Principles for Mathematics Instruction for ELLs

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In the era of the Common Core, the need for research-based principles for ELL instruction in mathematics cannot be overstated. The first section of this document describes principles derived from research on instruction for ELLs, from instruction in mathematics, and from characteristics of instruction aligned with the Common Core. The second section describes principles derived from research specific to language and mathematics education. Together, the four types of principles provide research-based guidance for teaching mathematics to ELLs.

1. What is effective instruction for ELLs?

Although it is difficult to make generalizations about the instructional needs of all students who are learning English, instruction should be informed by knowledge of students' experiences with instruction, language history, and educational background (Moschkovich, 2010). In addition, research suggests that high-quality instruction for ELLs that supports student achievement has two general characteristics: a view of language as a resource rather than a deficiency, and an emphasis on academic achievement, not only on learning English (Gándara & Contreras, 2009).

Overall, students who are labeled as ELLs are from non-dominant communities and they need access to curricula, teachers and instructional techniques proven to be effective in supporting the academic success of these students. The general characteristics of such environments are that curricula provide "abundant and diverse opportunities for speaking, listening, reading, and writing" and that instruction should "encourage students to take risks, construct meaning, and seek reinterpretations of knowledge within compatible social contexts" (Garcia & Gonzalez, 1995, p. 424).

2. What is effective mathematics instruction?

According to a review of the research (Hiebert & Grouws, 2007), mathematics teaching that impacts student achievement and promotes conceptual development has two central features. First, teachers and students attend explicitly to concepts. Second, teachers give students time to wrestle with important mathematics. Another research-based recommendation is to maintain tasks at high cognitive demand, for example, by encouraging students to explain their problem-solving and reasoning (AERA 2006; Stein, Grover, & Henningsen, 1996). Mathematics instruction for ELLs should follow these general recommendations for effective mathematics instruction to focus on mathematical concepts, emphasize the connections

among those concepts, use high cognitive demand mathematical tasks, and maintain high cognitive demand throughout lessons.

3. What is mathematics instruction that is aligned with the CCSS?

First and foremost, mathematics instruction that is aligned with the CCSS means *teaching mathematics for understanding*. Students should use and explain connections between representations, share and refine their reasoning, and develop meaning for symbols.

Mathematics instruction for ELLs should align with the CCSS, particularly in these four ways:

1. *Balance conceptual understanding and procedural fluency.* Instruction should balance student activities that address important conceptual and procedural knowledge and connect the two types of knowledge.
2. *Maintain high cognitive demand.* Instruction should use high cognitive demand mathematics tasks and maintain the rigor of tasks throughout lessons and units.
3. *Develop productive beliefs.* Instruction should support students in developing beliefs that mathematics is sensible, worthwhile, and doable.
4. *Engage students in mathematical practices*. Instruction should provide opportunities for students to develop the kind of expertise described in the Common Core State Standards for mathematical practice.
    - Make sense of problems and persevere in solving them.
    - Reason abstractly and quantitatively.
    - Construct viable arguments and critique the reasoning of others.
    - Model with mathematics.
    - Use appropriate tools strategically.
    - Attend to precision.
    - Look for and make use of structure.
    - Look for and express regularity in repeated reasoning.

    To help students acquire such expertise, instruction should provide opportunities for students to solve problems, model with mathematics, identify and explain connections between different representations, communicate their thinking, and construct and critique arguments.

Connecting Mathematical Content to Language

Mathematics instruction for ELLs should follow the three groups of principles described in the previous section. In addition, there are several recommendations that are specific to mathematics instruction for ELLs.

Research shows that ELLs, even as they are learning English, can participate in discussions where they grapple with important mathematical content. Instruction for this population should not emphasize low-level language skills over opportunities to actively communicate about mathematical ideas. Research on language and mathematics education provides three general guidelines for instructional practices for teaching ELLs mathematics (Moschkovich, 2010). Mathematics instruction for ELLs should address much more than vocabulary and support ELLs' participation in mathematical discussions as they learn English. Instruction should also draw on multiple resources available in classrooms (objects, drawings, graphs, and gestures) as well as home languages and experiences outside of school. These general guidelines are expanded as the following instructional principles. (For more detailed versions of these principles see Moschkovich, 2012.)

Principle 1. *Focus on students' mathematical reasoning, not accuracy in using language.*

- Instruction should focus on uncovering, hearing, and supporting students' mathematical reasoning, not on accuracy in using language (Moschkovich, 2010).
- Recognize students' emerging mathematical reasoning.
- Focus on the mathematical meanings learners construct, not the mistakes they make or the obstacles they face (Moschkovich, 2007b).

Principle 2. *Focus on mathematical practices, not language as single words or definitions.*

- Instruction should move away from simplified views of language and interpreting "language" as vocabulary, single words, grammar, or a list of definitions (Moschkovich, 2007a, 2010).
- An overemphasis on correct vocabulary and formal language limits the linguistic resources teachers and students can use to learn mathematics with understanding.

- Instruction should provide opportunities for students to actively use mathematical language to communicate about mathematical situations.
- Instruction should provide opportunities for students to actively engage in mathematical practices such as reasoning, constructing arguments, looking for and expressing structure and regularity, etc.

Principle 3. *Recognize the complexity of language in mathematics classrooms and support students in engaging in this complexity.*

Language in mathematics classrooms includes multiple:

- Representations (objects, pictures, words, symbols, tables, graphs).
- Modes (oral, written, receptive, expressive).
- Kinds of written texts (textbooks, word problems, student explanations, teacher explanations).
- Kinds of talk (exploratory and expository).
- Audiences (presentations to teacher, to peers, by teacher, by peers).

Principle 4. *Treat everyday and home languages as resources, not obstacles.*

- Everyday language and academic language are interdependent and related—not mutually exclusive (Moschkovich, 2010).
- Everyday language and experiences are not necessarily obstacles to developing academic ways of communicating in mathematics (Moschkovich 2007a, 2007b).
- Home languages provide resources for mathematical reasoning and communication (Moschkovich 2007b, 2007c, 2009, 2011).

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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.