

**Research-Based Curriculum**

**Mathematics**  
**Readers**  
**2nd Edition**

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# Fostering Content-Area Literacy

## Reading Across the Content Areas

It is usually regarded as the task of the English or language arts teacher to guide students through the effective use of reading comprehension strategies. However, comprehension strategies best serve students when they are employed across the curricula and in the context of their actual learning. It is only then that students can independently use the reading strategies successfully. Dr. Patricia S. Moyer (2000) summarizes the importance of integrating reading across the content areas:

*When language skills are embedded in meaningful contexts, they are easier and more enjoyable for children to learn. In the same way, numbers and their operations, when embedded in meaningful real-world contexts, give children the opportunity to make sense of mathematics and to gain mathematical power (pp. 248–249).*

## Mathematics and Literacy

Mathematics and literacy are naturally linked, especially in the area of problem solving. This is because mathematics mastery requires a certain level of language and reading comprehension skills. Students need to be able to determine key details and main ideas, interpret words and phrases, and evaluate content in a variety of formats. These skills must be explicitly taught for students to be successful in mathematics.

## 21st-Century Literacy Demands

The literacy demands of the twenty-first century are tremendous. Literacy was defined a century ago by one's ability to write his or her own name. In the 1940s, one needed to be able to read at the 8th-grade level to function adequately in the factory setting. To be considered literate today, one needs to be able to read at the 11th- or 12th-grade level as a part of workplace duties, leisure activities, and civic duties.

We have entered a new era in education—one that is deeply tied to the technological advances that permeate our modern lives. Today, some children can use a cell phone to take a picture before they even learn to speak. Students use the Internet and online libraries to access information from remote locations. Now, more than ever, it is the content-area teacher's responsibility to prepare students for the reading demands of our technological age. To become effective and efficient readers, students must utilize comprehension strategies

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automatically and independently. Students need to be able to read, write, and communicate collaboratively in a cross-cultural world (ILA 2016). To do so, students need teacher guidance to help them become independent readers and learners. Students must not only understand what they read but also question it and explore beyond it.

## The Reading Process

Teachers can optimize the effectiveness of reading materials with students by utilizing the three-part framework of the reading process to facilitate mathematics learning. What teachers do during each stage of the reading process is crucial to students' comprehension.

### Before Reading

Prior to beginning a reading activity, teachers can set the stage for learning by generating interest in the topic, activating and building prior knowledge, and setting the purpose for reading. Teachers should also take time to introduce key concepts and vocabulary, thereby providing a critical foundation for conceptual understanding. Before reading, students may do the following:

- scan visual aids
- preview the text
- skim the text
- brainstorm related ideas
- make predictions about the text
- generate questions about the text

### During Reading

During reading, students actively read text in a variety of settings. In this stage of the reading process, students are engaged in answering questions (either self-generated or teacher-generated), monitoring their comprehension of the text, clarifying the purpose for reading, visualizing the information, and making connections. While reading, students may do the following:

- reread for clarity
- seek answers to questions about the text
- observe and discuss text structure
- make connections between ideas
- visualize content
- generalize about specific content

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## After Reading

Students expand their understanding of the material after reading the text. During the final stage of the reading process, students build connections among the bits of information they have read, enabling themselves to deepen their understanding and reflect on what they have learned. After reading, students may do the following:

- reread to review and locate specific information
- confirm predictions
- clarify meaning
- relate the reading to the reader
- synthesize new information
- summarize what was read
- generate new questions

### Reading Activities

Reading activities in *Mathematics Readers* are organized using this three-part framework:

- Before Reading
- During Reading
- After Reading

These sections include multiple opportunities to foster curiosity and reflect on new learning.

## Writing Across the Curriculum

Teachers may wonder where writing fits within the mathematics curriculum. What do run-on sentences have to do with fractions and geometry? Writing is the process through which students are able to articulate their thinking. Whether students are learning to write or writing to learn, writing allows them to translate complex ideas into words and language that they understand.

### Writing to Learn

If a student is an exemplary writer in one discipline, it does not mean that he or she will have the same success writing in another (Gentry, McNeel, and Wallace-Nesler 2014). The writing required in mathematics often has a different voice and requires a different skill set from the writing required in science, social studies, or language arts. A wide variety of writing assignments and activities can help students become actively engaged in mathematics. All of these writing formats encourage students to think about mathematics and connect prior knowledge or experiences with new learning:

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- mathematics journals
  - mathematical models
  - vocabulary journals
  - observations
  - explanations about reasoning
  - error analysis
  - data analysis

