Effective Vocabulary Instruction in Science

by Thersea Burzynski, CESA 10
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• Overview of research related to vocabulary instruction/learning
• Strategies matched to research
• Marzano’s Six Step process for Vocabulary Instruction
• Activities for staff
“Scientific investigations,” Neils Bohr pointed out, “are not exclusively formal, mathematical affairs for they also involve informal discussions in which key concepts are explored and understood.”

Foundations of Physics Vol 18, p. 1233
TIERS of Vocabulary

Tier III - Domain Specific
Discipline Specific Vocabulary
(chlorophyll, isotope, magma)

Tier II - High Frequency
Multiple Meaning Words
(analyze, calculate)

Tier I - Basic
General Words
(has, take, boat)

Beck, McKeown, and Kucan
Explicit Vocabulary Instruction

Research indicates that direct instruction in vocabulary can increase vocabulary learning and comprehension.

Effect Size = .97 SD
(John Hattie, 2009)
Elements of Effective Vocabulary Direct Instruction

• **Presenting individual terms and their descriptions in rich contexts** (Graves, 2000; National Reading Panel, 2000; Stahl & Fairbanks, 1986) • Asking students to generate information about terms (Anderson & Reder, 1979; Graves, 2000; Nagy, 2005; National Reading Panel, 2000; Scott et al., 2003; Stahl & Clark, 1987; Stahl & Fairbanks, 1986; Vogel, 2003)

• **Using multimedia methods (words, pictures, animations, etc.) to introduce and practice terms** (Mayer, 2001; Mayer & Moreno, 2002; National Reading Panel, 2000; Neuman et al., 2011; Sadoski & Paivio, 2001)

• **Asking students to relate new terms to words they already know** (Anderson & Reder, 1979; Booth, 2009; Chi & Koeske, 1983; Entwisle, 1966; Glaser, 1984; Levelt, Marzano, Robert J.; Rogers, Katie (2014-12-10). Roelofs, & Meyer, 1999; Scott et al., 2003; Stahl & Murray, 1994; Stahl & Nagy, 2006; Tinkham, 1997)

Based on the research, Marzano developed a process for building academic vocabulary.
1) Provide a description, explanation, or example. Include a visual representation.

(Flaw with relying on dictionary definitions)
2) Ask students to put the term into their own words.

3) Ask students to construct visual.
## Sample Vocabulary Notebook Page

<table>
<thead>
<tr>
<th>Term:</th>
<th>Subject:</th>
<th>Topic/Category:</th>
<th>Level of understanding:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**Description in words:**

- 
- 
- 
- 

**Synonyms:**

- 
- 
- 
- 

**Antonyms:**

- 
- 
- 
- 

**Picture:**
4) Engage students periodically in adding experience with the words.

Examples include:
- Phenomenon Exploration/Explanation
- Modeling
- Inquiry
- Videos
- Labs
- Field Trips
- Demonstrations
- Reading/Research

Vocabulary for the New Science Standards: Marzano’s Resource Site:
5) Students should USE/SPEAK the words often.

Examples Include:
- Argument/Debate
- Summarizing
- Discourse Structures
- Word Walls, modeling, notebooking
- Writing
Through well-structured talk, students are guided—or apprenticed—into fundamental practices of science.
Pause and Chunk Information Regularly:

– Keep your ‘lectures’ short
Pause every 5 to 8 min. in ES & 8 to 12 min. in MS/HS

– Have students ‘chunk’ or process the information through strategies such as summarization, think-pair-share, or compare and contrast.

Eric Jensen: Engaging Students with Poverty in Mind
Informational Writing & Persuasive Writing Examples:

- Research Proposals
- Editorials
- Article Reviews
- Letters to the Editor
- Commentary Forums
- Research Articles
- Letters to community members or govt
- Blogs
- Lab Reports
6) Involve students periodically in games that allow them to play with terms.

