What Your Colleagues Are Saying . . .

"This book is so incredibly practical and grounded in the hands-on implementation of the five practices! It takes the ideas of the earlier book, which focused more on the "what" of each practice, and looks closer at the when, why, and how that is so important for teachers in their planning. In each chapter, I found myself nodding in agreement as the authors described challenges in using the five practices and thoroughly enjoyed the opportunities to reflect on the practices in relation to my own planning and teaching."

Kristin Gray
Director of Elementary Curriculum and Professional Learning
Illustrative Mathematics

"This is a powerful and readable guide to shifting our elementary school mathematics instruction toward maximizing our students' learning. But it's the clarity and familiarity of the challenges we all face when trying to implement these five practices—and the practicality and detail of the guidance provided in each chapter to address these challenges—that set this book apart and make it so useful for professional growth."

Steve Leinwand
Researcher/Change Agent
American Institutes for Research
Washington, DC

"This book is packed with practical guidance, support, and actual footage of what it looks like to enact ambitious teaching through these practices. If there's a teacher or leader out there wondering how to ensure their classroom embraces ambitious teaching that is empowering and equitable, this is your guide. Read it. Practice it. Make it yours. There just isn't anything else out there pushing us to think and act as strategically in our math classrooms like this does."

Levi J. Patrick
Assistant Executive Director of Curriculum and Instruction
Oklahoma State Department of Education

"Peg Smith has done it again. Building on her previous work with Mary Kay Stein (2018), Smith and coauthors Miriam Sherin and Victoria Bill have taken the next step in supporting teachers to engage students in rich mathematics discussions. Filled with examples and insights, both in print and on video, this book allows teachers to 'see it in action,' make sense, and reflect on the challenges, and it provides support and guidance to implement the five practices in their own instruction. Perfect for teachers, teacher leaders, coaches, or others who support teachers in their instructional practices, this book literally connects theory to practice and provides honest and thoughtful reflections and guidance to work towards our ultimate goals—students' mathematics learning and agency."

Cynthia H. Callard
Professor and Executive Director
Center for Professional Development and Education Reform
Warner Graduate School of Education and Human Development
University of Rochester
Rochester, NY

"Every elementary school math teacher needs to understand the practices in this book and know how to use them effectively in the classroom. Use of these practices will empower elementary school students to understand mathematics and feel like they can do math!"

Lois A. Williams
Adjunct Professor, Mathematics Education Consultant, Author
Mary Baldwin University
Scottsville, VA

"This book is a comprehensive, ready-to-use, professional development plan inside a book's covers! Its components include student work, classroom video, features addressing challenges teachers face, as well as providing reflective opportunities to pause and consider. This amazing, must-have resource will truly engage elementary school mathematics teachers in 'doing' *The 5 Practices*."

Francis (Skip) Fennell
Professor of Education and Graduate and Professional Studies Emeritus
Project Director, Elementary Mathematics Specialists and Teacher Leaders Project
McDaniel College
Past President, Association of Mathematics Teacher Educators (AMTE)
Past President, National Council of Teachers of Mathematics (NCTM)

"This book takes *5 Practices for Orchestrating Productive Mathematics Discussions* to the next level as readers experience what these practices look like in real mathematics classrooms in Grades K–5. Readers will engage in analysis of videos and student work as they deepen their understanding of the five practices. The authors specifically address the challenges one might face in implementing the five practices in classrooms by providing recommendations and concrete examples to avoid these challenges."

Cathy Martin
Executive Director, Curriculum and Instruction
Denver Public Schools
Denver, CO

"The authors insightfully anticipate teachers' challenges and have designed a creative tool to support teacher learning. Their book is filled with highly practical reflective questions all tied to the five practices, enabling teachers to think for themselves. The result is a book that empowers elementary level teachers to determine the best ways to advance their own professional development to improve students' mathematical lives."

Ruth M. Heaton
Chief Executive Officer
Teachers Development Group
West Linn, OR

"As an elementary math teacher, nothing has helped me become more intentional and purposeful than the *5 Practices*. In a continued effort to move student thinking forward, I really appreciated how the authors walked us through specific K–5 examples because this will definitely help me improve my craft."

Graham Fletcher
Math Specialist
Atlanta, GA

"At Illustrative Mathematics we were looking for a framework that would enable us to embed in our curriculum ambitious but achievable goals for teacher practice. The five practices was the perfect fit: a memorable, learnable set of principles that could be used by novice and veteran teachers alike to get their students thinking and sharing their reasoning."

Bill McCallum
President, Illustrative Mathematics
University Distinguished Professor of Mathematics
University of Arizona

"Mathematical discourse is the heart of effective instruction, but is challenging to implement well. Finally, this book provides a step-by-step guide for bringing the five practices for orchestrating discourse—anticipating, monitoring, selecting, sequencing, and connecting—fully into classroom practice at the elementary level. Through video examples, tasks, and student work, the authors provide practical advice for engaging young students in powerful class discussions centered on their strategies and mathematical thinking. This book is an invaluable professional resource."

