WEBINAR OVERVIEW

1. Introductions
2. Background: Who are ELs?
3. Myths about math and language
4. Principles and strategies for teaching (Resources and references)

Introductions: Who are we?

Richard:

I work at the University of Ottawa, which is a bilingual (French-English) university.

I was a high school math teacher in the UK and in Pakistan, before immigrating to Canada in 2006.

Much of my research is about learning mathematics and language diversity, involving children from immigrant background, indigenous backgrounds and French immersion programs.

I and my family are French-English bilingual.
Introductions: Who are we?

Judit:
I am a professor at the University of California, Santa Cruz. Before doing my
PhD work in mathematics education, I taught college level math courses at
San Francisco State University.

My research focuses on how adolescents learn algebra, adolescent bilingual
math learners, classroom discussions, and language and learning math.

My training is in the learning sciences, my area of expertise is mathematical
thinking and learning. I am not an expert on linguistics, bilingual education, or
language acquisition. I depend on experts in ESL, bilingualism, and
sociolinguistics for insights and research on language.

Spanish is my first language, my family and I immigrated to the USA from
Argentina when I was 14.

POLL: Who are you?

1. How familiar are you with language issues
   in math classrooms?
   a) very  b) some  c) a little  d) not at all

2. Which grade levels are most familiar to
   you?
   a) K-2  b) 3-5  c) 6-8  d) 9-12  e) 13-14

Who are English Learners?
Who are ‘English Learners’?

- ‘English learners’ is a label for learners in many situations - recent immigrants, students from established immigrant communities, Native Americans, or a combination.
- We see ELs as bilingual (or multilingual) - they live in more than one language. Some researchers also use the term ‘emergent bilinguals.’
- Some students are considered ‘former’ ELs, but their English is likely still developing.


<table>
<thead>
<tr>
<th>Home language</th>
<th>Number of ELL students</th>
<th>Percentage distribution of ELL students</th>
<th>Number of ELL students as a percent of total enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish, Castilian</td>
<td>3,741,066</td>
<td>77.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Arabic</td>
<td>114,371</td>
<td>2.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Chinese</td>
<td>101,347</td>
<td>2.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Vietnamese</td>
<td>81,157</td>
<td>1.7</td>
<td>0.2</td>
</tr>
<tr>
<td>English</td>
<td>80,333</td>
<td>1.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Somali</td>
<td>34,813</td>
<td>0.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Hmong</td>
<td>34,813</td>
<td>0.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Russian</td>
<td>33,057</td>
<td>0.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Haitian, Haitian Creole</td>
<td>30,231</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Tagalog</td>
<td>27,277</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Korean</td>
<td>27,266</td>
<td>0.6</td>
<td>0.1</td>
</tr>
</tbody>
</table>

About ELs...

- It is important to separate language proficiency and proficiency in math.
- Language is not the only explanation for poor math performance: poor schools, racism, etc.
- Who are the students in your classes? What languages they speak? What are their backgrounds? What are their previous experiences with math instruction?

Five myths about ELs and math

<table>
<thead>
<tr>
<th>MYTHS</th>
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<tbody>
<tr>
<td>1. ELs cannot.....succeed in math, participate in discussions, work with word problems, etc.</td>
</tr>
<tr>
<td>2. There’s no language in math (Example 1, Richard)</td>
</tr>
<tr>
<td>3. It’s just vocabulary (Example 1, Richard)</td>
</tr>
<tr>
<td>4. Using two languages to learn math is bad (Example 2, Judit)</td>
</tr>
<tr>
<td>5. Precision is mainly about using the exact word (Example 2, Judit)</td>
</tr>
</tbody>
</table>
MYTH 1: ELs cannot succeed in math, participate in discussions, work with word problems, etc

Research shows...

There seem to be relationships between language proficiency and math performance:

- Bilinguals outperform monolinguals in math
- Emergent bilinguals match monolinguals if they have high proficiency in one language
- Emergent bilinguals may do less well than monolinguals if they have low proficiency in both languages (likely true for monolinguals too)

Research shows...

Students are able to participate in mathematical discussions and problem solving, particularly when:

- Tasks make sense or relate to situations they recognize
- Discussion is encouraged, supported and guided by skillful interventions
- Time to think, understand, prepare, etc.
- Not only text but “text PLUS” other things such as diagrams, gestures, materials, etc.
MYTH 2: There's no language in math
MYTH 3: Els just need to learn math words

So what is the language of math?

The following is the formula for the area of a circle:

$$A = \pi r^2$$

If the radius of a circle is 1.25 cm, which of the following is closest to its area?

A. 15.4 cm²
B. 7.9 cm²
C. 4.9 cm²
D. 3.9 cm²

What aspects of language might ELs need to be familiar with to engage in a discussion about this problem?

So what is the language of math?

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If the radius of a circle is 1.25 cm, which of the following is closest to its area?

