The Language of Math: The Common Core And English-Learners
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The Language of Math: the Common Core and English-Learners

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Related article:
Common-Core Math Standards Put New Focus on English-Learners
An on-demand archive of this webinar will be available at www.edweek.org/go/webinar in less than 24 hrs.
MATHEMATICS, THE COMMON CORE, AND LANGUAGE: How Can Instruction Support English Learners in Mathematics Classrooms?

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Understanding Language
Language, Literacy, and Learning in the Content Areas

Work supported by NSF, Spencer Foundation, UCSC Senate grants, and Understanding Language Initiative supported by Carnegie and Gates Foundations.

Center for the Mathematics Education of Latinos/as
National Science Foundation Award No. ESI-0424983
RESEARCH BASED RECOMMENDATIONS FOR EFFECTIVE MATH TEACHING

1. a) Teachers and students attend to concepts
   b) Teachers give students time to wrestle with important mathematics.

   Hiebert & Grouws (2007) NCTM Research Brief online

2. High cognitive demand:
   a) Students focus on mathematical concepts
   b) Teachers maintain the rigor of tasks by encouraging students to explain and justify their reasoning.

   Do the Math: Cognitive Demand Makes a Difference.

   AERA Research Points, Fall 2006, Volume 4, Issue 2
EFFECTIVE RESEARCH-BASED MATH TEACHING

Effective Math Instruction

Conceptual Understanding:
- Attend to concepts
- Time to wrestle with math
- High cognitive demand: explain, justify
MATHEMATICAL PROFICIENCY

13 + 13 + 13 + 13 + 13

5

PROCEDURAL FLUENCY:
Add 13s, divide by 5

CONCEPTUAL UNDERSTANDING:
13 is added to itself 5 times, then divided by 5, so answer is 13.

CONCEPTS:
Repeated addition model for multiplication
Multiplication & division are inverse operations

NRC REPORT  Adding it up: helping children learn mathematics.
Kilpatrick, Swafford, & Findell (Eds.), 2001.
MATH TEACHING
ALIGNED WITH CCSS

1. Balance emphasis on conceptual understanding and procedural fluency

2. Maintain high cognitive demand

3. Develop beliefs that math is sensible, worthwhile, and doable

4. Depth before breadth

5. Students engage in MATH PRACTICES (8)

www.corestandards.org/the-standards/mathematics
CCSS STANDARDS FOR MATHEMATICAL PRACTICE

1) Make sense of problems and persevere in solving them
2) Reason abstractly and quantitatively
3) Construct viable arguments and critique the reasoning of others
4) Model with mathematics
5) Use appropriate tools strategically
6) Attend to precision
7) Look for and make use of structure
8) Look for and express regularity in repeated reasoning
MATH TEACHING ALIGNED WITH CCSS

- Conceptual Understanding
  - More Depth
  - Less Breadth
- Math Practices
- Communication
MATH TEACHING ALIGNED WITH CCSS?

FIRST: Teach math for understanding!

What are students doing?

✓ Use and connect multiple representations
✓ Show and describe meaning for symbols
✓ Share, refine, and critique their reasoning
✓ Use language to do math
✓ Engage in MATH PRACTICES (8)

Resources online (free tasks, lessons, videos):
NCTM, Inside Mathematics, Mathematics Assessment Project, “Understanding Language”
EFFECTIVE MATH INSTRUCTION
CCSS ALIGNED

Effective Math Instruction

Conceptual Understanding
Math Reasoning
Math Communication

CCSS
RESEARCH BASED RECOMMENDATIONS FOR INSTRUCTION THAT SUPPORTS ACADEMIC SUCCESS FOR ELS

1. Based on rigorous, standards-based curriculum; provide additional time & instruction, but not lower expectations

2. Treat language as a resource, not a deficit; emphasize academic achievement, not only learning English

3. Teachers reject deficit models of students, hold high expectations for all students, can change curriculum and instruction to meet specific needs of students.

4. Provide “abundant and diverse opportunities for speaking, listening, reading, and writing” and “encourage students to take risks, construct meaning, and seek reinterpretations of knowledge within compatible social contexts”

Garcia & Gonzalez, 1995
ACADEMIC SUCCESS FOR ELS

• No deficit models
  • Linguistic resources
  • Cultural resources
  • Multiple modes
  • Multiple communication settings

Meaning
Understanding
Reasoning
Communication
INTERSECTION

**Effective Math Instruction**
- Conceptual Understanding
- Math Reasoning
- Math Communication

**CCSS**

**Academic Success for ELs**
- No deficit models
- Linguistic resources
- Cultural resources
- Multiple communication settings, modes, purposes
SUPPORTING ELs in MATH CLASSROOM

Provide students opportunities for multiple:
1. Resources for mathematical thinking
2. Communication settings
3. Modes of communication
4. Purposes
OPPORTUNITIES FOR MULTIPLE

1. **Resources for mathematical thinking**
   - Linguistic: everyday and home language
   - Cultural: invented algorithms, community activities
   - Representations: drawings, gestures, objects, symbols, etc.

2. **Communication settings**: work alone, in pairs, small groups, teacher-led discussions, etc.

3. **Modes**: speaking, listening, reading, writing, drawing, graphing, etc.

4. **Purposes**: Students describe, compare, explain, argue, articulate ideas, interpret information, share explanations, present solutions, defend claims, etc.
RECOMMENDATIONS

For supporting ELs (and other students developing literacy, reading, academic language, math discourse, academic literacy in mathematics, etc.)