DeAnn Huinker
Professor, Mathematics Education
University of Wisconsin–Milwaukee
NCTM Board of Directors
Milwaukee, WI

"This book is a must for all elementary teachers who want to teach mathematics deeply and equitably, or as Smith, Bill, and Sherin write—ambitiously. From the first page, you are invited to take a deep dive into each of the *5 Practices* by unpacking the practice, considering the potential instructional challenges associated with the practice, and, through the use of videos, teacher responses, and student work, analyze the challenging and rewarding work of facilitating productive student discourse. Read this book, try what's suggested in your classroom, and watch ALL of your students truly shine as they demonstrate meaningful mathematical thinking and reasoning."

Beth Kobett
Associate Professor
Stevenson University School of Education
NCTM Board of Directors
Stevenson, MD

"*The Five Practices in Practice: Successfully Orchestrating Mathematics Discussions in Your Elementary Classroom* is THE tool for helping make ambitious elementary mathematics teaching a reality. It gives a rich, elementary lens to the original groundbreaking work through classroom examples, tasks, and accompanying videos. Simply put, it is a must-have for any mathematics teacher, coach, or administrator."

John SanGiovanni
Coordinator of Elementary Mathematics
Howard County Public School System
Howard County, MD

"I've been a fan of *5 Practices for Orchestrating Productive Mathematics Discussions* for a long time! In this practical, teacher-friendly follow-up to the popular resource, the authors provide educators with a roadmap to support facilitating productive mathematics discussions in their classrooms. In this new addition to the series, educators are treated to a comprehensive blueprint for implementing the five practices that includes scaffolds, realistic suggestions grounded by research, feedback and authentic data from practicing teachers, vignettes, grade-specific examples and opportunities to reflect on classroom practice, making this resource a valuable tool for elementary educators."

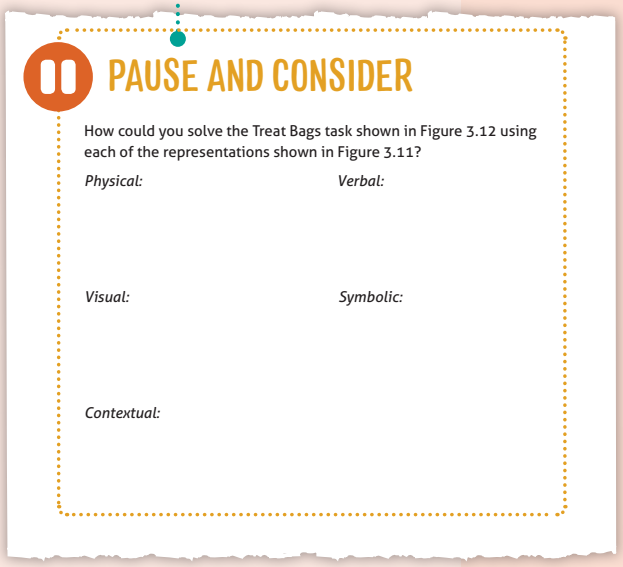
Latrenda Knighten
Elementary Mathematics Instructional Specialist
Baton Rouge, LA

The Five Practices in Practice
at a Glance

Candid quotes from been-there teachers illuminate the topic of each chapter.

> "While students are working and I'm checking in with them, I'm going to be thinking about how to sequence the math and the kids. I might have ideas, but I have to wait and see what they do. I'll be trying to see who's got something that can help us make sense of the math goals for today."
>
> —ANDREW STRONG, FIFTH-GRADE TEACHER

Pause and Consider moments invite teachers to reflect on and make connections to their own practice.



PAUSE AND CONSIDER

How could you solve the Treat Bags task shown in Figure 3.12 using each of the representations shown in Figure 3.11?

Physical:

Verbal:

Visual:

Symbolic:

Contextual:

hat they have written or drawn. Using students' own
n often be helpful. Be aware that what you anticipated
do is not always what they end up doing. Asking students
ns about their work is an important way to uncover how
g about the task and their solution. As Ms. Tyus explained,
ıtegies outlined and I have my assessing questions. But
ıappen in the task. They might do different things."
ɔed this point, saying, "You never know what you're going
ɛs" and that for him, the next step is "just to assess their
lid you do this? Explain it to me." Assessing questions are
use they can help you uncover what students are doing,
that aligns with what you anticipated.

ıg questions are most useful when they make students'
: in ways that can then help you move their thinking
the lesson goals. You want to understand not only *what*
ıt *why* they did it. Understanding the reasons behind a
gy often provides the clues you need to help the student
ɔosition or move deeper into the task.

TEACHING TAKEAWAY

Look and listen *carefully.* Modify your planned assessing questions in real time based specifically on what students are doing and saying, rather than what you thought they would do or say.

Teaching Takeaways provide on-your-feet support for teachers, so they can jump into implementing the strategies discussed.

Video showcase panels highlight the rich film footage available for each topic and include related questions for consideration.

Analyzing the Work of Teaching 2.1

Launching a Task

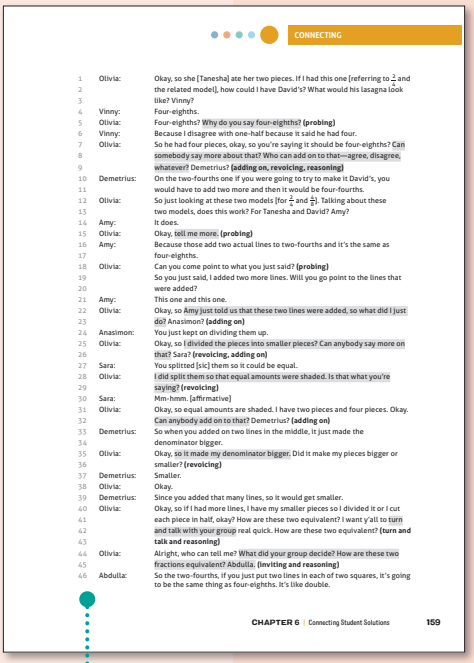
Video Clip 2.1
In this activity, you will watch Video Clip 2.1 from Tara Tyus's first-grade class.