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What aspects of language might ELs need to be familiar with to engage in a discussion about this problem?
The language of math includes...

- Vocabulary (Area, formula, ...)
- Logical connectives (if, and, because, ...)
- Sentence structure (e.g. defining, explaining, questioning, conjecturing, proving)
- Deixis (‘the following’, its, this, that, the, we, ...)
- Interpreting and connecting text and graphics
- Reading formulae and other notation
- Participating in math discussion
- ...

MYTH 4: Using two languages to learn math is bad
MYTH 5: Precision is about using the exact word

• Judit: Two girls comparing lines

Take 2-3 minutes to think about the problem on the next slide

COMPARING LINES HANDOUTS

- Problem Handout by email
- Focus Questions Handout by email
- Math Practices Handout by email
- Transcript Handout by email

Analysis of video clip example is in chapter 2 of this NCTM book
• “Supporting mathematical reasoning and sense making for English Learners.” In NCTM book Focus on High School Mathematics: Fostering Reasoning and Sense Making for All Students. Moschkovich (2011)
**COMPARING LINES: The problem**

Two students worked on this problem: They drew two lines.

- If you change the equation \( y = x \) to \( y = 0.6x \), how would the line change?

- The steepness would change. Why or why not?

**WATCH VIDEO CLIP**

**USING THESE TWO FOCUS QUESTIONS**

1. What mathematical practices did students use?
2. What resources did students use?

- Listen and watch carefully
- Read subtitles
- When student speaks Spanish, translation is below in parentheses
- I will read transcript after showing the video clip

**COMMON CORE MATHEMATICAL PRACTICES**

1) Make sense of problems & persevere in solving them
2) Reason abstractly and quantitatively
3) Construct viable arguments & critique the reasoning of others
4) Model with mathematics
5) Use appropriate tools strategically
6) Attend to precision

**FOCUS ON** MPs 1, 2, 3, and 6
VIDEO CLIP: COMPARING LINES

TRANSSCRIPT: COMPARING LINES

Marcela: No, it's less steep . . .
Giselda: Why?
Marcela: See, it's closer to the x-axis . . . isn't it?
Giselda: Oh, so if it's right here . . . it's steeper right?
Marcela: Porque fíjate, digamos que este es el suelo,
(Because look, let's say that this is the ground)
entonces, si se acerca más, pues es menos steep.
(then, if it gets closer, then it's less steep.)
Giselda: Oh, I got it. I thought you meant
qué es la diferencia entre esto y el otro, know what I mean?
(which is the difference between this and that one)
Marcela: Pero fíjate (But look).
Giselda: But that's not what they want.
Marcela: Yeah! . . . Well, kind of, cause see this one . . . is . . .
está entre el medio de la x y de la y, right?
(is between the x and the y)
This one (the line y=-0.6x) is closer to the x than to the y,
so this one (the line y=-0.6x) is less steep.

VIDEO CLIP
FOCUS QUESTIONS

1. What mathematical practices did students use?
2. What resources did students use?
COMMON CORE MATH PRACTICES

MP1. Make sense of problems
Understanding a situation, concept, or context by connecting it with existing knowledge

MP2. Reason abstractly
Drawing logical conclusions based on assumptions and Definitions

MP3. Construct viable arguments

MP6. Attend to precision

MATH PRACTICES in EXAMPLE?

Mathematical Practices
1. Using phrases that reflect math practices
   If ___, then ___
   Let’s say this is ___
   Reasoning abstractly (MP2)
   Constructing arguments (MP3)

2. Attending to precision (MP6)
   Stated an assumption explicitly so that the claim was precise
   “Digamos que este es el suelo, entonces……”
   Let’s say that this is the ground, then………
MATH PRACTICES in EXAMPLE?

Mathematical Practices
1. Using phrases that reflect math practices:
   - If … then … Reasoning abstractly (MP2)
   - Let’s say this is … Constructing arguments (MP3)

2. Attending to precision (MP6)
   - Stated an assumption explicitly so that the claim is precise
     “Digamos que este es el suelo, entonces……”
     Let’s say that this is the ground, then……
   - Connecting a claim to the graph
     Used axes as reference to support a claim about the line:
     “Está entre el medio de la x y de la y”
     Is between the x and the y

MATH PRACTICE 6
ATTEND TO PRECISION

In this example:
Precision was not about using the precise word, but making a precise claim
that applies only under precise conditions.
Consider MP6 “Attend to precision”:
• Means more than using the precise word
• How does “precision” work in mathematical practices?

Notice when students “attend to precision” at the claim level
“Multiplication makes result bigger”
Focus on precision NOT at the word level
but at the claim level.
Ask:
“When does multiplication make the result bigger?”
“Multiplication by a whole number larger than 1 makes result bigger.”
“Multiplication by a whole number larger than 1 (not 0, not 1) makes result bigger.”
RESOURCES in EXAMPLE 2?

