Contents

Series Preface ............................................................................................................... v

1 Introduction ............................................................................................................... 1
   Anita Bright, Holly Hansen-Thomas, and Luciana C. de Oliveira

   Mary A. Avalos, Edwing Medina, and Walter G. Secada

3 Developing Academic and Social Mathematical Discourse Through Modeling and Interaction: Creating a Geometrical Town ........................................... 29
   Holly Hansen-Thomas and Johna Gordon

4 Students at the Core: Creating and Analyzing Life Scatter Plots ......................... 43
   Anita Bright

5 Building Functions From Context: A Framework for Connecting ELLs’ Understandings of Natural Language and Symbol Sense in Algebra ........................ 57
   Rachael H. Kenney and Luciana C. de Oliveira

6 Creating Waves in High School Mathematics ....................................................... 71
   Diane Kinch and Greisy Winicki-Landman
7 Maximizing Algebra Access Through Conversational Lecture and Tablet Technology
Angela Thompson and Alexander Radosavljevic

8 Using Multiple Representations of Functions in Mathematical Discussions With English Language Learners
William Zahner and Rodrigo J. Gutiérrez

9 Fostering English Language Learner Perseverance in Mathematical Problem-Solving in High School
Filiberto Barajas-López and Julia Maria Aguirre

10 Conclusion
Holly Hansen-Thomas, Anita Bright, and Luciana C. de Oliveira
The Common Core State Standards are a set of educational standards for kindergarten through 12th grade in English language arts and mathematics. These standards “are designed to ensure that students graduating from high school are prepared to enter credit bearing entry courses in two or four year college programs or enter the workforce” (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2013). They specify what students in grades K–12 should know and be able to do to graduate from high school, attend and graduate from college, and participate in the global economy. The CCSS have been adopted by 45 states, the District of Columbia, four territories, and the Department of Defense Education Activity (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2012).

The K–12 student population in the United States is becoming increasingly diverse. More than 15% of the K–12 student population is comprised of English Language Learners (ELLs), which represents over 5 million students in U.S. schools (National Clearinghouse on English Language Acquisition, 2012). Yet this student population is consistently ignored when content standards are conceptualized and often treated like an afterthought. This was the case with the CCSS, which were designed for a general student population and provide little guidance for teachers who have ELLs in their classrooms. The only direction given is a two-page document entitled “Application of Common Core State Standards for English Language Learners” (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) that provides very general information about ELLs and their needs. This document does not provide any guidance for teachers in how to adapt and use the CCSS with ELLs, and nothing about how to address the demands and expectations of the standards with this student population.
Given CCSS adoption in so many parts of the country and the demographic shifts in the number of ELLs, it is imperative that teachers be prepared to address and adapt the CCSS to the language and content needs of ELLs. This book series focuses on this urgent need to provide guidance for teachers who will be implementing the CCSS in classrooms with ELLs. When I started to conceptualize this series, I immediately thought that teachers of ELLs would need to know more about some pedagogical practices that will help them focus on the CCSS with ELLs, modifying what they already do with their students without simplifying instruction. The main goals of the series are to examine the potential content and linguistic challenges of the CCSS for ELLs and describe practices, strategies, and key ideas related to supporting ELLs across the grade levels in the content areas covered by the CCSS.

The audience for the book is practicing teachers, pre-service teachers, graduate students, academics, researchers, and professional development providers. These books can be used in a variety of courses, including methods, literacy, and mathematics courses in elementary and secondary teacher education programs. The books will also be a resource for practicing teachers implementing the CCSS with ELLs and professional development providers who work with practicing teachers. The Common Core State Standards for English Language Learners series aims to

1. examine the potential content and linguistic challenges of the CCSS for ELLs in English language arts, mathematics, and literacy in science, history/social studies, and technical subjects at the specific grade level span;
2. focus on edited volumes from leading researchers and practitioners working on the CCSS and with experience in the content areas and grade levels covered by each book;
3. incorporate both applied and practitioner perspectives grounded in theoretical perspectives on the CCSS and ELLs; and
4. provide accessible practices for pre-service and practicing teachers that could be used in a variety of different teacher education programs and professional development sessions.

The CCSS for ELLs book series includes the following edited books:

- The Common Core State Standards in English Language Arts for English Language Learners: Grades K–5
- The Common Core State Standards in English Language Arts for English Language Learners: Grades 6–12
- The Common Core State Standards in Mathematics for English Language Learners: Grades K–8
- The Common Core State Standards in Mathematics for English Language Learners: High School
- The Common Core State Standards in Literacy in History/Social Studies, Science and Technical Subjects for English Language Learners: Grades 6–12
The editors of these volumes worked hard to put together informative and practical books with chapters that can be adapted to different English language proficiency levels of ELLs across grades. As series editor, I planned for every book to provide helpful insights for teachers into their current practices in ways that will help them consider the needs of ELLs in every aspect of classroom instruction as they use the CCSS.