As you watch the clip, consider the following questions:

- What did the teacher do to help her students *get ready* to work on the Ms. Tyus's Markers task?
- What did the teacher learn about her students that indicated they were ready to engage in the task?
- Do you think the time spent in launching the task was time well spent?

online resources

Videos may also be accessed at
resources.corwin.com/5practices-elementary



CONNECTING

Olivia: Okay, so she [Tanesha] ate her two pieces. If I had this one [referring to $\frac{2}{4}$ and the related model], how could I have David's? What would his lasagna look like? Vinny?

Vinny: Four-eighths.

Olivia: Four-eighths? Why do you say four-eighths? **(probing)**

Vinny: Because I disagree with one-half because it said he had four.

Olivia: So he had four pieces, okay, so you're saying it should be four-eighths? Can somebody say more about that? Who can add on to that—agree, disagree, whatever? Demetrius? **(adding on, revoicing, reasoning)**

Demetrius: On the two-fourths one if you were going to try to make it David's, you would have to add two more and then it would be four-fourths.

Olivia: So just looking at these two models [for $\frac{2}{4}$ and $\frac{4}{8}$]. Talking about these two models, does this work? For Tanesha and David? Amy?

Amy: It does.

Olivia: Okay, tell me more. **(probing)**

Amy: Because those add two actual lines to two-fourths and it's the same as four-eighths.

Olivia: Can you come point to what you just said? **(probing)**
So you just said, I added two more lines. Will you go point to the lines that were added?

Amy: This one and this one.

Olivia: Okay, so Amy just told us that these two lines were added, so what did I just do? Anasimon? **(adding on)**

Anasimon: You just kept on dividing them up.

Olivia: Okay, so I divided the pieces into smaller pieces? Can anybody say more on that? Sara? **(revoicing, adding on)**

Sara: You splitted [sic] them so it could be equal.

Olivia: I did split them so that equal amounts were shaded. Is that what you're saying? **(revoicing)**

Sara: Mm-hmm. [affirmative]

Olivia: Okay, so equal amounts are shaded. I have two pieces and four pieces. Okay. Can anybody add on to that? Demetrius? **(adding on)**

Demetrius: So when you added on two lines in the middle, it just made the denominator bigger.

Olivia: Okay, so it made my denominator bigger. Did it make my pieces bigger or smaller? **(revoicing)**

Demetrius: Smaller.

Olivia: Okay.

Demetrius: Since you added that many lines, so it would get smaller.

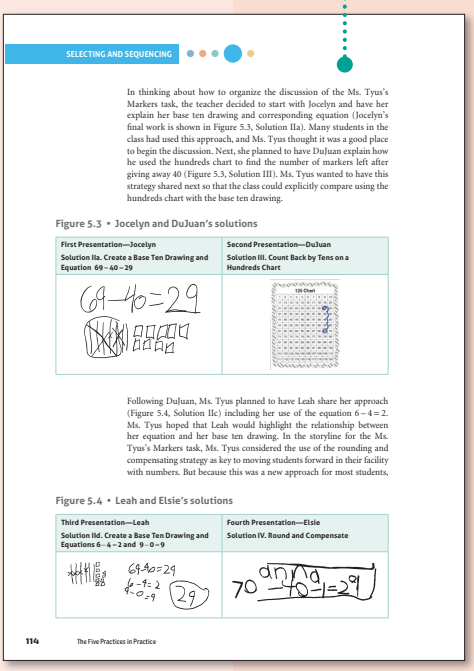
Olivia: Okay, so if I had more lines, I have my smaller pieces so I divided it or I cut each piece in half, okay? How are these two equivalent? I want y'all to turn and talk with your group real quick. How are these two equivalent? **(turn and talk and reasoning)**

Olivia: Alright, who can tell me? What did your group decide? How are these two fractions equivalent? Abdulla. **(inviting and reasoning)**

Abdulla: So the two-fourths, if you just put two lines in each of two squares, it's going to be the same thing as four-eighths. It's like double.

CHAPTER 6 | Connecting Student Solutions 159

Illustrative vignettes and examples demonstrate real-world applications of the concepts discussed in each chapter.



SELECTING AND SEQUENCING

In thinking about how to organize the discussion of the Ms. Tyus's Markers task, the teacher decided to start with Jocelyn and have her explain her base ten drawing and corresponding equation (Jocelyn's final work is shown in Figure 5.3, Solution IIa). Many students in the class had used this approach, and Ms. Tyus thought it was a good place to begin the discussion. Next, she planned to have DuJuan explain how he used the hundreds chart to find the number of markers left after giving away 40 (Figure 5.3, Solution III). Ms. Tyus wanted to have this strategy shared next so that the class could explicitly compare using the hundreds chart with the base ten drawing.

