Supporting English Learners in Middle School Mathematics

OELAS
December 6, 2018

Time: 10:00am – 11:15am (Session 1)
Room: Tucson A – B
What is WestEd?

WestEd is a nonprofit research, development, and service agency that works with education and other communities to promote excellence, achieve equity, and improve learning for children, youth, and adults.

EL Services is a part of WestEd’s Comprehensive School Assistance Program (CSAP) that supports schools and districts to bridge the gap between research and practice specifically to enhance outcomes for English learners.
"You can’t learn math without language. There is an **old idea** that you can **work around the language**, and just get to the content. This isn’t true."

-Phil Daro

*Unlocking Learning II Math as a Lever for English Learner Equity, March 2018*
“Recognizing how language and math learning actually enhance and amplify one another is key to understanding how math instruction should be approached with students’ language needs at the center of every lesson.”

*Unlocking Learning II Math as a Lever for English Learner Equity, March 2018*
Quick Write

Take two minutes to jot down responses to the following questions:

What are the language demands of mathematics?

How can language and mathematics enhance and amplify each other?
One of the sides of the horse pen blew over and needs to be replaced. Farmer Sara needs to buy new fence material for the missing side. The perimeter of the whole horse pen is 76 feet. What is the measurement of the missing side? Explain two ways you could find this out.

What are some of the language demands of this problem that teachers need to be aware of in order for EL students to be successful?
Math and English Learners

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- 3rd Grade Performance Task

- Multiple meaning words
- Change in verb tense (past to present)
- Causal conjunctions
- Math vocabulary
- Genre: Explanation
- Referents
Standards for Mathematical Practices

MP.1 Make sense of problems and persevere in solving them.
MP.2 Reason abstractly and quantitatively.
MP.3 Construct viable arguments and critique the reasoning of others.
MP.4 Model with mathematics.
MP.5 Use appropriate tools strategically.
MP.6 Attend to precision.
MP.7 Look for and make use of structure.
MP.8 Look for and express regularity in repeated reasoning.
Mathematics Content and Language Working in Tandem: High-yield Pedagogical Practices

• **High-yield**: something that produces maximized results

• **Pedagogy**: the art, science, or profession of teaching
High-yield Pedagogical Practice: Model Lesson

Unpacking Word Problems
## Key Linguistic Features in Word Problems

<table>
<thead>
<tr>
<th>Question</th>
<th>Language Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the problem to be solved?</td>
<td>• Questions</td>
</tr>
<tr>
<td></td>
<td>• Commands</td>
</tr>
<tr>
<td></td>
<td>• Conjunctions</td>
</tr>
<tr>
<td>What relevant information is provided in the text?</td>
<td>• Technical vocabulary</td>
</tr>
<tr>
<td></td>
<td>• Complex noun groups</td>
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<tr>
<td></td>
<td>• Nominalizations</td>
</tr>
<tr>
<td></td>
<td>• Ellipsis (…)</td>
</tr>
<tr>
<td></td>
<td>• References (pronouns, demonstratives)</td>
</tr>
<tr>
<td></td>
<td>• Being processes (is/are/has/have)</td>
</tr>
<tr>
<td></td>
<td>• Conjunctions</td>
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</tbody>
</table>
### Features of Word Problems

#### Purpose
- To put math in context
- To allow opportunities to demonstrate reasoning and conceptual understanding
- To show students that math is everywhere

#### Structure
- Introduction with background information: Shane is playing a board game. He moved ahead three spaces in his first turn, 3 spaces forward for his second, and ahead one more for his third. For his next turn, he had to go back 6 spaces. After that, Shane got a card that said he could move his playing piece ahead two times the greatest forward move so far. How many spaces from the beginning is Shane’s piece?
- Descriptive facts & details about the problem
- Ends with an “ask” of the reader to do or solve something. This can be a question or with a command such as “explain” or “describe”.

### Language Features

#### Past, present, or future tense verbs
- She bought three bags of flour. Louis has 58. How much would they have to spend?

#### Long noun phrases
- The kids must combine their money so that they can purchase all of the things they will need for their trip.

#### Comparative connectives
- Greater than, less than, more, etc. (Sheila has 16 fewer marbles than Dominic.)

#### Sequential connectives
- First, next, finally, before, etc. (First, Sara ran 3 miles. Then she ran another 4 miles; Ticket prices increase by $2 after 6pm.)

#### Causal connectives
- When, because, so that, due to, etc. (When winter comes, the average temperature drops by 14 °C.)

#### Question words and phrases that request information
- How many...? Indicating quantity; What...? Or Which...? Indicating a choice will be made between two or more possible answers; Why...? Indicating an explanation

#### Simple, compound and complex sentences
- Bob had three kittens; Lost had six dogs and three cats; Jane has to buy breakfast, lunch and dinner for seven people for the week; but cannot exceed a $50 budget.

#### Noun groups that include quantifiers
- She then added 14 cups of sugar and boiled it for 20 minutes.

#### Domain specific and general academic vocabulary
- The price of the grain increased by 6% over the cost; Explain how many laps each car completed in the 250km race.
High-yield Pedagogical Practice: Model Lesson

Your Role:

- Be a learner. (So you can experience what it’s like for your students to do this.)
- Fully participate in the learning. (We’ll debrief afterward to discuss how to apply this to your classroom.)
Learning Target

We will unpack and discuss the meanings of sentences in a word problem to understand the language structures, vocabulary, and math concepts needed to solve the problem.
Consider the following prompt:

An artist used silver wire to make a square that has a perimeter of 40 inches. She then used copper wire to make the largest circle that could fit in the square, as shown below.

What makes this prompt challenging? What do you think it’s asking you to produce?
An artist used silver wire to make a square that has a perimeter of 40 inches. She then used copper wire to make the largest circle that could fit in the square, as shown below.

Part A:
How many more inches of silver wire did the artist use compared to copper wire? (Use $\pi = 3.14$.) Justify your response.
An artist used silver wire to make a square that has a perimeter of 40 inches. She then used copper wire to make the largest circle that could fit in the square, as shown below.

<table>
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<tr>
<th>Text Chunk</th>
<th>What Does It Mean?</th>
<th>Mathematical Wonderings</th>
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<tr>
<td>An artist used silver wire</td>
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<tr>
<td>to make a square</td>
<td></td>
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<tr>
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As you unpack the sentences in the word problem, discuss with your partner:

- Who or what is this chunk about?
- What is the ‘who’ or ‘what’ doing?
- What new information does this chunk add?
- What does the phrase _____ mean or do?
- Is this a context sentence or an ask or task sentence?
Let’s Take a Look at the Lesson Plan...

Talk with your table:

- How does the lesson support students’ development of content knowledge and language?

- How were mathematical language routines used as scaffolds in the lesson, or how could they be?
Preparing for a Word Problem Unpacking Lesson

- Write the sentences on register tape.
- Tear the dense, packed sentence into “chunks”.
- Create questions or prompts to highlight the meaning of each chunk (to unpack it).
How many more inches of silver wire did the artist use compared to copper wire? (Use \( \pi = 3.14 \)) Justify your response.
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<td>did the artist use compared to copper wire?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Use $\pi = 3.14$)</td>
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<tr>
<td>Justify your response.</td>
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Let’s Debrief the Day...

Share with a partner.

I used to think...
Now I think...
As a result, I will...
“Treating ELs as the people they can become means that we see students not in terms of what they lack—in their case, full control of academic English—but as capable and intelligent learners who, with the right kind of support, are as able to participate in learning and achieve academically as their English-(proficient) peers.”

- Pauline Gibbons

*Scaffolding Language/Scaffolding Learning* (2015)