Guidelines for Design of Mathematics Instruction and Materials for ELLs

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in collaboration with the Understanding Language Initiative's Mathematics Work Group members Phil Daro and Tina Cheuk. These Guidelines *are based on the* ELA Guidelines *written by the Understanding Language ELA Work Group: George Bunch (chair), Martha Inez Castellon, Susan Pimentel, Lydia Stack, and Aída Walqui.*

One aim of the Understanding Language (UL) Mathematics Work Group is to provide general guidelines for instructional design that maximize alignment with the Common Core mathematics standards for ELLs. Work in the service of this goal has informed and been informed by UL's *Key Principles for ELL Instruction.* The *Key Principles* are meant to guide educators and administrators as they work to help ELLs meet standards in various content areas.

The purpose of the *Mathematics Guidelines* is to move toward a shared framing of approaches to designing mathematics instruction and materials for ELLs in ways aligned with the Common Core State Standards.

These guidelines draw in part on papers prepared for the Spring 2012 Understanding Language Conference at Stanford University (http://ell.stanford.edu/papers/practice), and were modeled after the *Guidelines for ELA Instructional Materials Development*. In fact, some guidelines are taken verbatim from the *ELA Guidelines* or modified only by referring to mathematics instead of ELA.

Although developed to be consistent with the UL project-wide *Key Principles* and to parallel the *ELA Guidelines,* the *Mathematics Guidelines* are distinct in that they specifically address the Common Core State Standards for Mathematics and are intended to directly inform the selection, adaptation, or use of mathematics instructional materials to address the needs of ELLs.[2]

[2] Neither these *Guidelines* nor the UL *Principles* should be confused with the *Publisher's Criteria for the Common Core State Standards in Mathematics*, a much more extensive document intended for commercial textbook companies and curriculum developers that was prepared by the CCSSO and others independent from the work of Understanding Language and which does not focus explicitly on ELLs.

Guidelines for Mathematics Instructional Materials Development

1. **Focus on the Standards for Mathematical Practice.** Consider how the Standards for Mathematical Practice (SMP) are addressed across the various modes of communication (reading, writing, listening, speaking) that will be used during instruction.
    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.

    When considering SMP 6 (Attend to precision) during instruction for ELLs it is important to remember that emerging language may sometimes be imperfect. It is also crucial to recognize that mathematical precision does not lie in using one precise individual word, but in making precise mathematical claims. Lastly, mathematically precise statements need not be expressed in full sentences.
2. **Keep tasks focused on high cognitive demand, conceptual understanding, and correspondences among representations.** Mathematics instruction for ELLs should follow the general recommendations for high-quality mathematics instruction: a) Focus on mathematical concepts and the connections among those concepts; and b) Use and maintain high-cognitive-demand mathematical tasks, for example, by encouraging students to explain their problem solving and reasoning (AERA, 2006; Stein, Grover, & Henningsen, 1996). Explanations and justifications need not always include words. Instruction should support students in learning to develop oral and written explanations, but students can also show conceptual understanding by using diagrams and other representations. For example, students might use an area model to *show* that two fractions are equivalent or how multiplication by a positive fraction smaller than one makes the result smaller.
3. **Create multiple instructional pathways that provide students with different academic and linguistic backgrounds access to, engagement with, and achievement of the standards.** The goal is to create structures that allow students to participate in

classroom communities that serve as "apprenticeship" opportunities that lead, over time, to students' acquisition of the expertise described in the Standards for Mathematical Practice.