Figure 5.3 • Jocelyn and DuJuan's solutions

First Presentation—Jocelyn Solution IIa. Create a Base Ten Drawing and Equation 69 – 40 = 29	Second Presentation—DuJuan Solution III. Count Back by Tens on a Hundreds Chart
69 – 40 = 29	100 Chart

Following DuJuan, Ms. Tyus planned to have Leah share her approach (Figure 5.4, Solution IIc) including her use of the equation 6 – 4 = 2. Ms. Tyus hoped that Leah would highlight the relationship between her equation and her base ten drawing. In the storyline for the Ms. Tyus's Markers task, Ms. Tyus considered the use of the rounding and compensating strategy as key to moving students forward in their facility with numbers. But because this was a new approach for most students,

Figure 5.4 • Leah and Elsie's solutions

Third Presentation—Leah Solution IId. Create a Base Ten Drawing and Equations 6 – 4 = 2 and 9 – 0 = 9	Fourth Presentation—Elsie Solution IV. Round and Compensate
69-40=29 6-4=2 9-0=9 29	70 – 40 – 1 = 29

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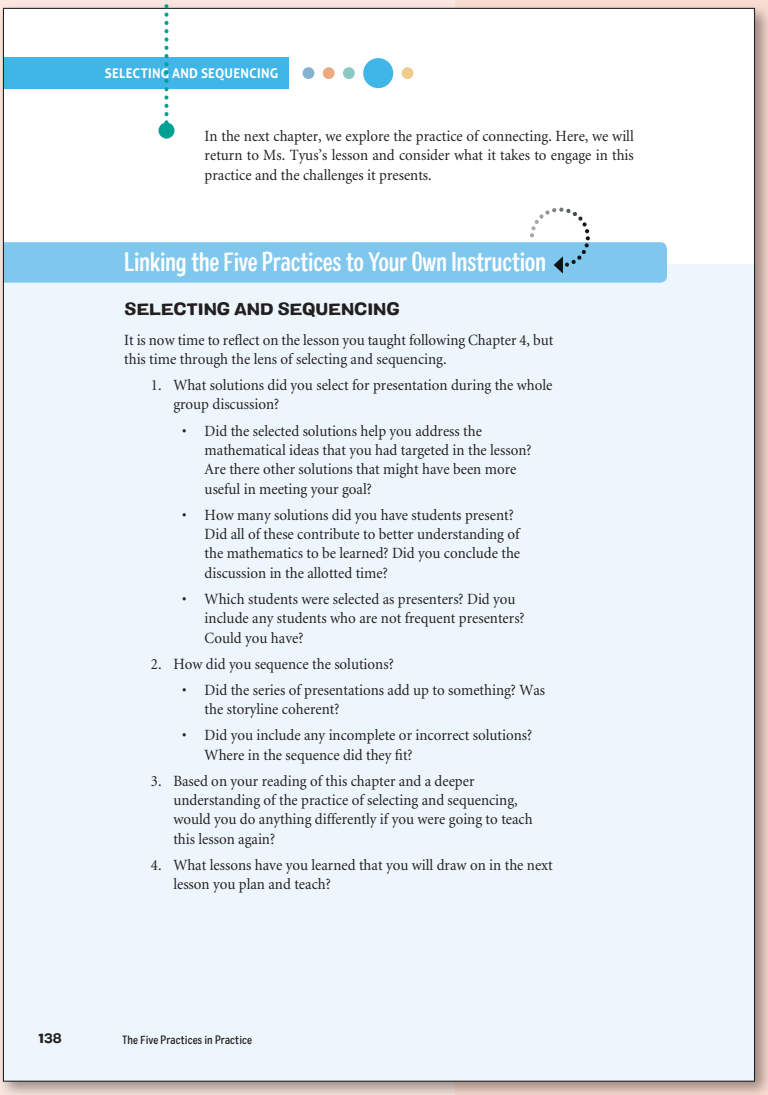
An in-depth **Linking the Five Practices to Your Own Instruction** feature helps teachers move even deeper into implementation, providing detailed support and additional reflective opportunities.



SELECTING AND SEQUENCING

In the next chapter, we explore the practice of connecting. Here, we will return to Ms. Tyus's lesson and consider what it takes to engage in this practice and the challenges it presents.

Linking the Five Practices to Your Own Instruction

SELECTING AND SEQUENCING

It is now time to reflect on the lesson you taught following Chapter 4, but this time through the lens of selecting and sequencing.

1. What solutions did you select for presentation during the whole group discussion?
   - Did the selected solutions help you address the mathematical ideas that you had targeted in the lesson? Are there other solutions that might have been more useful in meeting your goal?
   - How many solutions did you have students present? Did all of these contribute to better understanding of the mathematics to be learned? Did you conclude the discussion in the allotted time?
   - Which students were selected as presenters? Did you include any students who are not frequent presenters? Could you have?
2. How did you sequence the solutions?
   - Did the series of presentations add up to something? Was the storyline coherent?
   - Did you include any incomplete or incorrect solutions? Where in the sequence did they fit?
3. Based on your reading of this chapter and a deeper understanding of the practice of selecting and sequencing, would you do anything differently if you were going to teach this lesson again?
4. What lessons have you learned that you will draw on in the next lesson you plan and teach?