✓ Important for all students

➢ ESSENTIAL for ELs!!!
TEACHING PRACTICES
IMPORTANT FOR ALL STUDENTS

• **Teach math for understanding**
  More than computation, memorization, repetition
  
  CONNECTING MULTIPLE REPRESENTATIONS: Objects, manipulatives, drawings, symbols, equations, tables, graphs etc.

• **Focus on student reasoning**
  Students explain why (not only share answers)

• **Include different kinds of communication**
  Talking, reading, writing, drawing, graphing, etc.
TEACHING PRACTICES
ESSENTIAL FOR ELS

✦ More than talk or text
  a) MULTIPLE REPRESENTATIONS: Objects, manipulatives, drawings, symbols, equations, tables, graphs etc.
  b) MULTIPLE MODES: Talking, reading, writing, drawing, graphing, etc.

✦ More than whole-class/teacher-led discussions

MULTIPLE COMMUNICATION SETTINGS are ESSENTIAL for ELs

CYCLE→ Write responses alone, pair work, small group work, then whole-class discussion

Support presentations: Provide ELs opportunities to prepare, share, review, and practice their presentation

Understanding Language web site
http://ell.stanford.edu/content/mathematics-resources-additional-resources
Resources online: Free tasks/lessons

NCTM  www.nctm.org

Mathematics Assessment Project
http://map.mathshell.org/materials/index.php

Understanding Language
http://ell.stanford.edu/teaching_resources/math
THANK YOU!!!
The Language of Math: the Common Core and English-Learners

Mark Driscoll,
Education Development Center
The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A110076 to the Education Development Center, Inc. The opinions expressed are mine and do not represent views of the Institute or the U.S. Department of Education.
Mathematics Coaching Supporting English Learners (MCSEL)

• Develop and study professional development (PD) materials to support mathematics teachers of English learners, grades 6-8:
  - materials for leading PD seminars
  - materials for Classroom Inquiry Cycles to follow each seminar
Guiding Principles

• Challenging Mathematical Tasks
e.g., geometric reasoning and quantitative reasoning activities

• Multimodal Representation
e.g., diagramming; writing; speaking

• Academic Language
esp. language access and language production strategies

• Repeated Structured Practices
esp. analyzing visual representations instructional routine, and creating visual representations instructional routine
The Verbs of Mathematical Practice

1. Make sense of problems and **persevere** in solving them.
2. **Reason** abstractly and quantitatively.
3. **Construct** viable arguments and **critique** the reasoning of others.
4. **Model** with mathematics.
5. **Use** appropriate tools strategically.
6. **Attend to** precision.
7. **Look for** and **make use** of structure.
8. **Look for** and **express** regularity in repeated reasoning.
Learning Academic Language by Using Academic Language

- “Mathematical concepts, objects, and relationships arise through language, and within particular socio-cultural environments, in response to human thinking about quantity, relationships, and space” (Barton, *The Language of Mathematics*, 2008)

- Learning mathematics involves participation in the mathematical discourse practices in a classroom or other mathematical learning community (e.g., Moschkovich, 2002).
Hurdle: Widespread Lack of Knowledge about Mathematical Visual Representations

• One strategy: Invite students to analyze how fictional students used visual representations as mathematical thinking tools
Triangle Task:
Mario’s Thinking
Transforming a Triangle: Mario

Given

Step 1

Step 2

Step 3

What do you notice?

8 square units
What Changed?
Individual writing and discussion

Given

Step 1

Questions:
A. What changed:
  • From the Given to Step 1?
What Changed?
Individual writing and discussion

**Questions:**

A. What changed:
   - From the Given to Step 1?
   - From Step 1 to Step 2?
What Changed?
Individual writing and discussion

Given

Step 1

Step 2

Step 3

Questions:

A. What changed:
   • From the Given to Step 1?
   • From Step 1 to Step 2?
   • From Step 2 to Step 3?

8 square units
What Changed?

Individual writing and discussion

**Given**

**Step 1**

**Step 2**

**Step 3**

Questions:

A. What changed:
   - From the Given to Step 1?
   - From Step 1 to Step 2?
   - From Step 2 to Step 3?

B. Mario discovered _____________

8 square units
Promising Practices:

• Alternate *analyzing* diagram tasks, like Mario, with *creating* diagram tasks
• Engage EL students with visual representations as mathematical *thinking tools*
• Regularly integrate language access and language production strategies in mathematics lessons
• Collaboratively analyze EL students’ work –esp. ESL and math teachers together, looking for potential (example follows)
A Problem

Rita has read 224 pages of her book. She has 1/5 of the book left to read. What is the total number of pages in the book?
Rita has read 224 pages of her book. She has 1/5 of the book left to read. What is the total number of pages in the book?
A website, growing out of our past work with mathematics teachers of English learners, and a site we hope will continue to grow:

mathandlanguage.edc.org
An on-demand archive of this webinar will be available at www.edweek.org/go/webinar in less than 24 hrs.
The Language of Math: the Common Core and English-Learners

Required Reading from *Education Week*:

Free download! **Spotlight on Math Instruction**
Math instruction is undergoing shifts in the common-core era. In this Spotlight, see how computer-based testing impacts math performance, find out which textbooks are aligned to the common core, and learn how to take a blended learning approach to math instruction.