Math Language Demands of the Common Core for ELLs and Implications for Instruction

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Goals for the session

- Examine the critical role language plays in the new Common Core State Standards and the Next Generation Science Standards for English Language Learners (ELLs).
- Identify specific math language that supports ELLs' access and success in Mathematics in the era of the Common Core.
- Explore ways to engage English Learners in high levels of discourse in Mathematics classrooms

Major Shifts in New Standards

<table>
<thead>
<tr>
<th>ELA</th>
<th>Math</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular practice with complex text and its vocabulary</td>
<td>Provide opportunities for students to be the main focus of mathematical discussions and use a variety of strategies</td>
<td>Developing and using models</td>
</tr>
<tr>
<td>Existing knowledge through context-rich Informational Texts</td>
<td>Support mathematical discussions and use a variety of strategies</td>
<td>Constructing explanations and developing solutions</td>
</tr>
<tr>
<td>Emphasis on reading, writing, and speaking that is grounded in evidence from the text</td>
<td>Focus on students' mathematical reasoning and students' sense of the language of mathematics</td>
<td>Engaging in argument from evidence</td>
</tr>
</tbody>
</table>

Cross-Cutting Foundations

- Mathematics, the Common Core and Language: Recommendations for Mathematics Instruction for ELLs Aligned with the Common Core (Judith Moschkovich)
- Instruction for Diverse Groups of English Language Learners (Leo Van Lier & Aida Walqui)
- Language and the Common Core State Standards (Aida Walqui & Margaret Heritage)

What do the New Standards Imply? Focus on Language

- "Students can, without significant scaffolding, comprehend and evaluate complex texts across a range of types and disciplines and they can construct effective arguments and convey intricate and multifaceted information" (ELA student portraits, p. 7)
- Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures, and build a logical progression of statements to explore the truth of their conjectures" (Math practices, pp. 6-7)

Old Paradigm
New Paradigm

Extended Discourse (talk)
- Discussing Complex Problems
- Giving Explanations

Math
- Constructing Arguments
- Making Conjectures
- Reading Complex Sentences
- Stating Assumptions
- Vocabulary in Context

Mathematics Vocabulary
- Multiple terms for the same thing
  - and, plus, combine, put together, increased by
  - subtract, decreased by, take away, minus, less
- Common words with specific mathematical meanings
  - set, point, field, table, pair
- Conceptually dense words
  - coefficient, exponent, least common multiple

The Syntax of Mathematics

- Word order
  - By what percent is 16 increased to make 24?
- Passive verbs
  - 10/5 can be renamed as 2

- Multiple clauses and phrases
  - The chart shows the maximum amount of three pollutants [that] a light-duty truck may emit per mile.

Mathematics Difficulties

- Logical connectors
  - if… then, because, for example, consequently
- Lack of one-to-one correspondence between symbols and words
  - The number a is 5 less than the number b. \( a = b - 5 \)
- References of variables
  - 3 times a number is 2 more than 2 times the number.

Discussion Question

- What are you doing now to enable English Learners to achieve and understand some of these linguistic competencies in math?

THE ENGLISH LANGUAGE PROFICIENCY DEVELOPMENT FRAMEWORK

THE LANGUAGE OF MATH, SCIENCE AND LANGUAGE ARTS
Common Core State Standards & Next Generation Science Standards

- Demand all students develop ever increasing levels of language competency in order to acquire and perform the knowledge and skills articulated in the standards
- Involvement of language skills:
  - Identifying a speaker's key points (L)
  - Elaborating on these ideas in group settings (S)
  - Evaluating complex Problems (R)
  - Constructing effective arguments (S, W)

The Double Challenge for English Learners

To fully meet the demands of the Common Core State Standards (CCSS) & the Next Generation Science Standards (NGSS) English Learners must

- learn how to effectively employ a second language in an academic setting
- while learning through that second language the knowledge and skills in multiple disciplines.

English Language Proficiency Development (ELPD) Framework

- States have adopted the more rigorous academic content expectations of the CCSS & NGSS and are explicitly required within NCLB to develop ELD standards.
- To enable English Learners to meet these more rigorous expectations, California used the ELPD framework to write and adopted new ELD standards that are CCSS aligned

Purposes of the ELPD Framework

- The ELPD Framework is a mechanism to help states understand the relationship between content area standards of the CCSS & NGSS and the developing language needs of English Learners.
- The ELPD Framework is intended to communicate to states and districts the underlying academic language that all students, but especially English Learners, must acquire to successfully access the demands of the CCSS & NGSS.

Structure of the ELPD Framework

- Match Standards
- Progressions
- Foundations

Standards Match

(Disciplinary Ideas) Key Practices
Analytic Tasks
Language Functions

| Productive | Receptive |
Table 2: Key Practices and Disciplinary Core Ideas (Dissc) of the Mathematics (K-12)

<table>
<thead>
<tr>
<th>Students as Mathematicians</th>
<th>Standards for Mathematical Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3</td>
<td>A-APR.D.6</td>
</tr>
<tr>
<td>G4</td>
<td>A-APR.D.6</td>
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<tr>
<td>G5</td>
<td>A-APR.D.6</td>
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<tr>
<td>G6</td>
<td>A-APR.D.6</td>
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<tr>
<td>G7</td>
<td>A-APR.D.6</td>
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<tr>
<td>G8</td>
<td>A-APR.D.6</td>
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<tr>
<td>G9</td>
<td>A-APR.D.6</td>
</tr>
<tr>
<td>G10</td>
<td>A-APR.D.6</td>
</tr>
</tbody>
</table>

Section 2.4: Classroom Match

The Classroom Match tables offer conceptualizations of the multiple features of students' and teachers' language use in the disciplines while engaged in the learning of the key practices in the CCSS and NGSS.