Figure 3.6 • The Lasagna task

Lasagna

There were two pans of lasagna at the school picnic. The parents cut each pan of lasagna into equal portions.

Tanesha has 2 portions from one pan, while David has 4 portions from the other pan. They both received the same amount of lasagna. How is this possible?

1. Show how the lasagna was divided into portions so Tanesha's 2 portions are equal to David's 4 portions.
2. Shade in the portion of lasagna eaten by each child.
3. Write fractions that describe each student's portion of the pan of lasagna.
4. Explain how you know that Tanesha and David each received the same amount of lasagna. Explain your thinking by referring to the pictures, symbols, and words.

Source: Adapted from Hamilton County Department of Education Grade 4 Task 11.

Clearly designed tasks promote mathematical reasoning and problem solving.

Figure 4.3 • Challenges associated with the practice of monitoring

CHALLENGE	DESCRIPTION
Trying to understand what students are thinking	Students do not always articulate their thinking clearly. It can be quite demanding for teachers, in the moment, to figure out what a student means or is trying to say. This requires teachers to listen carefully to what students are saying and to ask questions that help them better explain what they are thinking.
Keeping track of group progress—which groups you visited and what you left them to work on	As teachers are running from group to group, providing support, they need to be able to keep track of what each group is doing and what they left students to work on. Also, it is important for a teacher to return to a group in order to determine whether the advancing question given to them helped them make progress.
Involving all members of a group	All individuals in the group need to be challenged to answer assessing and advancing questions. For individuals to benefit from the thinking of their peers, they need to be held accountable for listening to and adding on, repeating and summarizing what others are saying.

Challenge and Description charts distill and demystify some of the common issues teachers encounter when teaching the concepts at hand.

What It Takes/Key Questions charts break down the critical components of the practice and explain what it takes to succeed and the questions you need to ask yourself to stay on track.

the components of this practice along with key questions to guide the process of monitoring.

Figure 4.1 • Key questions that support the practice of monitoring

WHAT IT TAKES	KEY QUESTIONS
Tracking student thinking	How will you keep track of students' responses during the lesson?
	How will you ensure that you check in with all students during the lesson?
Assessing student thinking	Are your assessing questions meeting students where they are?
	Are your assessing questions making student thinking visible?
Advancing student thinking	Are your advancing questions driven by your lesson goals?
	Are students able to pursue advancing questions on their own?
	Are your advancing questions helping students to progress?

THE 5 PRACTICES in Practice

Successfully Orchestrating Mathematics Discussions in Your Elementary Classroom

Margaret (Peg) Smith • Victoria Bill
Miriam Gamoran Sherin • Foreword by Dan Meyer

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CHAPTER 4 Monitoring Student Work

CHAPTER 5 Selecting and Sequencing Student Solutions

CHAPTER 6 Connecting Student Solutions

CHAPTER 7 Looking Back and Looking Ahead

Visit the companion website at
http://resources.corwin.com/5practices-elementary
for downloadable resources.

List of Video Clips

Note From the Publisher: The authors have provided video and web content throughout the book that is available to you through QR (quick response) codes. To read a QR code, you must have a smartphone or tablet with a camera. We recommend that you download a QR code reader app that is made specifically for your phone or tablet brand.

Videos may also be accessed at **resources.corwin.com/5practices-elementary**

Foreword

Why did you become a teacher?

Was it, as with many elementary teachers I've worked with, because you loved kids? Perhaps even at a young age you were an effective caregiver, and you knew how to care for more than just another person's tangible needs. You listened, and you made people feel *listened to*. You had an eye for a person's value and power. You understood where people were in their lives, and you understood how the right kind of question or observation could propel them to where they were going to *be*.

Spending a few decades helping people feel heard, helping them unleash and use their tremendous capacity—perhaps you thought that was a worthwhile way to spend what you thought would be the hours between 7 AM and 4 PM every day.

How do the demands of teaching mathematics affect your love for students?

Perhaps you *love* math and you're grateful for the opportunity to help students experience math as you have. Or perhaps you're fearful of math and you're able to relate to students who feel the same way. In either case, what I have learned in my work with math teachers is that it is impossible to separate your love for your students from your feelings about and knowledge of mathematics. Both sources of your energy—students and math—are vital. Neither source is renewable without the other. The teachers who struggle to love their students as people will struggle to help them learn mathematics. The teachers who struggle to love mathematics miss out on opportunities to express their love for their students as people.

If teachers draw their energy only from mathematics, for example, their students can become abstractions and interchangeable. They can convince themselves it's possible to influence *what students know* without care for *who they are*, that it's possible to treat their *knowledge* as deficient and in need of fixing without risking negative consequences for their *identity*. But students know better. Most of them know what it feels like when the adults in the room position themselves as all-knowing and the students in the room as all-unknowing. Your love for and understanding of mathematics are no help at all when students have decided you care less about them than about numbers and operations.

On the other hand, if teachers draw their energy only from students, then the day's mathematics can become interchangeable with any other day's. Some days, it may feel like an act of care to skip students past mathematics they find frustrating or to skip mathematics altogether. But the math that teachers skip one day is foundational for the math another day or another year. Students will have to pay down their frustration later, only then with compound interest. Your love and care for students cannot protect them from the frustration that is often fundamental to learning.