## Writing to Apply

When students use their new knowledge in mathematics to write in a more formal manner, they are writing to apply. In these activities, students are asked to analyze and synthesize information and then communicate their thoughts in a coherent, organized manner. This type of writing can be more challenging for students because they need to not only understand the content and be able to process it at a higher level but also communicate it using the strategies of the writing process, the features of the chosen genre, and the conventions of the grade level. Opportunities for students to write as a means to communicate understanding may include the following:

- predictions, observations, and conclusions
- explanations of procedures and strategies
- arguments and justifications
- reflections and summaries

### Writing Across the Curriculum

Recognizing the importance of writing as part of mathematical discourse (NCTM 2000), each lesson in *Mathematics Readers* features activities that encourage students to communicate their mathematical understanding through writing. Writing is woven throughout the week of instruction and includes activities that expect students to engage in mathematical processes such as the following:

- arguments
- justifications
- narratives
- observations
- analyses

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## The Reading/Writing Connection

Reading and writing are interactive processes that use similar strategies. When taught together, they reinforce each set of skills and improve achievement. Together, reading and writing create an atmosphere of communication in which critical thinking is an integral part of the process. Teachers who promote higher-order thinking skills with both reading and writing processes will help develop critical thinking among their students.

Readers and writers engage in similar processes. “Composition and comprehension both involve planning, composing, and revising” (Roe and Smith 2009, 255). Students can be explicitly shown how the two processes are connected.

Readers	Writers
<ul style="list-style-type: none"><li>• have purpose for reading (before, during, and after reading)</li></ul>	<ul style="list-style-type: none"><li>• have purpose for writing (prewriting, revising, and editing)</li></ul>
<ul style="list-style-type: none"><li>• use prior knowledge to make connections to a particular topic</li></ul>	<ul style="list-style-type: none"><li>• use prior knowledge when writing about a topic</li></ul>
<ul style="list-style-type: none"><li>• make predictions</li></ul>	<ul style="list-style-type: none"><li>• provide foreshadowing</li></ul>
<ul style="list-style-type: none"><li>• interpret the writer’s meaning</li></ul>	<ul style="list-style-type: none"><li>• construct meaning</li></ul>
<ul style="list-style-type: none"><li>• change comprehension strategies while reading</li></ul>	<ul style="list-style-type: none"><li>• change and develop meaning while writing</li></ul>
<ul style="list-style-type: none"><li>• reread to clarify meaning</li></ul>	<ul style="list-style-type: none"><li>• rewrite to clarify meaning</li></ul>

Writing is often the expression of ideas and thoughts gathered while reading. Mathematics texts are often heavily loaded with difficult vocabulary words and complex concepts that are challenging for students to understand. Encouraging students to both read and write helps them process the information presented. When students read content without writing about it, they miss a crucial step in the process of comprehending the information. Too often in mathematics, students read and write with little attention to rereading information or a problem. Also, we give students one chance to write about their thinking without taking advantage of revising and editing their work from a mathematics perspective.

Writing helps create the bridge between content knowledge and understanding. A wide variety of writing assignments and activities can help students become actively engaged in mathematics. Additionally, writing activities promote active learning, encourage discussion, engage all students, and develop critical thinking.

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## The Reading and Writing Connections

Reading and writing activities in *Mathematics Readers* are woven throughout the lessons to make the content more meaningful.

## Developing Academic Vocabulary

Research conducted over past decades has consistently found a deep connection between vocabulary knowledge, reading comprehension, and academic success (Baumann, Kame'emui, and Ash 2003). Kamil and Hiebert describe vocabulary as “a bridge between the word-level processes of phonics and the cognitive processes of comprehension” (2005, 4). This is a useful way to visualize the importance of vocabulary for young or struggling readers. But meaning does not automatically follow successful decoding. If a word is not in a student’s oral vocabulary, the student cannot apply word-recognition strategies effectively, and reading comprehension is hindered (National Reading Panel 2000).

Vocabulary instruction is at the very core of learning because students cannot learn from words that they do not understand. All students need explicit vocabulary instruction before reading a text to better understand the content. Knowing and using mathematics terms are essential to learning mathematics. Students must know and be able to use appropriate mathematics vocabulary to explain their thinking both in written and oral forms. Often these terms are more complex (e.g., obtuse angle) or are used in a different way from the more common definition of a term (e.g., area).

The task is even more complicated for English language learners and struggling readers. “Developing readers cannot be expected to simply ‘pick up’ substantial vocabulary knowledge exclusively through reading exposure without guidance. Specifically, teachers must design tasks that will increase the effectiveness of vocabulary learning through reading practice” (Feldman and Kinsella 2005, 3). It is not enough to give students a list of words and have them look up the definitions in dictionaries or glossaries.

