Using Language to Make Math Meaningful for ELLs

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March 25, 2017

Learning Targets:

1. I can explain why math can be so difficult for English Language Learners.

2. I can identify at least 2 explicit language strategies (using nonlinguistic representations and/or oral processing) for teaching math vocabulary that can strengthen ELL students' language proficiency & math understanding.

Who are ELL Students?

A highly heterogeneous and complex group:
* Newcomers to the US
* 2nd and 3rd generation in US
* Not strong in L1
* Multiple language backgrounds
* Parents speak no or little English
* Parents can speak English
* Students of poverty*
Math as a Language
Math is NOT a universal language!

- Cultural differences in how math is taught
- Large Emphasis on word problems in USA
- Limited Prior/Background Knowledge

- "Doing Math" requires academic reading skills **and** knowledge of content-specific vocabulary—CALP (Cognitive Academic Language Proficiency) vs. BICS (Basic Interpersonal Communication Skills)

Math & Linguistics

- Multi-meaning (Polysemous) words: table (chart/furniture), odd (strange/not even), others?
- Synonyms: add, plus, combine, sum total (+)
- Homophones: sum/some, whole/whole
- Prepositions: above, over, from, by, near, below, etc.

Academic Language

- (Includes: Vocabulary, Syntax, Discourse, & Functions)
- ALL Students are Academic Language Learners

- "Bricks and Mortar"—students need mortar words (academic vocabulary/ connecting words) in order to hold together all of the bricks (content vocabulary)

- Students need instruction in both brick and mortar words!

Data & Norris (2003)
Let's think about this...

Is Math a universal language?

...NO! Math is its own technical language!

- Many content-specific words for math are not addressed in other disciplines. Math requires competence with two languages (Kester, Bondy, & Roch, Gibbs-Dowen, 2009).
- The linguistic ambiguities in math are often overlooked by teachers but can cause students difficulty (Pierce & Fontaine, 2009).
- We need to be aware of how mathematical terms and non-mathematical vocabulary can impact student learning and understanding.

Let's Process This...

- Using one of your sticky notes:
  - Write down one reason why math can be difficult for ELLs using this sentence starter:
  - Many ELLs struggle with math because...

<table>
<thead>
<tr>
<th>Academic Language</th>
<th>Multi-Meaning Words</th>
<th>Synonyms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Context</td>
<td>Technical Language</td>
<td></td>
</tr>
<tr>
<td>Content-Specific Vocabulary</td>
<td>Homophones</td>
<td>NOT Universal</td>
</tr>
</tbody>
</table>

Quiz, Quiz, Trade

When you are done writing down your idea on a sticky note:
  - **STEP 1:** Stand up and put your hand up
  - **STEP 2:** Make eye contact with someone who also has his/her hand up and pair up with that person
  - **STEP 3:** Partner A reads and explains his/her idea.
  - **STEP 4:** Partner B offers praise or feedback.
  - **STEP 5:** Switch roles.
  - **STEP 6:** Partners trade cards and raise their hands to find new partners.
  - **STEP 7:** Repeat steps 1-6 a number of times.

Quiz Quiz Trade: Can use note cards that have questions on one side and answers on the other side. Give each student one of these cards.
- Partners quiz each other with questions and answers on their cards, provide feedback for their partners, and then trade cards.
- Great for vocabulary or key ideas being taught in any subject
Now we understand the challenge:
So what's the solution?

* By teaching math and language simultaneously, we can help ELLs strengthen their mathematics knowledge & their language abilities.

* Reading strategies proven effective for general language instruction are also effective for the instruction of mathematical language development (Nunes & Bryant, 1996).

The 5 Domains of Language
We also need to address the domains during content area subjects, like math...

1. Listening
2. Speaking
3. Reading
4. Writing
5. Visual Literacy

* To read, write, speak, and listen to mathematics with understanding is called mathematics literacy (Thompson, Kanold,ichold, Kanold, & Thompson, 2006).