What is needed, of course, is love for students *and* mathematics. I could share with you any number of maxims and slogans that testify to that truth. I could perhaps convince some of you to believe me. But still that would not answer the key question: How?

My answer: anticipate, monitor, select, sequence, and connect.

Those actions, initially proposed by Smith and Stein in 2011, and ably illustrated in this book with classroom videos, teacher testimony, and student work samples, support a teacher's love for students and a teacher's love for math in ways that make both math and students matter.

For teachers who are motivated by a love of students, those five practices invite the teacher to learn more mathematics. The more math teachers know, the easier it is for them to find value in the ways their students think. Their mathematical knowledge enables them to monitor that thinking less for *correctness* and more for *interest*. Would presenting this student's thinking provoke an *interesting* conversation with the class, whether the circled answer is correct or not? A teacher's mathematical knowledge enables her to connect one student's interesting idea to another's. Her math knowledge helps her connect student thinking together and illustrate for the students the enormous value in their ideas.

And if you are also motivated by a love of mathematics, and want students to love mathematics as well, those five practices offer a way to connect your students as people to the math they produce. Students are not a blank screen onto which teachers can project and trace out their own knowledge. Meaning is *made* by the student. It isn't *transferred* by the teacher. The more teachers love and want to protect interesting mathematical ideas, the more they should want to know the meaning students are making of those ideas. Those five practices have helped me connect student ideas to canonical mathematical ideas, helping students see the value of both.

Neither a love of students nor a love of mathematics can sustain the work of math education on its own. We work with *math students*, a composite of their mathematical ideas and their identities as people. The five practices for orchestrating productive mathematical discussions, and these ideas for putting those practices into practice,

offer the actions that can develop and sustain the belief that both math and students matter.

You might think your path into teaching emanated from a love of mathematics or from a love of students. But it's the same path. It's a wider path than you might have thought, one that offers passage to more people and more ideas than you originally thought possible. This book will help you and your students learn to walk it.

—Dan Meyer
Chief Academic Officer, Desmos

Preface

In 2001, a group of researchers at the University of Pittsburgh launched the ASTEROID (A Study of Teacher Education: Research on Instructional Design) project funded by the National Science Foundation. The project investigated what mathematics teachers learned from participation in practice-based teacher education courses—courses that used cognitively demanding mathematical tasks, narrative cases, and student work as a focus of critique, inquiry, and investigation (Smith, 2001). Mary Kay Stein and I (Peg) were co-principal investigators on the project and I was the course instructor.

The first course, taught in the summer of 2002, focused on proportional reasoning. The goals of the course were both to enhance teachers' own ability to reason proportionally and to enhance their capacity to teach proportional reasoning. The students in the course were 14 elementary and three secondary teachers, some of whom had just completed their Master of Arts in Teaching degree and others who were working on Master's of Education degrees. In order to investigate what teachers learned and how our instruction supported or inhibited learning, we videotaped each class session. We also gave teachers pre-/post-tests, interviewed them, and kept notebooks of all work produced in the course.

As the research team watched videos of teacher-students solving cognitively challenging (aka high-level) tasks, they noticed a certain pattern in the way I, as the instructor, facilitated work around and discussions of the tasks. I had solved the problems in multiple ways prior to the class, often seeking input from graduate students on alternative approaches. The researchers saw how I interacted with students as they worked and how I made notes of what specific students were doing. They saw how I identified students to present their solutions, how I ordered the solutions in particular ways, and how I helped my students make connections between different strategies, ensuring the mathematical ideas were central. While I was aware of what I was doing, I did not give much thought to why I was doing it, and I did not codify my actions.

The research team noticed the regularity of my teaching pattern and the impact it appeared to have on the quality of the discussions around high-level tasks. They recognized the parallel between a teacher educator teaching teachers and K–12 teachers teaching children. They were excited by the potential this model had to support the work of K–12 classroom teachers. We all knew we were on to something powerful. We gave labels to each of the identified actions so that others could

learn them and voila!—the five practices—anticipating, monitoring, selecting, sequencing, and connecting—were born!

From that moment forward—in collaboration with others—I have written about the five practices in journal articles, and my co-author Mary Kay Stein and I published the book that anchors this new series, which you may know as *5 Practices for Orchestrating Productive Mathematics Discussions* (2011). The book sold more than 100,000 copies before we published the second edition in 2018.

What accounts for the surprising success of the five practices? Over the last three decades, there has been a growing consensus that traditional forms of mathematics teaching were not sufficiently preparing students for success in school and beyond. The release of the *Common Core State Standards* (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) brought new demands for more ambitious teaching and an increased focus on the importance of engaging students in mathematical discussion. Such discussion gives students the opportunity to share ideas and clarify understandings, develop convincing arguments regarding why and how things work, develop a language for expressing mathematical ideas, and learn to see things from other people's perspectives.

So one answer to the question is that the five practices provides a five-step model of what teachers can do before and during instruction that gives them some control in facilitating discussions—an aspect of instruction that has proven to be especially challenging. The five practices are *doable* and something teachers could continue to get better at doing over time.

Despite the uptake of the five practices by teachers and teacher educators, teachers continue to find aspects of the practices challenging. Questions such as "Where do I find good tasks?," "How do I find time to adequately plan?," "What do I do if students all think about a problem the same way?," and "How do I wrap up the conversation at the end of a lesson without taking over?" abound.

