Objectives

- Review research findings on how literacy interacts with math and science performance.
- Examine the aspects of math texts that make them difficult for students to understand.
- Examine the aspects of science texts that make them difficult for students to understand.
- Preview sample approaches to addressing both literacy skills and content knowledge.

Why Literacy Needs to be Applied in Math and Science

- Adolescent “comprehenders” are a heterogeneous group
  - Range in reading abilities
  - Variation in nature of difficulties
- Dual issue:
  - Accessing text
  - Learning content/concepts
College and Career Readiness
- Engaging students with authentic, increasingly complex texts

Teachers’ Attempts to Address the Issue

Is There an Advantage to Reading the Text Aloud to Students?

(Reed, Swanson, & Vaughn, in preparation)
Understanding the Nature of the Problem

Reading Difficulties (RD)  
Co-morbid Difficulties (RD+MD)  
Math Difficulties (MD)

What Makes Math Text Challenging?

- Semantics
- Syntax

Semantics

- Content-specific terms (e.g., argand plane)
- Multiple meaning words
Key Word Mnemonic Strategy

Parallel (Pair of Elves)
Lines that are the same distance apart and will never intersect

The pair of elves are the same distance apart and will never intersect.

Paul Riccomini, Ph.D.

Make a Key Word Mnemonic Card

1. Associate the math term with a similar sounding word/expression
2. Add a representative picture/graphic
3. Describe the picture in a sentence that uses the two target terms

Possible terms:
- Acute Angle
- Bisector
- Factor Tree
- Hyperbola
- Logarithm
- Rhombus
- Scale Factor
- Vertical Ellipse

Categorization Strategy

- Group related terms

<table>
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<th>5 m/7</th>
<th>6/12</th>
<th>5/8</th>
<th>20</th>
<th>4x+1=17</th>
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<td>4x+1</td>
<td>4x+1</td>
<td>quotient</td>
<td>20 = 5x</td>
<td>share equally</td>
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- Respond to questions:
  - What name will you give this group?
  - How are these words/expressions alike?
  - Can you explain why these words/expressions belong in the group?

(Berson, 1997)
Math Grammar: Problems with Syntax
- Typically read left to right
- Order governed by parts of speech
  - The dog bit the boy. VS The boy bit the dog.
- What happens if we apply that to math?

Example of Misconceptions

Teaching Students to Deal with Complex Math Text
- Sort extraneous from relevant information
- Order dictated by steps of problem and symbols within equation

Jana was earning money to march with her school band in the Rose Bowl Parade. It will cost each of the 50 band members $800 to pay for the trip. Jana has already saved $400 and is selling candles that cost $10 each to earn the rest of the money she needs. In the first week, Jana sold 15 candles. Next week she hopes to double her sales. How much money will she have earned from her two weeks of candle sales if she meets her goal next week?
Binary Framework

- $16 + 20 + 7 + 4 + 53$
- $2(8 + 7) + 15(1 ÷ 1)$

(Adams, 2003)

What Makes Science Text Challenging?

- Semantics
- Syntax

Technical Vocabulary

- Multi-syllable
- Rare
- Dense
- Integrated with graphics
Breaking Apart Multisyllable, Rare Words
(Reed & Vaughn, 2012)

- Sedimentary: sed (to settle); ment (a product of); ary (adjective, describing word)
- Evaporites: e (out of); vapor (steam); ate (mineral or fossil)
- Breccia: brecc/brech (fragment, break); ia (plural noun)
- Igneous: ign (fire); eous (composed of, resembling)
- Diorite: dior (to distinguish); ate (mineral or fossil)
- Granite: gran (grainy, made of grains); ate (mineral or fossil)
- Extrusive: ex (out); trus (to thrust or push); ive (describes something that has a tendency to)
- Metamorphic: meta (change); morph (shape, structure, form); ic (adjective, describing word)
- Foliated: foli (leafy); ate (noun, naming word)
- Graphite: graph (black lead, to write); ate (mineral or fossil)

Caution About Simplifying

- Alternative texts
- Rewriting

Alternatives Texts

- Which led to fewer misconceptions?
  A. Narrative story versions
  B. Informational versions of traditional rhetorical structure
Example of the Problem with Simplifying

Gravitational attraction is in direct proportion to the product of the objects’ masses and inverse proportion to the square of their distance apart.

Re-write:
The pull of gravity is stronger when the objects are heavier and closer together.

Dealing with Density: Showing Relationships Among Related Words

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<th>Vector capacity</th>
<th>Linear capacity</th>
<th>Impedance to flow</th>
<th>Frictional force</th>
<th>Net force on object</th>
<th>Resultant contact with flat surface</th>
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<td>+</td>
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</tbody>
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(Kosanovich, Reed, & Mier, 2010)

Integration of Text and Graphics

(Reed & Vaughn, 2012)

Both arteries and veins are structures that carry blood throughout the body. Their walls are made of three layers, but there is an important difference between the two types of blood vessels. The walls of arteries are much thicker than the walls of veins.

**Cross-sectional View of Arterial and Venal Walls**

The reason arteries need to be thicker is because they carry blood away from the heart under strong pressure exerted each time the heart muscle contracts or pumps. Blood moving back toward the heart in the veins has much less force.
Supporting the Integration of Text and Graphics: Posing Open Questions (Chin, 2007)

- How is the diagram/graph/image related to the explanation of _____?
- What does ____ tell you about ____?
- What happens to _____ when _____?
- How can you tell if _____?
- How can you describe _____?

Supporting the Integration of Text and Graphics: Graphic Organizers (Steely & Carnine, 2001)

Syntax of Scientific Explanations

**Combustion:** A combustion reaction is when oxygen combines with another compound to form water and carbon dioxide. These reactions are exothermic, meaning they produce heat. An example of this kind of reaction is the burning of naphthalene:

\[ C_{10}H_8 + 12 \text{ O}_2 \rightarrow 10 \text{ CO}_2 + 4 \text{ H}_2\text{O} \]
Syntax of Scientific Discourse

- Few personal pronouns
- Few or no personal experiences
- Based on abstractions
- Generalize phenomena through nominalizations

Tracing Arguments/Logic in a Scientific Text

Newton’s law of universal gravitation states that gravitational force decreases with distance and mass. Newton’s laws of motion describe the relationship between forces acting on a body and its motion due to these forces. Newton used universal gravitation, along with his laws of motion, to substantiate Kepler’s laws of planetary motion.

Credit: NASA

EVEN COLLEGE STUDENTS NEED HELP LEARNING HOW TO READ SCIENCE TEXTS

(VIDEO: Georgetown University)
References
