

Introduction

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Deepening Students' Mathematical Understanding with Children's Literature focuses on using high-quality books to create engaging and meaningful tasks that deepen pre-kindergarten and elementary school students' mathematical learning. Such instruction is consistent with both the *Common Core State Standards for Mathematics* (CCSSM) Standards for Mathematical Content (Content Standards) and Standards for Mathematical Practice (SMPs; National Governors Association Center for Best Practices and Council of Chief State School Officers [NGA Center and CCSSO] 2010). With the perspective of theory evolving into practice, our goal is to provide resources that support educators in developing the background knowledge required to decide why, when, and how to incorporate children's literature most effectively. Throughout the book, relevant exemplars illustrate principles and guidelines for selecting and using quality children's literature to provide access to meaningful mathematics for all students.

Since the 1980s, reform efforts in mathematics education have emphasized the need for all students to have equitable access to mathematical opportunities. We recognize that the magnitude of inequities in mathematics education often seems beyond us to remedy, especially when considered on a large scale (e.g., nationally or internationally). We also can feel unprepared for the challenge of supporting all learners mathematically, even in a context in which we typically feel some power and confidence (e.g., the learning of an individual child or group of children in a single lesson on a given day in our classroom). How, we may ask, can we reach all students all the time, giving them all the opportunities they need? Research and wisdom of practice have, of course, revealed no foolproof guidelines for doing so—yet there are broader principles and standards, developed and refined during recent decades (e.g., National Council of Teachers of Mathematics [NCTM] 1989, 1991, 1995, 2000, 2014; National Research Council 2001), that can provide some guidance.

We believe that the United States has taken a strong step toward helping all students achieve mathematically, as individual states have adopted the CCSSM content and practice standards (NGA Center and CCSSO 2010) or have tailored standards to meet their own needs. The remarkable level of alignment of the CCSSM and related state standards offers promise for equitable content and practices. Especially promising are the practice standards, or SMPs, which have the power to affect the *how* of teaching and learning, for we know that how students learn a concept deeply impacts their understanding and facility with its use (e.g., NCTM 1991, 2014). We label the relevant CCSSM Content Standards and SMPs for each task we present throughout this book for grades K–6. (The Common Core does not address teaching and learning prior to kindergarten.)

Considerations When Teaching Mathematics with Children's Literature

While there is much for teachers to consider when teaching mathematics with children's books, in this Introduction we focus on three key considerations:

- Use of trade books versus textbooks and reference books
- Reading level
- Explicit, implicit, and invisible mathematical content

Other considerations are addressed in individual chapters (see Overview of the Book, below).

Trade Books Versus Textbooks and Reference Books

Three types of books are typically found in classrooms—textbooks, reference books, and trade books (Tunnell et al. 2016)—and there is a place and a need for all three. Indeed, trade books do not supplant textbooks, manipulatives, discourse, and other tools for the teaching and learning of mathematics. Children's reference books—such as mathematics dictionaries, atlases, fact books, and handbooks—can also be delightful tools for teaching mathematics. Nonetheless, this book focuses on using trade books (those books found in bookstores and libraries) in mathematics instruction, as they have been found to have distinctive roles in developing students' mathematical learning. (Both the body of research and wisdom of practice related to this topic are discussed in chapter 1.)

Several features of trade books make them more appealing than textbooks and reference books to young people (Tunnell et al. 2016), including a conversational writing style, inviting illustrations, interesting and engaging language, depth of content, a strong authorial voice, and the potential for being current. Of course, not all trade books—even those with explicit mathematics content—are appropriate for mathematics instruction. When trade books are too much like textbooks, we recommend that they not be used, as we discuss in more detail in chapter 2.

Does Reading Level Matter?

When selecting a trade book for a mathematical purpose, the readability of the text is seldom a primary concern; regardless of the students' grade level or the range of reading levels represented in the classroom, the teacher typically introduces the book selected for mathematics instruction through a shared reading experience. Of more concern are the accuracy of the mathematics, the developmental appropriateness of the content, and the extent to which mathematical ideas are presented in an engaging and comprehensible manner.