Students who are struggling with learning a language are not going to find the process easier by simply being given more words to sort through (Echevarria, Vogt, and Short 2004). Struggling readers and English language learners need context-embedded activities that acquaint them with the necessary and most central words for comprehension of the content. Explicit instruction and repeated use within context combine for strong vocabulary development resulting in high rates of retention. “The teacher’s role then is to help students connect the formal mathematical vocabulary term with their current understanding of the idea or concept” (Dunston and Tyminski 2013, 40).

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### **Developing Academic Vocabulary**

- Mathematics Investigation: Students are introduced the key math vocabulary and use words and phrases within context.
- Problem Solving: Key mathematical words and phrases are reinforced within context.

## **The Importance of Strong Mathematical Content**

Students come to the classroom with different learning styles, different levels of mathematical proficiency, language barriers, and varying mindsets toward learning. To meet these diverse needs, teachers must understand the development of mathematics by considering the progression of concepts, strategies, and models that can become powerful forms of representation and tools to develop thinking (Fosnot 2010).

### **Instructional Shifts: Focus, Coherence, and Rigor**

In 2000, the National Council of Teachers of Mathematics (NCTM) released Principles and Standards for School Mathematics, which affirmed that mathematics is a combination of content and process (NCTM 2000). Following its release, a joint project of the National Academy of Sciences, the U.S. Department of Education, and the National Science Foundation resulted in the book *Adding It Up: Helping Children Learn Mathematics* (National Research Council 2001). This publication introduced the five strands of mathematical proficiency, which include conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition to clarify what mathematical proficiency entails. It also stated that a goal of mathematics education is for all students to become proficient in math content and processes. This laid the groundwork for the National Governors Association Center for Best Practices and the Council of Chief State School Officers to work collaboratively in developing mathematical content and practice/process standards that focus on the conceptual and procedural understandings students must have to develop mathematical proficiency (2010). Ultimately, these documents, and the college-and-career readiness standards that have evolved from them, are designed to close the education gap and provide all students equal opportunity to achieve mathematical literacy.

There has been a concerted effort to shift away from the frequently cited “mile wide, inch deep” criticism first noted by Schmidt, McKnight, and Raizen in 1997. Today’s mathematics

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curriculum focuses on helping students develop deeper understanding with fewer topics at each grade level. In fact, “less topic coverage can be associated with higher scores on those topics covered because students have more time to master the content that is taught” (Ginsburg 2005). The takeaway here is to teach less and learn more!

Another shift in today’s standards is coherence. Coherent standards explicitly connect learning within and across grades to deepen students’ understanding of mathematical ideas. Each standard is not a new event but an extension of previous learning.

The third instructional shift, rigor, does not mean “harder.” Rather, this characteristic of the standards relates to the importance of connecting application, conceptual understanding, and skills in learning mathematics (Student Achievement Partners 2013). Conceptual understanding can be thought of as the ability to explain math to someone else, represent it in different ways, apply it to solve simple and complex problems, reverse givens and unknowns, and compare and contrast it to other concepts (NCTM 2014). This is a shift away from thinking of mathematics as a group of “tricks,” but rather to think of it as deep, connected ideas with a goal of mathematical understanding rather than simply following procedures.

### **Focus Coherence, and Rigor**

*Mathematics Readers* helps teachers address the instructional shifts of focus, coherence, and rigor with lessons that:

- align to college-and-career readiness standards
- build students’ conceptual understanding as they progress across grade levels
- challenge students to use higher-order thinking skills

## **Using Real-Life Problem Solving to Teach Mathematics**

In mathematics, it is not enough just to be able to compute. Students need to be able to read about situations, make inferences about the types of solutions that might be possible to a given problem, and write about various paths to solutions. Students also need to be able to find solutions to real problems that arise in life. Simply using procedural knowledge to compute arithmetic exercises is not enough to help students reach these goals. Students need both procedural and conceptual knowledge to learn and understand mathematics (NCTM 2000).

For students to use appropriate representations of mathematical concepts that build understanding, they must be able to relate to situations or applications through which the concepts are taught. Research shows that real-life applied activities and problem-solving activities establish a contextual setting for many lessons, providing motivation and

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encouraging curiosity (Hiebert and Carpenter 1992). When students are engaged and interested in a topic, they are more likely to retain the information and apply it in the future. “Overall, the challenging and interesting tasks found in application problems help teachers engage students in learning” (Seeley 2004).

Problem solving can help students make connections between mathematics and the real world. “It is through problem solving that we can look at a situation, analyze it, and determine possible solution paths and reasonable solutions. It is problem solving that makes mathematics meaningful in our daily lives” (Gojak 2011, 24).

### **Problem Solving**

Each book in *Mathematics Readers* includes a problem solving activity that relates to the topic and mathematical concept of the book. These activities promote mathematical reasoning and reflect the multistep, higher-order questioning seen on today’s assessments.