Shared Focus: Language and Content

Language and content need to simmer together until they generate learning (Debbie Arechiga).
2 Big Ideas for Teaching Math Vocabulary with Language:

#1: Nonlinguistic representations

#2: Oral processing opportunities

Vocabulary—How Do We Help ELLs Learn New Words?
* Provide repeated exposures
  * Learning new words is a process—takes time & intentionality
  * ELLs need ample opportunities to use the new language
* Incorporate multiple language domains
  * Reading, Writing, Listening, Speaking, Visual Literacy
* Connect to background knowledge
  * How does the new word connect to previous learning?
* Using correct vocabulary during instruction

BIG IDEA #1: Teaching Vocabulary with Nonlinguistic Representations

Erynn Torrey
Use Visuals to Develop Understanding of Vocabulary

**Visual Literacy in Math:**

*Receptive:* Students can interpret meaning from graphic representations

*Productive:* Students can use visuals to communicate their understanding

Using the 5th Domain

* Pictorial forms of mathematics are a powerful aid to understanding the language of mathematics because they provide a different way of communicating the language.

* Learners will have increased retention of vocabulary words when they manipulate them in a variety of ways through varied instructional methods (Miller, 2007).

Nonlinguistic Representations:

The brain stores information in 2 ways:

* Linguistic Form
* Imagery Form (Nonlinguistic)

Combining both systems increases what students can learn and remember!

**Examples:**

* Graphic Organizers
* Pictures/Visual Representations
* Kinesthetic Activities

(For more information, see: Marzano, Pickering, & Pollock, 2007)
Linking Math to Non-Linguistic Representations

- T-charts
- Venn diagrams
- Part/whole charts
- Charts/motions
- Pictures
- Color-coding
- Webs/mapping
- Word Walls Organized by Category
- Manipulatives to Represent a Problem: place value blocks, pattern blocks, unifix cubes, counters, etc.

Make Learning Vocabulary ENGAGING and FUN!

- Have students record words: Cognitive Content Dictionary, 4 Square vocabulary, Frayer Model Map
- Incorporate songs, chants, motions (Karshman, 2006)
- TPR → Total Physical Response (Ayer, 1994)
- Integrate vocabulary games & activities
- http://www.amathsdictionaryforkids.com/ → an interactive dictionary and great visual resources

Vocabulary Games/Activities

Vocabulary Theater:
- Students act out words like charades, others guess

Bingo:
- Students write words on a Bingo board, teacher provides definitions or pictures for words, and students cover up words being described until someone gets a Bingo

Vocabulary Match-up:
- Students have word cards and definition cards (and/or picture cards they match up (can also be played as Memory)

Snowball Fight:
- (Use 4 Square or other template) Each student has a paper with a vocabulary word. Students crumple papers and throw at one another for an allotted time. Then grab nearby snowball, open it and add to the template in the area of their choice for the word

Pictionary:
- One partner picks a word and draws it, the other partner guesses
Make Words Visible for Students to Reference

- CCSS Vocabulary Cards
  - This website has cards for each grade level (including Spanish cards!)
- I use these and then supplement with additional words, as needed
- I organize the words by concept/category→ easier for ELLs
  - (Ellis, 2007)

BIG IDEA #2: Teaching Vocabulary with Oral Processing Opportunities

- We need to focus on communication in the mathematics classroom

- ELLs "must interact directly and frequently with people who know the language well enough to reveal how it works and how it can be used" (Lily Wong Fillmore).
Importance of Talk Time

- **Precision Partners** *(Anna Archer)*
  - Based on math AND language ability
- **Think-Pair-Share** → time to process, share ideas in non-threatening environment, and practice using the language
- **Sentence Frames** and **Word Banks** for guiding talk time
- **Collaborative Activities** to promote participation in mathematical discussions

Math Talk

- American classrooms often consist of a teacher lecturing and asking students simple questions with known answers.
- Teacher should serve as a facilitator and a guide for students as they become math thinkers.
- Gradual Process... It takes time
- Eventually students become more comfortable with it
- Teacher can identify misconceptions and gaps in understanding

Questioning Strategies

**Math Talk Moves**

- Focused strategies for getting students talking
  1. **Revoicing**
     - So you're saying that...
  2. **Restating**
     - Can you repeat what ___ said in your own words?
  3. **Reasoning**
     - Do you agree/disagree, why?
  4. **Adding On**
     - Would someone like to add on?
  5. **Using Wait Time**
     - Take your time... we'll wait...
Sentence Frames

Kate Knezza

* Maximize opportunities for student talk.
* Facilitate the use of academic language for content discussion.

Examples:
* I solved this problem by ________________.
* I think __________ because ________________.

Sentence Frames Help Students:
* Use new vocabulary.
* Practice correct grammar.
* Stretch beyond their current proficiency level.
* Become familiar with the language of assessment.