For the mathematical tasks included in this book, the grade levels of the identified CCSSM may not directly align with the readability and interest grade levels the publishers have assigned to a specific children's literature title. Many children's literature

selections are rich in mathematics concepts appropriate for the curriculum at several grade levels, thus allowing broad latitude in curricular timing. Teachers also find that students at more advanced grade levels can learn from—and enjoy—picture books ostensibly written for younger audiences (e.g., *What’s Your Angle, Pythagoras?* [Ellis 2004]). Conversely, books that present more advanced mathematical ideas (e.g., *Infinity and Me* [Hosford 2012]) can still interest younger children and may be used earlier than indicated by the CCSSM, in this case foreshadowing ideas the students will encounter much later in the mathematics curriculum.

Explicit, Implicit, and Invisible Mathematical Content

Columba, Kim, and Moe (2009) describe three ways that content may be presented and visible in trade books: content-explicit, content-implicit, and content-invisible. For example:

Content-explicit “books convey the content of mathematics . . . explicitly. In many cases, these books were written to inform and to teach the concepts presented in the book” (Columba, Kim, and Moe 2009, p. 36). David Adler’s *Circles* (2016) is an example of a content-explicit book that defines this shape, its names, and its parts and explains how to find the area of a circle.

Content-implicit means that the mathematical ideas “included in the book are not central to the story. Rather, the concepts are implicit in the story, subtly and cleverly presenting opportunities for the reader to make the connection to the concepts” (Columba, Kim, and Moe 2009, p. 37). Demi’s *One Grain of Rice* (1997) is an example of a content-implicit book. First and foremost, it is a folktale that shares cultural values. The doubling pattern presented throughout the story provides a growing pattern to be analyzed, which leads to other explorations of patterns.

A content-invisible book “may not have any visible or apparent connection to [mathematics]. However, in the hands of a creative teacher with the vision to integrate literature into teaching content area subjects, these books possess marvelous potential as a tool to teach these concepts” (Columba, Kim, and Moe 2009, p. 37). Eve Bunting’s *Yard Sale* (2015) is an example of a content-invisible book. Chapter 5 illustrates how this book can be used to build on students’ funds of knowledge in culturally relevant mathematics instruction.

Readers will find examples of content-explicit, content-implicit, and content-invisible books woven throughout the eight chapters of this book.

Overview of the Book

Deepening Students’ Mathematical Understanding with Children’s Literature provides a rationale for incorporating trade books into mathematics instruction, guidelines for selecting books, and guidance on developing meaningful mathematical tasks in the context of both the CCSSM Content Standards and the SMPs.

Chapter 1: Why Use Children's Literature in Mathematics? addresses the value of integrating children's literature into mathematics instruction. Eula Ewing Monroe and Olivia Haworth Dial, with Stevie Carr and Bree De La Mare, present the literature base on this topic, focusing first on the handful of controlled research experiments that are available. They then share the wisdom of practice reaped from accounts of teachers who have found purpose in and experienced the joy of using children's books in mathematics instruction with their students.

In *Chapter 2: Selecting a Good Book for Mathematics Instruction*, Terrell Young, Amy Roth McDuffie, and Barbara Ward suggest four key roles of literature in mathematical learning:

- Providing a context for problem solving
- Exploring problem-solving and reasoning processes
- Providing sources for mathematical investigations
- Providing opportunities to practice procedural skills and to see a variety of contexts and ways that these skills can be applied

To assist teachers in book selection, the authors present a scale for evaluating the potential of a book for use in a dialogic learning environment (i.e., an environment in which students learn through questioning, explaining, and discussing ideas), thus focusing on students' making sense of mathematics.

In *Chapter 3: Children's Literature and the Standards for Mathematical Practice*, Eula Ewing Monroe, Stevie Carr, and Bree De La Mare describe the SMPs, which specify student practices for learning and doing mathematics that contribute to the development of their mathematical expertise. Although not yet tested by research, wisdom of practice indicates that children's literature offers unique and meaningful opportunities for children to engage in the SMPs. Using carefully selected children's books, the authors offer selected tasks to address specific SMPs.

In *Chapter 4: Using Children's Literature in Posing Worthwhile Mathematical Tasks*, Debra Fuentes, Stephanie Smith, and Marvin Smith define worthwhile mathematical tasks, present criteria and frameworks for considering the characteristics of cognitively demanding mathematical tasks, and discuss the four-phase research-based process of implementing such tasks with children's literature. The four phases of this process are: identifying clear learning goals, creating or selecting tasks that match those goals, incorporating children's literature as meaningful contexts for mathematical tasks, and attending to successful implementation that maintains cognitive demand.