“Digamos que este es el suelo”
(Let’s say that this is the ground)
1. First language for explaining & clarifying
2. Everyday language and experiences
   the x-axis is the ground
   “gets steeper”

Using two languages CAN support a mathematical discussion!

SUMMARY: WHAT DOES RESEARCH SAY ABOUT THESE MYTHS?

MYTH 1: ELs can.....succeed in math, participate in discussions, work with word problems, etc. in the right conditions

MYTH 2: There’s a lot of language in math

MYTH 3: It’s much more than vocabulary

MYTH 4: Using two languages can support a mathematical discussion

MYTH 5: Precision matters at the claim level

Principles and strategies for teaching
Some research-based principles for supporting ELs in math

1. Avoid deficit assumptions.
2. Focus on students’ mathematical reasoning, and mathematical practices, not single words or vocabulary.

3. Make use of students’ language and other types of resources:
   - The different languages they may know
   - Their knowledge of math and mathematical language
   - Their own experiences of the world
   - Deixis (this one, that one, etc.)
   - Other students’ ideas and interpretations
   - Multiple representations (symbols, gestures, writing, concrete materials, graphs, diagrams, etc.)
   - Different types of talk (expository, exploratory, etc.)

(Math) instruction that pays attention to language

4. Ensure students have the opportunity to talk and write mathematical language, in addition to listening and reading
5. As part of planning, include and address mathematical language objectives alongside mathematics objectives
6. Combine language learning and mathematics learning in the same activity
7. Work with ESL/ELD colleagues (don’t do this on your own, we didn’t!)
Some strategies for combining math and language

Discuss students’ mathematical thinking with them

- Provide opportunities for students to talk about (and write about) mathematics
- Listen to make sense
- Pose questions to provoke further thinking
- Revoice using more mathematical language (written or spoken)
- Draw attention to important mathematical ideas
- Draw attention to important mathematical language (visually, verbally,...)

Some task types for combining math and language

- Jumbled sentences
- Gap-fills
- Matching phrases to a diagram
- Writing frames
- Cartoons
- Animations

Example: Towers

These towers are made with toothpicks. What will the next tower look like? And the one after that? Find a general expression for the number of toothpicks in the nth tower.
Jumbled sentences

Tower 4 has 3 toothpicks
Tower n has 3 toothpicks
Tower 3 has 3 toothpicks
Tower 2 has 3 toothpicks

more than
Tower 1
more than
Tower 3
more than
Tower n-1
more than
Tower 2

Matching phrases to a diagram

Tower 1
3 toothpicks
more
Tower 3
3 toothpicks
more
Tower 2
4 toothpicks

10 toothpicks
7 toothpicks

Writing (or speaking) frames

I noticed that
1 square needs 4 toothpicks
2 squares joined together need 7 toothpicks
3 squares joined in a line need 10 toothpicks

I think that
for n joined up squares I will need
4 + 3(n-1) toothpicks
because
the number of toothpicks goes up by 3 and I started with 4 toothpicks in the first square
PROVIDED ONLINE

- Resources for teaching
- References
- A pdf of the slides

QUESTIONS?

In CHAT type your question

THANK YOU!
RESOURCES FOR SUPPORTING MATHEMATICAL DISCUSSIONS

1) Anticipating
2) Monitoring students’ responses to tasks (Video clip example today)
3) Selecting
4) Sequencing
5) Make mathematical connections

RESOURCES FOR SUPPORTING MATHEMATICAL DISCUSSIONS


FREE CURATED RESOURCES ONLINE
Understanding Language
SUPPORTING ELLS IN MATHEMATICS
Resources for math tasks aligned with CCSS
Developed by “Understanding Language” Initiative
• Annotated tasks (MAP, FALS)
• Templates for activities focused on language
“Language of Math Tasks”
http://ell.stanford.edu/

WIDA
WIDA, based at the University of Wisconsin, Madison, offers instructional resources, assessment materials and professional development opportunities for teachers of ELs across the curriculum (i.e. not a math specific web resource).
https://wida.wisc.edu
REFERENCES

PRESENTATION IS BASED ON PUBLICATION:

OTHER PUBLICATIONS:
NCTM Using Two Languages When Learning Mathematics Brief
How can research help us understand mathematics learners who use two languages? Research Brief, NCTM, 2009, online
http://www.nctm.org/clipsonbriefs.aspx
More publications listed and posted on web page
http://people.ucc.ie/~jmoschko/

MOSCHKOVICH REFERENCES

VIDEO CLIP EXAMPLE IS IN THIS PUBLICATION:
2. “Mathematics, the Common Core, and Language,” 2012, available online
http://ell.stanford.edu/

OTHER PUBLICATIONS:
NCTM Using Two Languages When Learning Mathematics Brief
How can research help us understand mathematics learners who use two languages? Research Brief, NCTM, 2009, online
http://www.nctm.org/clipsonbriefs.aspx
More publications listed and posted on web page
http://people.ucc.ie/~jmoschko/
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