In addition, teachers and teacher educators repeatedly ask me, "Do you have any video of teachers doing the five practices?" The need for authentic examples of what these practices look like in real classrooms was clear.

The Five Practices in Practice: Successfully Orchestrating Mathematics Discussions in Your Elementary Classroom (Smith, Bill, & Sherin, 2019) is the second book in a series that addresses many of the questions that teachers have raised with me over the years, and it provides what teachers and teacher educators have been clamoring for—classroom video of teachers engaged in orchestrating productive discussions. (The middle school book was published in Spring 2019 and the high school book will follow in 2020.)

This book goes beyond the first and second editions of the original *5 Practices* by providing a detailed unpacking of the practices and by identifying specific challenges teachers face related to each practice. The book includes numerous examples drawn from elementary school classrooms to illustrate aspects of the five practices and the associated challenges. A central component of these examples is video excerpts from elementary school classrooms that provide vivid images of real teachers using the five practices in their efforts to orchestrate productive discussions.

We hope this book will be a valuable resource for teachers!

—Peg Smith

Acknowledgments

Since the publication of *5 Practices for Orchestrating Productive Mathematics Discussions* (Smith & Stein, 2011), we have worked with and heard from hundreds of teachers who have reported on their successes and struggles in implementing the five practices in their classrooms. We have taken their feedback to heart. This book is our attempt to provide additional guidance on enacting the five practices in elementary school classrooms.

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Victoria Bill is a former elementary and middle school mathematics teacher. She is currently a fellow and mathematics team lead with the Institute for Learning at the University of Pittsburgh Learning Research and Development Center. She has been designing and facilitating professional development with administrators, coaches, and teachers in urban districts for more than 20 years. She also develops curriculum, intervention materials, and performance-based assessments. Bill was the co-principal investigator on a collaborative research project between researchers from the Learning Research and Development Center, the Institute for Learning, and the Tennessee Department of Education, in which an instructional mathematics coaching model was developed. Bill regularly speaks at the NCTM, the National Council of Supervisors of Mathematics, and NCTM Research Conferences. She is co-author of the NCTM best seller *Taking Action: Implementing Effective Mathematics Teaching Practices, Grades K–5*.

Miriam Gamoran Sherin is Associate Provost for Undergraduate Education and the Alice Gabrielle Twight Professor of Learning Sciences at Northwestern University. Her research interests include mathematics teaching and learning, teacher cognition, and the role of video in supporting teacher learning. Sherin investigates the nature and dynamics of teacher noticing, and in particular, the ways in which teachers identify and interpret student thinking during instruction. *Mathematics Teacher Noticing: Seeing Through Teachers' Eyes*, edited by Sherin, V. Jacobs, and R. Philipp, received the American Educational Research Association Division K 2013 Excellence in Research in Teaching and Teacher Education award. In 2016, Sherin and her colleagues were awarded the NCTM Linking Research and Practice Outstanding Publication Award.

“Our district was introduced to the five practices about three years ago and they were so powerful we decided to infuse them into our professional learning for teachers. We were already working with NCTM’s *Principles to Actions* and the idea of facilitating mathematical discourse, and we felt like the five practices really extended that—providing great supports for teachers when they were trying to plan, and determining how they could support students through productive struggle as they were engaging in high-level tasks.”

—JESSICA SLAYTON, DIRECTOR OF MATHEMATICS, METRO NASHVILLE PUBLIC SCHOOLS

CHAPTER 1

Introduction

At the heart of efforts to help students in Grades K–5 learn mathematics is the idea of *ambitious teaching*. It's referred to as *ambitious* because of the substantial student learning goals that it encompasses—that all students have opportunities "to understand and use knowledge . . . [to] solve authentic problems" (Lampert & Graziani, 2009, p. 492). The Common Core State Standards for Mathematics (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) provide a powerful vision of these goals through their description of grade-level, domain-specific content standards and the cross-cutting Standards for Mathematical Practice.

We believe that the phrase *ambitious teaching* is also appropriate because teaching in ways that align with these goals is a formidable task! To help you and other teachers understand what this looks like, *Principles to Actions: Ensuring Mathematical Success for All* (National Council of Teachers of Mathematics, 2014) describes a set of eight teaching practices that serve as a foundation for ambitious teaching (Figure 1.1 on the next page). These practices are based on what we know from research about how to effectively support students' learning of mathematics.

Figure 1.1 • Eight effective mathematics teaching practices

Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.
Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.
Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.
Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.
Pose purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense-making about important mathematical ideas and relationships.
Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.
Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.
Elicit and use evidence of student thinking. Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

Ambitious teaching also requires attention to equity. Mathematics has long been considered a gatekeeper, limiting opportunities for some students while promoting opportunities for others (Martin, Gholson, & Leonard, 2010). These differences are apparent as early as kindergarten, with African American and Latinx students more likely to be in classrooms that focus on procedural aspects of mathematics and/or that underestimate these students' capacities to engage in high-level problem solving (Aguirre et al., 2017; Turner & Celedón-Pattichis, 2011). Ambitious teaching requires you to challenge these long-standing practices and provide access and opportunity for every student so that they can develop strong positive identities as learners of mathematics (Aguirre, Mayfield-Ingram, & Martin, 2013).