• **Games for the Science Curriculum** by Norman Herr PH.D.
• **Metaphors and Analogies Power Tools for Teaching Any Subject** by Rick Wormeli
• **Vocabulary Games for the Classroom** Lindsay Carleton and Robert Marzano
When we process information, we do so spatially. The brain likes to put things into categories.

Implications for Student Learning:
- Allow for the categorizing of terms
- Label authentic objects, specimens, or visuals
- Use graphic organizers and concept maps
- Identify missing pieces to a ‘grouping’
- Lists: beneficial primarily for short term memory
Place pictures or actual objects into categories based on some identified characteristic or quality while verbally using the words represented.
Concept Circles, Janet Allen

Template for Concept Circles
<table>
<thead>
<tr>
<th>System</th>
<th>Key Words</th>
<th>System Features</th>
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</thead>
<tbody>
<tr>
<td>atmosphere</td>
<td></td>
<td>1) dust storms  2)                3)</td>
</tr>
<tr>
<td>land</td>
<td></td>
<td>1) mountains  2) volcanoes 3)</td>
</tr>
<tr>
<td>hydrosphere</td>
<td></td>
<td>1) lakes  2) 3)</td>
</tr>
<tr>
<td>life</td>
<td></td>
<td>1) plankton  2) coral reefs 3)</td>
</tr>
</tbody>
</table>

**Word bank:**
- Glaciers
- Hurricanes
- Water
- Clouds
- Oceans
- Forests
- Biosphere
- Impact Craters
- Air
- Litho/Geosphere

NASA Education
This activity promotes connections across disciplines relating to word parts.

<table>
<thead>
<tr>
<th>Word Part</th>
<th>Discipline</th>
<th>Example Word</th>
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<tbody>
<tr>
<td>peri-</td>
<td>Physical Ed.</td>
<td>isometric exercise</td>
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<td>iso-</td>
<td>Geography</td>
<td>isoline</td>
</tr>
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<td>Meteorology</td>
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<td>isotope</td>
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<td>Mathematics</td>
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<td>-port</td>
<td>Visual Arts</td>
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<td>-meter</td>
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</table>
Greek and Latin Foundations

Science Root & Affix List

Etymology Dictionary

Biology and Medical - Root and Affix Dictionary

Root Words Frequently used in Chemistry
Activity for A Science Dept.

Discuss:
● How do we have students learn science vocabulary (tier III words)?
● How important is it to explicitly teach tier II or process words?
● Do we have specific discourse structures or protocols in place?
Edgar Dale’s Degrees of Knowing Word Meanings (1965)

Stage 1: I never saw or heard the word before.
Stage 2: I know there is such a word but I don’t know what it means.
Stage 3: I’ve heard it and seen it. I know what it has to do with but I can’t tell you what it means specifically.
Stage 4: I know what it means, I’ll recognize it whenever I see it or hear it, I can use it.

Sample Rating Scales to Use w/Students
Engaging Tasks allow for a deep building of concept development and vocabulary use:
- investigation
- discourse
- modeling & representations
- analysis
- explanations
- argument
- application
- extended research

Multiple encounters with vocabulary in a variety of contexts allow words to go from the receptive level of understanding to the productive level:
- categorize
- compare/contrast
- identify similarities and differences
- deconstruct
- analogies and metaphors
<table>
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<tr>
<th>Term</th>
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<th>3</th>
<th>4</th>
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</table>
The ACT does not expect you to know the exact definition as much as the general concept and the context of the terms used in the passages.
As part of the SAT redesign there will be less of an emphasis on vocabulary terms with little context such as the sentence completion questions and there will be a greater emphasis on the meaning of words in extended contexts and on how word choice shapes meaning, tone, and impact.

Specifications for the New SAT
Although some might question whether the time spent on vocabulary instruction is worthwhile, Judith Scott, Dianne Jamieson-Noel, and Marlene Asselin (2003) explained that “when conceptual understanding is central, the time devoted to understanding the vocabulary is well worth the effort....”

*Marzano, Robert J.; Rogers, Katie (2014-12-10). Vocabulary for the New Science Standards*
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