Luciana C. de Oliveira, Ph.D.
Series Editor

The Common Core State Standards for English Language Learners
As mathematics educators increasingly focus on the Common Core State Standards for Mathematics (CCSSM; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), new questions begin to emerge around how best to ensure that both the content and language of mathematics are accessible to all students, including English language learners (ELLs). Helping students actually access the mathematics content is of urgent importance, and providing a range of ways to ensure that students can “get at” the content and language is key.

However, simply accessing the mathematical ideas and concepts is not the sum of the work of mathematics educators of ELLs. Our students also need supportive opportunities to express their mathematical thinking, including their insights, conjectures, comparisons, and questions. Mathematics is not simply receptive; it’s productive, as well, and students need ways to share their understandings and ideas with others.

As each student arrives in school with a series of family-provided and perhaps also previous-schooling-provided memories and experiences to draw from, it’s important for teachers to probe, learn about, and build upon these opportunities. When planning the ways to best tailor instructional experiences for high school ELLs, there are many factors educators must consider. These range from building upon the real-life experiences of each student (Ladson-Billings, 1995) to factoring in the kinds of formal and informal schooling each student has experienced (Abedi, Lord, & Holstetter, 1998); from family experiences with and attitudes toward mathematics education (Tate, 1995) to the kinds of algorithms the student may have already learned (Phillipp, 1996). And, of course, the role of language in mathematics is a factor not to be forgotten. In short, what may
The Common Core State Standards in Mathematics for English Language Learners, High School

have at first seemed like the most basic and accessible of topics may in fact be laden with multiple and complex ideas to keep in mind.

In many ways, mathematics has the potential to be one of the most inviting and gentle academic content areas a high schooler who is learning English may initially encounter in school. Because so much of mathematics content can be made visible and concrete, mathematics experiences in school have the potential to serve as a kind of “on-ramp” for engagement with the school experience, providing a ready sense of success. For high school students also learning English, success and deepening understandings of mathematical concepts can provide a rich and solid foundation upon which new learning in other content areas may be built (Moschkovich, 2007). Mathematics is a ready and capable mode through which English itself may be taught and learned, and this text will highlight ways educators may capitalize on this.

As such, with a focus on ways to best tailor instruction to capitalize upon the strengths each student brings to the classroom, this text will explore some of the ways high school mathematics content may be made readily accessible to ELLs by building from their strengths and scaffolding their opportunities to learn more, invoking what Gutiérrez (2009) would refer to as “playing the game” of learning mathematics while also “changing the game” by “rewriting the narrative about who contributes to mathematics and who does well in it” (p. 11). The chapters included in this work will outline some of the big ideas in this realm of mathematics education for high school ELLs and will describe specific lessons and instructional moves teachers may make that will support their students in learning both the mathematical content and also the associated English structures that accompany the content. Each chapter will provide a different window into shaping instruction to build on the strengths of students while also scaffolding their learning.

In Chapter 2, titled “Planning for Instruction: Increasing Multilingual Learners’ Access to Algebraic Word Problems and Visual Graphics,” Avalos, Medina, and Secada provide suggestions on how teachers can shift instructional practices so that ELLs have access to the mathematics content and are better equipped to meet the CCSSM Mathematical Practices (MP) with a specific focus on MP #1: Make sense of problems and persevere in solving them, and MP #3: Construct viable arguments and critique the reasoning of others.

In Chapter 3, titled “Developing Academic and Social Mathematical Discourse Through Modeling and Interaction: Creating a Geometrical Town,” Hansen-Thomas and Gordon describe a layered lesson focused on geometry content. Built around student-created “geometrical towns,” this chapter provides a description of how two different MPs—modeling with mathematics (MP #4), and constructing viable arguments and critiquing the reasoning of others (MP #3)—can be seamlessly threaded into this content-rich lesson. With a tight focus on cooperative learning and the urgency of needing students to participate in academic discourse, Hansen-Thomas and Gordon describe a lesson that includes multiple geometry concepts, making it applicable at various points within an academic year. Dense with supportive opportunities for students to practice communicating their mathematical thinking, the real-life, highly motivating lesson described in this chapter is flexible and has multiple points of entry for students at varying levels.

Building upon and drawing from the lived experiences of students, Bright, in Chapter 4, titled “Students at the Core: Creating and Analyzing Life Scatter Plots,” describes a lesson that speaks to
two MPs—reason abstractly and quantitatively (MP #2), and attend to precision (MP #6)—while exploring the content related to representing data on two quantitative variables on a scatter plot, and describing how the variables are related. Using ELL-friendly scaffolds such as explicit cueing and sentence frames, this lesson provides the opportunity for students to share part of their own lives and to learn about the histories of their classmates and perhaps their teacher, as well. The opportunities to build a rich classroom community while simultaneously focusing on rigorous mathematics are abundant in this lesson.