In *Chapter 5: Using Children's Literature to Connect Mathematics Learning to Children's Funds of Knowledge*, Amy Roth McDuffie, Barbara Ward, and Terrell Young provide background on how accessing community and cultural funds of knowledge can support students' learning. The authors contend that children's literature can be an important resource in connecting to students' diverse cultural, linguistic, and

community-based knowledge and experiences in ways that support their mathematics learning and enact equitable pedagogies. The authors use three recently published books to present examples of math lessons that span instruction across the elementary school grades, supporting mathematics learning while at the same time valuing and drawing on students' diverse experiences, interests, and knowledge.

In *Chapter 6: The Power of Context: Promoting Equity and Access in Mathematics Learning Using Children's Literature*, Stefanie Livers and Karen Karp highlight the richness that children's literature brings to mathematics instruction, allowing a diverse student body both to access mathematics and to learn about equity. The authors identify the necessity for equity and access in mathematics, connect literature to selected CCSSM standards, and provide sample lesson ideas for meaningful mathematics for all students. The literature highlighted includes multicultural main characters, female protagonists, and characters with exceptionalities, thus opening opportunities for more students to connect with both the context and the mathematics.

In *Chapter 7: Get the Picture: Connecting Young Children to Mathematics through Books*, Carrie Cutler explains how picture books provide meaningful connections between preschool children's lives and powerful mathematics learning. Cutler discusses the use of books to help young children develop conceptual understanding within five foundations for mathematics learning: number and counting, geometry and spatial sense, measurement, patterns and classifying, and the mathematical processes of problem solving and reasoning. For each mathematical foundation, the author lists specific titles and offers brief teaching suggestions.

In *Chapter 8: Reviews of a Decade of Trade Books with Mathematics Content*, Patricia Austin examines trade books published between 2008 and 2015, annotating the content and offering evaluative comments. The selection of books draws from library databases and award lists and includes both individual and series titles. The reviews are organized by genre and within each category by grade range.



More4U offers a treasure trove of ideas for teaching mathematics and addressing the CCSSM Content Standards and SMPs with children's literature. The More4U materials that accompany *Deepening Students' Mathematical Understanding with Children's Literature* comprise two major components: a Children's Literature Annotated Bibliography and a Children's Book List. Each resource can be found on the NCTM website (www.nctm.org/more4u) and is described in more detail below.

Children’s Literature Annotated Bibliography

The searchable Children’s Literature Annotated Bibliography includes 422 sources—64 books or book chapters and 358 journal articles—of national or international circulation that describe various aspects of using children’s literature in mathematics. The majority of the articles are within the K–6 range; a few are available at other grade ranges.

The Children’s Literature Annotated Bibliography is grouped into two parts: *Teaching Ideas* and *Research*.

Teaching Ideas entries typically describe or give suggestions for tasks and identify children’s books to be used for specific mathematics content. They constitute the preponderance of the entries in the bibliography.

Teaching Ideas entries can be readily accessed according to the following organization:

- by grade level ranges—primary, intermediate, middle school, or secondary, and
- within those ranges, according to type of sources—books/book chapters and articles.

The Research section comprises 26 sources. They are grouped according to source: articles; projects, theses, and dissertations; and other.

These sources represent three research domains: qualitative, quantitative, and mixed methods. Together, these sources yielded the research findings reported in *Chapter 1: Why Use Children’s Literature in Mathematics?*

This organization and the SEARCH function on your computer will help you narrow your search for instructional ideas, tasks, and research to the grade(s) and content of interest. (See the introduction to More4U for instructions.)

You may need to ask your librarian for ways you can access these resources.

Children’s Book List

Each of the approximately 1,600 children’s literature titles in this list has been analyzed and connected to the relevant Common Core domain(s). The selection of domains was a qualitative decision, using information from the teaching resources featured in the Children’s Literature Annotated Bibliography and our own professional judgment.

Books in the Children’s Book List are also featured in the Annotated Bibliography, and they represent multiple subgenres of fiction and nonfiction.

Conclusion

We have designed this book and the accompanying More4U materials for preservice and inservice teachers, librarians, teacher educators, professional development specialists,

and others who influence the use as well as the availability of trade books for mathematics instruction. Our goal is that these resources, developed from a theory-in-to-practice perspective, will be useful tools for enhancing the professional knowledge and practice of mathematics instruction that incorporates children's literature, thus deepening students' understanding of mathematics in rich and powerful ways.

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