These tables begin on page 32. Please turn to this page as we review these tables together.

To find the ELPD framework, online: Google ELPD CCSSO
Video Discussion

- Find a partner
- One person will take notes on ways students build on each other's thinking.
- The other person will take notes on ways students use the language of math.
- Use Key Practice 1 (page 21) - Make Sense of problems and persevere in solving them.
- Check off things you see and hear students do in the video
Match the words to a definition...

- **conversation**: Expression of one's thoughts or emotions by means of spoken language.
- **discourse**: Consideration of a question in open and usually informal debate.
- **discussion**: Formal, orderly, connected and extended expression of thought on a subject.
- **talk**: Oral exchange of sentiments, observations, opinions, or ideas with someone else.
  - (Zwiers, 2014)

**Constructive Classroom Conversations MOOC**

- High School Conversation Model
- 2013 Hakuta, Zwiers, & Rutherford
- Quach

**High School Conversation Example**

**Context**: During this 10th grade geometry lesson, which focused on geometrical relationships, students were asked to work in pairs to determine the length of a side of a square inscribed in a circle, describing the length in terms of $r$, the radius.

**High School Conversation Example**

- **Objective**: Students will apply their knowledge of area and/or the Pythagorean theorem to describe the length of a side of a square inscribed in a circle, using $r$, the radius of the circle.
- **Conversation Prompt**: Talk about ways to approach and answer the question (i.e. What is the length of a side of the squares, given the radius of the circle?) and justify your ideas.

**High School Conversation Example**

1. Student A: It says "write down the side of the inner square in terms of $r." What does that mean?
2. Student B: There's no numbers so we gotta just use $r$, I guess.
3. Student A: We can measure it. Here's a ruler. You do it.
4. Student B: OK. Just half across the circle. That's the radius. Looks like 1 inch. And the square side is like around 1 and a half.
5. Student A: So $r$ is 1, and it's another half. So, like 1 and a half times $r$.

**High School Conversation Example**

1. Student B: But what if $r$ isn't 1?
2. Student A: What do you mean? We measured.
3. Student A: It says "in terms of $r." We got a number, not with $r$.
4. Student A: Maybe it's close enough.
High School Conversation Example

- **DIMENSION 1**: Turn build on previous turns to build up an idea
  4. Half or more of the turns build on previous turns to effectively build up a clear and complete idea
  3. Half or more of the turns build on previous turns to adequately build up an idea, which may be incomplete or lack clarity.
  2. Few turns build on previous turns to build up an idea.
  1. Turns are not used to build up an idea.

High School Conversation Example

- **DIMENSION 2**: Turn focus on the knowledge or skills of the lesson's objectives
  4. Half or more of the turns effectively focus on the lesson's objectives and show depth or fostering of the intended learning.
  3. Half or more of the turns sufficiently focus on the lesson's objectives, but this focus may be superficial or lack clarity.
  2. Few turns focus on the lesson's objectives.
  1. Turns do not focus on the lesson's objectives.

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High School Conversation Example

- **Dimension 1**: Turn build on previous turns to build up an idea
  - Score 4 - Rationale for score
  - More than half the turns in this conversation build on previous turns (i.e., they respond to and question each other). They build up their solution for solving the problem, even though it is wrong, and it is clear enough to see what they are thinking (one of the reasons to have students converse), making it a 4, even though their idea is ultimately incorrect.

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Why collect short conversations?

- Listening to conversations like this one can help us zoom in on what we need to rethink and emphasize (e.g., in most cases in geometry, we can't have students be thinking "close enough")
- Show the language students are using as well as their thinking.
- Show the growth in using academic language over time.

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Realizing Opportunities for English Learners

- ELLs should not be removed from the challenges set out in the standards, but rather supported in meeting them. ELLs can meaningfully participate in instruction through "imperfect" language.
- Instruction must build on -- and build -- students' existing resources (L1, background knowledge, interests and motivations), precisely in order to expand them.
- Instruction must immerse students in meaning-making language and literacy activities with both micro- and macro-scaffolding (Innes-Regagnoli & Orizzioni, 2011)
Thanks you for your participation

Questions?
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Understanding Language Website
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A Science Lesson
9 year old
Advanced English Proficiency Level

Learning to Learn in a Second Language
by Pauline Gibbons

Science Lesson - Transcript 1

"Try this one... no it doesn't go... it doesn't move... try that... yes... it does a bit... that won't work... it's not metal... these are the best... it's making them go really fast."

Learning to Learn in a Second Language
by Pauline Gibbons

Science Lesson - Transcript 2

"We tried a pin, a pencil sharpener, some iron filings and a piece of plastic. The magnet didn't attract the pin, but it did attract the pencil sharpener and the iron filings. It didn't attract the pencil."

Science Lesson - Transcript 3

Students wrote about their experiment with the teacher. (Teacher Mediated Language)

"Our experiment was to find out what a magnet attracted. We discovered that a magnet attracts some kinds of metal. It attracted the iron filings, but not the pin. It also did not attract things that were not metal."

Science Lesson - Transcript 4

"A magnet is a piece of metal which is surrounded by an invisible field of force which affects any magnetic material within it. It is able to pick up a piece of steel or iron because its magnetic field flows into the metal, turning it into a temporary magnet."
References