More Vocabulary Games (with Oral Processing)

Quiz, Quiz, Trade:
* Students each have a card with a word and definition. They walk around to find partners, quiz each other, trade cards, and repeat with new cards.

Headbands:
* Students hold a vocabulary word up to their forehead. Their partner has to describe the word while the student guesses.

Taboo:
* Teacher puts a list of words on the board. One partner (who can see the words) describes the words to the other partner, one at a time. Points are awarded for words guessed correctly within the allotted time.

2 BIG Ideas for Teaching Math Vocabulary with Language:

#1: Nonlinguistic representations

#2: Oral processing opportunities
Final Thoughts:

- Why Vocabulary?
  - Students must understand math vocabulary if they are to master content and be able to apply it in future situations

- Why Nonlinguistic Representations?
  - Students need to create meaning, make associations, and make personal connections with math vocabulary and content

- Why Oral Processing?
  - Students need authentic opportunities to communicate their thinking and practice the use of mathematical language

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References:

TYPES OF VOCABULARY: BRICKS AND MORTAR

Dutro & Moran (2003) (Zwiers, 22) refer to “brick” and “mortar” terms as a way to distinguish between content-specific vocabulary and general cross-curricular academic language.

“Brick” words are the vocabulary specific to the content and concepts taught in a specific discipline. “Brick” words tend to be found in glossaries and in bold face print in the content area text books.

“Mortar” words and phrases are the general utility vocabulary required for constructing sentences and paragraphs to engage in discussions using academic English. Mortar words and phrases help to connect language together and are essential to its comprehension. Mortar terms include:

- **Connecting words**: best represents, for example, however and whereas
- **Prepositions and prepositional phrases**: on, in, under, behind, between
- **Academic vocabulary typically found in content area objectives, test questions and assignments**: analyze, plan, compare, evaluate

While native English speakers may have more familiarity with “mortar” terms, English learners often do not and such vocabulary requires explicit instruction.

Students need both bricks and mortar terms and phrases to fully participate in academic English discourse.

**Example**: Social Studies
- **Bricks**: federalism, sovereignty, monarchy, and sectionalism
- **Mortar**: therefore, consequently, implications, and corroborate

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Bricks</th>
<th>Mortar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>reciprocal, equation, proof, obtuse</td>
<td>estimate, solve, represents, approximate</td>
</tr>
<tr>
<td>Science</td>
<td>photosynthesis, igneous, genetic</td>
<td>hypothesis, variable, conclude, observe, evaluate</td>
</tr>
<tr>
<td>Language Arts</td>
<td>characterization, alliteration, theme, plot, simile, foreshadowing</td>
<td>in contrast, interpret, persuade, narrate, punctuation</td>
</tr>
<tr>
<td>New Word</td>
<td>Definition</td>
<td>Used in a Sentence</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------------</td>
<td>---------------------------------------------------------</td>
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<tr>
<td>point(s)</td>
<td>an exact position</td>
<td>The lines meet at one point.</td>
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<tr>
<td>line(s)</td>
<td>is a straight path that is endless</td>
<td>A number line goes on and on.</td>
</tr>
<tr>
<td>line segment(s)</td>
<td>a section of a line that has 2 endpoints</td>
<td>The 3 line segments formed a triangle.</td>
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<tr>
<td>ray(s)</td>
<td>a line with 1 endpoint that goes on in 1 direction</td>
<td>Two rays form an angle.</td>
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<tr>
<td>parallel lines</td>
<td>lines that are the same distance apart</td>
<td>The streets formed parallel lines that never cross.</td>
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<tr>
<td>New Word</td>
<td>Definition</td>
<td>Used in a Sentence</td>
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<td>-------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
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<tr>
<td>intersecting lines n.</td>
<td>-lines that cross at one point</td>
<td>Lines that cross one another are called intersecting.</td>
</tr>
<tr>
<td>perpendicular lines n.</td>
<td>-lines that intersect to create right angles</td>
<td>The perpendicular lines form perfect squares.</td>
</tr>
<tr>
<td>acute angle(s) n.</td>
<td>-an angle open less than a right angle</td>
<td>Acute angles are open a small amount.</td>
</tr>
<tr>
<td>right angle(s) n.</td>
<td>-an angle that forms a square corner (90°)</td>
<td>The corner of the paper formed a right angle.</td>
</tr>
<tr>
<td>obtuse angle(s) n.</td>
<td>-an angle open more than a right angle</td>
<td>The alligator’s open mouth made an obtuse angle.</td>
</tr>
<tr>
<td>New Word</td>
<td>Definition</td>
<td>Used in a Sentence</td>
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</table>
**Area**