4. **Facilitate students' production of different kinds of reasoning (algebraic, geometric, statistical, etc.) and comparisons of reasoning.** Include different language functions such as describing, comparing, and arguing. Although sentence frames can be useful scaffolds, these should be used flexibly and fluidly, more as *sentence starters* than rigid formulas for producing perfect sentences.
5. **Facilitate students' participation in different kinds of participant structures—from informal, collaborative group interactions to formal presentations—in ways that allow them to use their own existing linguistic resources and collaborate with others to articulate ideas, interpret information, and present and defend claims.** Support student participation in classroom mathematical discussions in multiple settings—pairs, small groups, and whole-class discussions. Consider the spectrum of ELLs both in terms of English proficiencies, mathematical proficiencies, and literacy in their first language. For examples of different types of support for ELLs at different language proficiency levels, see *Multiple Pathways for ELLs at Different Levels* (Appendix C, adapted from the ELA unit by Walqui, Koelsch, & Schmida, 2012).
6. **Focus on language as a resource for reasoning, sense making, and communicating with different audiences for different purposes.** Activities calling students' attention to features of language (e.g., grammatical structures, vocabulary, and conventions of written and oral language) should only occur in conjunction with, and in the service of, engagement with the text and representations of a mathematical task, and ideas and practices relevant to its solution. There are many ways to address vocabulary that include introducing, using, and reviewing. Vocabulary need not be pre-taught or introduced in isolation but instead should be included in activities that involve high cognitive demand mathematical work: reasoning, sense making, explaining, comparing solutions, etc. To introduce new vocabulary, it is useful for students to first have a successful and engaging experience discussing their mathematical reasoning and developing their conceptual understanding, then label, discuss, and review the vocabulary, grounding meanings in the students' mathematical work.
7. **Prepare students to deal with typical texts in mathematics, both in word problems and mathematics textbooks.** Typical texts in mathematics include written texts such as word problems, assessment problems, textbook explanations, and scenarios for

modeling. Oral texts include explanations, descriptions of solutions, conjectures, justifications, etc. There are several reasons not to adapt the language of a task:

- Changing the language of a task can change the mathematical sense of the task.
- It is not yet clear which adaptations are best to make for which students, for which purposes, or at which times.
- Instruction should support students in understanding complex mathematical texts as they are likely to appear in curriculum and assessment materials.
- Experiences that allow ELLs to engage (with support) with authentic language used in mathematics can provide opportunities for their continued language development.

Thus, the goal of instruction should not necessarily or always be to "reduce language demands" but instead to provide support and scaffolding for ELLs to learn how to manage complex text in mathematics.

8. **Consider how extended instructional units provide students with opportunities to encounter and engage with various kinds of text complexity.** For example, consider mathematical texts with multiple levels of meanings and purposes: textbook explanations, word problems, written/oral explanations produced by the teacher and other students, etc. Texts should include the complexity that is expected to be encountered in typical mathematics tasks used in assessments. Such tasks may include language that is ambiguous for some ELLs, e.g., "table" may mean a classroom table or a mathematical table. Language may be "inconsiderate" in its various levels of semantic and syntactic complexity and requirements for background knowledge (see Tables 1-2-3 in Section B in CCSSO's *Framework for English Language Proficiency Development*). Note that not *all* texts need to represent *all* types of complexity (see the next guideline).
9. **Prioritize particular aspects of mathematical text complexity for pedagogical focus at different points during instructional units, providing necessary levels of support for students to engage with those areas of complexity.** For ELLs (and other inexperienced or struggling readers), supports for non-targeted areas of text complexity can provide opportunities for students to focus on what is being prioritized. For example, if the pedagogical focus is on the ambiguous or inconsiderate language used in mathematics word problems or textbooks, then shorter or excerpted texts might be selected, and students might be provided with short notes on the meaning of key words or phrases encountered in the text. If the focus is on another aspect

of text complexity (for example, representing a word problem as an expression or equation or producing a diagram or graph for a problem presented in text) then ambiguous or inconsiderate language might be annotated for students. Different texts might be chosen to emphasize different aspects of text complexity, or a single text might be read multiple times, with a different focus for each reading.

10. **Provide opportunities to activate and build students' background knowledge in ways that do not foreclose opportunities for them to engage with typical mathematical texts.** Leveraging students' existing background knowledge to build new knowledge can occur in a number of ways before and during a task, lesson, or unit—without preempting the text, translating its contents for students, telling students what they are going to learn in advance of reading a particular text, pre-teaching vocabulary, or "simplifying" the text itself.
11. **Recognize that all students, including ELLs, have linguistic resources that can be employed to engage with activities designed to meet the Common Core State Standards that include typical mathematical texts.** As they continue to expand their linguistic repertoires in English, students can use a wide variety of linguistic resources—including home languages, everyday language, developing proficiency in English, and nonstandard varieties of English—to engage deeply with the kinds of instruction called for in the preceding guidelines (Bunch, Kibler, & Pimentel, 2012).

References for Guidelines

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Understanding Language

Language, Literacy, and Learning in the Content Areas

Understanding Language aims to enrich academic content and language development for English Language Learners (ELLs) by making explicit the language and literacy required to meet Common Core State Standards and Next Generation Science Standards http://ell.stanford.edu.