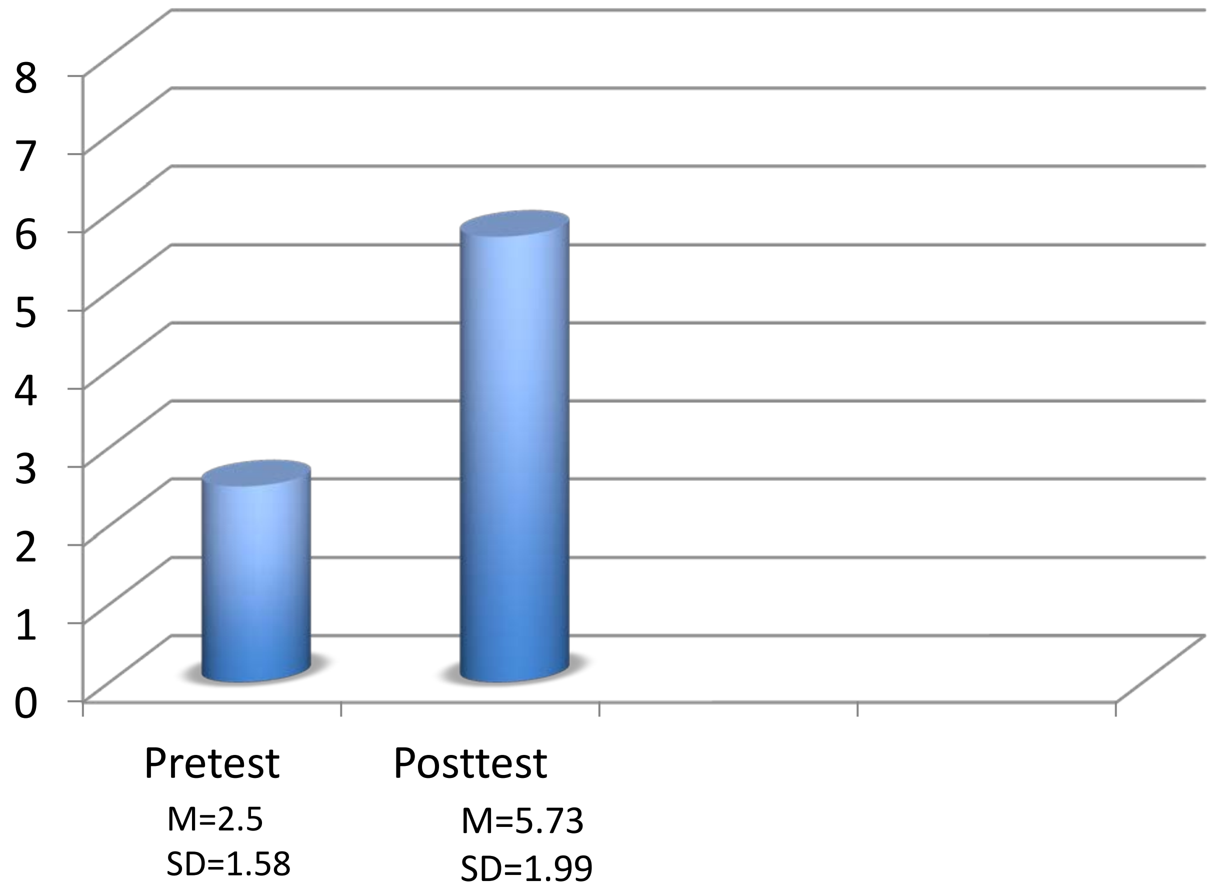
CONSISTENTLY…

Ms. Youssef focuses students' attention on key language features of the text and their meaning in context at the same time that she checks for and supports comprehension of key concepts in this unit. She reinforces students' understanding of how focusing on particular features of the text enables them to develop a coherent interpretation.

STUDENT LEARNING: CONTENT MEASURE



STUDENT LEARNING - WRITING MEASURE (WHAT DO YOU THINK ELECTRICITY IS? HOW DOES ELECTRICITY WORK IN A SIMPLE CIRCUIT?)

- There was an increase, on average, of five idea units from the pre- to post-writing assessment
- There was an increase in the range of ideas children included in their explanations
- Children added *connectors* to their writing (e.g., "If you have a fury [furry] blanket if you move a lot you will make electricity.")
- Children added *author attitude* (e.g., "How will we cook if we don't have electricity for the oven? We need electricity so much!")

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IN SUMMARY

- FGA holds promise as *one* of a repertoire of tools teachers can use to support English learners to interpret and learn with science text
- Its ideal use is enacted when the teaching of the metalanguage is tightly integrated with conversation about the content
- FGA can support teaching for both referential coherence and causal coherence (Kintsch, 1998; Van den Broek, 1998)
- Language/meaning connections can be experienced with text, first-hand investigations, demonstrations, and writing

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SCIENCE LITERACY

"...learning science provides an opportunity not only to build knowledge about the physical world but also to learn about the basic tools that are used to build knowledge and represent it for others. Taking an inquiry approach toward informational texts can allow students to learn how to question and be critical of texts rather than to always defer to the text or use texts simply for finding answers. Students who have been supported to learn the scientific practices identified in the NGSS are equipped to bring such a critical stance to text" (Palincsar, 2013).

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