**Definition**
- the number of square units in an object
- the number of square units to cover a surface
- space on the inside of the object

- common units include: cm² and m²

**Examples**
- A = A₁ + A₂
- A = l x w
- = 2 x 1
- = 2cm

**Facts/Characteristics**
- the inside of something

**Triangle**
- \( A = \frac{bh}{2} \)

**Rectangle**
- \( A = lw \)

**Circle**
- \( A = \pi r^2 \)

**Non-examples**
- \( V = \pi r^2 h \)
- 5+5+5+5

**can't find area because it is not a closed figure**

Determine the area of a parking lot.
<table>
<thead>
<tr>
<th>Question Stems</th>
<th>Advanced Beginning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beginning</strong></td>
<td><strong>Advanced Beginning</strong></td>
</tr>
<tr>
<td>Is this a _____? (yes or no)</td>
<td>How many ______ are there?</td>
</tr>
<tr>
<td>Point to the________.</td>
<td>How many more/less____ than ____?</td>
</tr>
<tr>
<td>Put the _____next to the ______.</td>
<td>What is this?</td>
</tr>
<tr>
<td>Show me ______.</td>
<td>Which one...?</td>
</tr>
<tr>
<td>Do you have the____?</td>
<td>Is this a _____ or a ______?</td>
</tr>
<tr>
<td>Where is the____?</td>
<td>This is a ______.</td>
</tr>
<tr>
<td>Should I use the ____ or the ____?</td>
<td>Label______</td>
</tr>
<tr>
<td>Do you have the_______?</td>
<td>Sort/group by____</td>
</tr>
<tr>
<td>Who has the _____?</td>
<td>Where is______?</td>
</tr>
<tr>
<td>Who wants the _____?</td>
<td>Tell your partner/team what I just said.</td>
</tr>
<tr>
<td>Find a picture of______?</td>
<td>Tell your partner/team what a student just said.</td>
</tr>
<tr>
<td>Give me the_______.</td>
<td>Give the <em><strong><strong>to</strong></strong></em>__.</td>
</tr>
<tr>
<td>Give the <em><strong><strong>to</strong></strong></em>__.</td>
<td>If you have the _____hold it up.</td>
</tr>
<tr>
<td>If you have the _____hold it up.</td>
<td>Thumbs up/clap twice/knock twice on the table if you agree that_____.</td>
</tr>
<tr>
<td>Thumbs up/clap twice/knock twice on the table if you agree that_____.</td>
<td>Do (e.g. squares) have (e.g. 6) sides?</td>
</tr>
<tr>
<td>Do (e.g. squares) have (e.g. 6) sides?</td>
<td>Which of these two have_____?</td>
</tr>
<tr>
<td>Which of these two have_____?</td>
<td><strong>Intermediate &amp; Advanced</strong></td>
</tr>
<tr>
<td><strong>Intermediate &amp; Advanced</strong></td>
<td><strong>Transitional</strong></td>
</tr>
<tr>
<td>How do you_____?</td>
<td>Tell me a story about this picture.</td>
</tr>
<tr>
<td>Tell me about_____.</td>
<td>Why is/are_____?</td>
</tr>
<tr>
<td>Describe_____.</td>
<td>Explain_____.</td>
</tr>
<tr>
<td>What happens if______?</td>
<td>What are your conclusions about______?</td>
</tr>
<tr>
<td>When you____ what do you do?</td>
<td>How would you change____?</td>
</tr>
<tr>
<td>Why is____?</td>
<td>Analyze_____.</td>
</tr>
<tr>
<td>What do you think about_____?</td>
<td>Design_____.</td>
</tr>
<tr>
<td>What is/are the cause(s) of______?</td>
<td>Predict_____.</td>
</tr>
<tr>
<td>What are the effects of______?</td>
<td>Evaluate_______.</td>
</tr>
<tr>
<td>How do you know?</td>
<td>How did you decide____?</td>
</tr>
<tr>
<td>Describe_____.</td>
<td>How did you get that answer?</td>
</tr>
<tr>
<td>Order________.</td>
<td>How would you explain...?</td>
</tr>
<tr>
<td>Estimate______.</td>
<td></td>
</tr>
</tbody>
</table>