## **Mathematical Discourse**

Long before NCTM’s communication process standard (2000), and the mathematical practices and processes described in next-generation standards, Albert Einstein remarked, “If you can’t explain it simply, you don’t understand it well enough.” Ultimately, this is the goal of mathematical discourse, the rich interaction that plays a vital role in students’ understanding. As students share and listen to others, learning takes place. The value of this interaction “cannot be overemphasized” (Van de Walle et al. 2014). To encourage and develop discourse, mathematics questions must move beyond “What’s the answer?” and teachers assessing the rightness (or wrongness!) of the response. Rather, “purposeful questions” requiring deeper thought, explanation, and justification are used to prompt meaningful discourse (NCTM 2014). As students share, reason, and reflect, they are also called upon to listen to the thoughts and approaches of others, ask questions, and try new strategies. With ongoing practice and guidance communicating math ideas verbally and in writing, students work toward the clear explanations that demonstrate understanding.

### **Math Talk**

Each book and lesson in *Mathematics Readers* includes opportunities for students to explain their strategies, justify their reasoning, and question themselves and others.

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# Differentiating for All Learners

Today's classrooms are filled with students of varying backgrounds, reading abilities, levels of English proficiency, and learning styles. A teacher's ability to differentiate instruction and respond effectively to the needs of a variety of learners is critical to the success of any program (Henry and Pianta 2011).

Differentiation encompasses what is taught, how it is taught, and the products students create to show what they have learned. These categories are often referred to as content, process, and product:

- **Differentiating by content**—varying instructional techniques and materials, such as asking leveled questions.
- **Differentiating by process**—offering varying grouping techniques or self-paced assignments.
- **Differentiating by product**—asking students to show their learning in ways that will enhance cognitive development and personal expression.

## Below-Level Learners

Without making adjustments in instruction, struggling readers quickly disengage and do not actively participate in the reading process. They need teachers who can make on-the-fly adjustments while continually analyzing student learning (Kibby and Klenk 2000). Below-level learners need concepts to be made more concrete for them. They typically need extra support with vocabulary and writing activities, including:

- concrete representations to build and demonstrate comprehension
- extra time for guided practice

## Above-Level Learners

All students need a firm foundation in the core knowledge of the curriculum. Even above-level learners may not know much of this information before a lesson begins. The difference is that these students usually learn concepts very quickly. Activities and end products can be adapted for individual students. Some examples may include:

- questions that require higher-order thinking skills
- making generalizations to extend and apply learning to more complex situations
- creating of graphic organizers

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## English Language Learners

Students who are English language learners are learning concepts and language simultaneously. They need to have context added to the language. Although they may have acquired social language skills (basic interpersonal communicative skills, or BICS), the language of school is academic in nature. One of the keys to success with English language learners is to ensure that they acquire the necessary vocabulary for greater comprehension of the content (cognitive academic language proficiency, or CALP):

- Always do vocabulary activities and allow time to apply new vocabulary.
- Introduce new vocabulary and discuss meanings in context.
- Allow extra time to process language and content.
- Use word walls with examples, visual displays, illustrations, and hands-on activities.
- Plan for paired oral rehearsal of academic language needed to respond to discussion questions.

### Differentiation Tools

This series helps teachers differentiate for all learners.

- Audio recordings of texts model fluency and support English language learners.
- Interactiv-eBooks support students through video, audio, and other digital functions.
- Graphic organizers support visual learners and language learning.
- Leveled books support above-, on-, and below-level learners.
- Differentiation strategies for above-level, below-level, and English language learners are embedded in the lessons.

## Using Technology to Improve Literacy

Within the last decade, there has been a shift in the ways students are expected to think and process information. Unlike their predecessors, students in today's classrooms have been deemed "digital natives." They were born into a digital world and have developed thinking patterns that are different from those of previous generations (Pressley 2001). This pedagogical shift has been recognized in the flux of digital technologies. According to focal points of twenty-first century learning, technology should be used widely and responsibly in the classroom—with the goal of enriching students' learning of language.

Extensive research has been conducted over the years to determine the effectiveness of technology in improving student performance. The following positive effects have been observed when technology has been used to enhance curriculum:

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- increased achievement
  - improved higher-order thinking skills and problem-solving abilities
  - enhanced motivation and engagement
  - improved abilities to work collaboratively

Educators across the content areas are challenged with preparing students for a more technologically advanced world (Harwood and Asal 2007).

## Using Technology to Improve Literacy

*Mathematics Readers* features a variety of digital resources that help teachers to weave technology into literacy instruction:

- Professional audio recordings of each book serve as a model of fluent reading and provide additional support for English language learners.
- Interactiv-eBooks engage students; extend the reading experience with digital writing, vocabulary, and comprehension activities; allow for fluency practice, and build twenty-first century skills.

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