In Chapter 5, titled “Building Functions From Context: A Framework for Connecting ELLs’ Understandings of Natural Language and Symbol Sense in Algebra,” Kenney and de Oliveira dig deeply into functions, and use this content as a vehicle with which to explore multiple ways to support the English language learning of students. Building on examples from Partnership for Assessment of Readiness for College and Careers (PARCC), Kenney and de Oliveira provide a clear and detailed roadmap for ways educators may help guide students through complex high-stakes assessment items.

Multiple MPs are addressed in Chapter 6, “Creating Waves in High School Mathematics,” by Kinch and Winicki-Landman. This chapter describes a lesson wherein students are asked to participate in and contribute to an “idea wave” that incorporates four different MPs: making sense of problems and persevering in solving them (MP #1), constructing viable arguments and critiquing the reasoning of others (MP #3), attending to precision (MP #6), and looking for and making use of structure (MP #7). Using examples from geometric transformations and incorporating sentence starters and collaborative strategies, this chapter highlights multiple ways students may be invited, encouraged, and supported in sharing their mathematical thinking and commenting on the thinking of others.

In keeping with this idea of creating supportive lessons that draw from and build upon the wisdom of students, Thompson and Radosavljevic, in Chapter 7, titled “Maximizing Algebra Access Through Conversational Lecture and Tablet Technology,” focus on a purposeful weaving together of tablet PC technology and a conversational lecture approach. Drawing from mathematics examples that center on functions, Thompson and Radosavljevic describe ways to not only move students through understandings of the mathematics, but also make explicit connections to the CCSS English Language Arts Standards, highlighting natural points of intersection between teaching the English language and mathematics. Thompson and Radosavljevic create a compelling case for the use of a tablet PC in instruction, and provide rich examples of ways the conversational lecture may be beneficial in engaging students in several of the MPs, including making sense of problems and persevering in solving them (MP #1), using appropriate tools strategically (MP #5), and attending to precision (MP #6).

In chapter 8, “Using Multiple Representations of Functions in Mathematical Discussions With English Language Learners,” Zahner and Gutiérrez call attention to the issue of balancing mathematical rigor with linguistic accessibility. Building on the ideas of creating multiple points of entry through questioning, making connections within and across representations, and allowing students to use multiple modes of communication, they describe how an algebra teacher and a precalculus teacher engage their students in demanding but well-supported mathematics. Continuously circling
back to the idea of multiple representations, Zahner and Gutiérrez help readers conceptualize several different ways to make this approach meaningful for ELLs.

With a keen focus on fostering perseverance and mathematical discourse, Barajas-López and Aguirre, in Chapter 9, titled, “Fostering English Language Learner Perseverance in Mathematical Problem-Solving in High School,” highlight some of the ways in which educators may foster greater engagement and participation from their students by intentionally inviting them to make connections to their own lived experiences. With a cautionary tale about how well-intentioned connections to real-life contexts may, at times, seem disconnected from the mathematics content, Barajas-López and Aguirre speak to key components of deeply transformative and meaningful instruction, focusing on cognitive demand, language demands, context, and identity.

In chapter 10, the conclusion of the book, Hansen-Thomas, Bright, and de Oliveira bring the key themes of the book together. Taken as a whole, these chapters keep students at the center of this work and seek to engage, motivate, and empower the learners in multiple ways. The chapters encompass a range of high school mathematics content and speak to a variety of ways in which educators may support ELLs in both receptive and productive skills. Touching upon different MPs, these chapters can provide the reader with a flexible set of ideas to draw from in crafting lessons and instructional experiences for their students, with a focus on simultaneously enriching their mathematics content understandings and their academic English language proficiency while also celebrating the life experiences adolescents may bring to the mathematics classroom. In short, these chapters may provide the reader with student-centered, mathematically rigorous ideas for their professional practice as educators of ELLs.

References
This chapter connects to:

- Mathematical Practice #1 (MP #1): Make sense of problems and persevere in solving them.
- Mathematical Practice #3 (MP #3): Construct viable arguments and critique the reasoning of others.

The Common Core State Standards and Specific Demands for ELLs

The Common Core State Standards for Mathematics (CCSSM, National Governors Association Center for Best Practices [NGA] & Council of Chief State School Officers [CCSSO], 2010) emphasize problem solving, reasoning, and communication; however, little guidance is available to teachers regarding how to integrate these mathematical practices in general, and to support ELLs in particular. While ELLs are categorized in various ways and English proficiency is defined differently across states (Cook, Boals, & Lundberg, 2011), previous research shows ELLs typically need 4 to 7 years to become proficient in English for academic purposes (Hakuta, Butler, & Witt, 2000). Is it possible for ELLs who make up a growing 4.4 million students (9%) in U.S. schools (U.S. Department of Education, 2014), to meaningfully participate in a community of practice for developing “mathematical power” when they are acquiring English? How can teachers shift instructional practices so that ELLs are able to meet the CCSSM mathematical practices (MPs)? This chapter provides suggestions on how teachers can shift instructional practices so that ELLs have access and are better equipped to meet the CCSSM MPs, specifically MP #1 (Make sense of problems and persevere in solving them) and MP #3 (Construct viable arguments and critique the reasoning of...