At the center of ambitious teaching is a focus on classroom discourse. As you facilitate meaningful discussions with students, you will typically engage in several of the effective mathematics teaching practices, including asking purposeful questions, eliciting and using evidence of student thinking, connecting to various mathematical representations, and supporting productive struggle among students as they learn

mathematics (Figure 1.1). In addition, allowing students to share their thinking with the class can help to position all students as valuable resources for learning and promote an equitable learning environment. In these ways, organizing discussions around students' ideas becomes critical for successfully enacting ambitious instruction.

What does it take, then, to organize and implement effective discussions? In this book, we present guidelines for using the five practices described by Smith and Stein (2018) in their book *5 Practices for Orchestrating Productive Mathematics Discussions*.

The Five Practices in Practice: An Overview

The five practices are a set of related instructional routines that can help you design and implement lessons that address important mathematical content in ways that build on students' thinking (Figure 1.2). Warning: There is actually a Practice 0, which serves as a foundation for the remaining practices—yup, this means there are six practices in total, but for historical reasons, we will still call the set "the five practices." (In case you are wondering how this could have happened, here is the scoop: After some early articles about the five practices were published, a mathematics coach with whom Peg was working suggested to her that a practice was missing—that before teachers could engage with the five practices, they

Figure 1.2 • The five practices in practice

<table>
<tr><td colspan="2" rowspan="2">Practices that take place while planning for instruction</td><td>Practice 0: Setting goals and selecting tasks (Chapter 2) Specifying learning goals and choosing a high-level task that aligns with those goals</td></tr>
<tr><td>Practice 1: Anticipating student responses (Chapter 3) Exploring how you expect students to solve the task and preparing questions to ask them about their thinking</td></tr>
<tr><td rowspan="4">Practices that take place during instruction but are considered while planning</td><td>Students work individually or in small groups</td><td>Practice 2: Monitoring student work (Chapter 4) Looking closely as students work on the task and asking questions to assess their understanding and move their thinking forward</td></tr>
<tr><td rowspan="2">As you move from small group work to whole class discussion</td><td>Practice 3: Selecting student solutions (Chapter 5) Choosing solutions for students to share that highlight key mathematical ideas that will help you achieve lesson goals</td></tr>
<tr><td>Practice 4: Sequencing student solutions (Chapter 5) Determining the order in which to share solutions to create a coherent storyline for the lesson</td></tr>
<tr><td>Whole class discussion</td><td>Practice 5: Connecting student solutions (Chapter 6) Identifying connections among student solutions and to the goals of the lesson that you want to bring out during discussion</td></tr>
</table>

needed to set goals and select a task. Though this idea was already implied in the five practices, the coach persuaded Peg to make it explicit, and hence Practice 0 was born!)

Teachers often think that ambitious teaching requires you to make all your instructional decisions during instruction based on what students say and do in class. The five practices, however, help you think through all aspects of the lesson *in advance* of teaching, thus limiting the number of in-the-moment decisions you have to make during a lesson. Careful planning prior to a lesson reduces what you need to think about during instruction, allowing you time to listen more actively, question more thoughtfully, and respond more acutely.

Practice zero, *setting goals and selecting tasks*, lays the groundwork for the remaining five practices. It is essential to be clear on what you want students to learn and to choose a cognitively demanding task that aligns with those goals. Once you have the task in mind, you can move to *anticipating student responses*. Here, the purpose is to think about how students might solve the problem, what challenges they might face, and how you will respond to their thinking. One benefit to doing so is that you can develop—before class—targeted questions you might want to ask students about these different approaches.

Although the next four practices take place during instruction, you will also want to think them through carefully during planning. *Monitoring student work* involves giving students time—usually in groups—to work on the task, while you circulate among them. As you look closely at how students are progressing, you can use the questions you developed earlier to assess what students understand and to try to move their thinking forward. As you prepare to transition students into a whole class discussion, you will engage in s*electing student solutions*—deciding which solutions you want to have shared in the discussion and who should present those solutions—as well as *sequencing student solutions*—deciding how you want to order the presentation of the solutions. Selecting and sequencing require close attention to the mathematical ideas that are highlighted in different solutions and to helping all students have access to the ideas shared in the discussion. As you plan the lesson you will consider what you want to be on the lookout for as you monitor students' work, what solutions will help you surface the mathematical ideas you are targeting, and what order of solutions will provide access to all students.

The final practice, *connecting student solutions*, takes place as the discussion unfolds in your classroom. The purpose is to make explicit the connections between students' solutions and the mathematical goals of the lesson. Drawing out these connections for students is essential to ensure that students take away from the discussion what you intended. This too is something you can consider as you plan the lesson!

Together, the five practices can help you prepare for and carry out meaningful discussions with your students, discussions that revolve around the thinking of your students. And that is the essence of ambitious instruction!

Purpose and Content

The purpose of this book is to deepen your understanding of the five practices as described by Smith and Stein (2018). Toward that end, Chapters 2 to 6 comprise two parts: unpacking the practice (Part One) and challenges teachers face in enacting the practice (Part Two). In Part One, we describe in some detail what is involved in engaging in the practice, provide questions that you should ask yourself as you undertake the practice, and use an example from an elementary classroom to illustrate the components of the practice. In Part Two, we highlight aspects of the practice that have proven to be challenging for teachers, suggest ways you can address the challenge, and provide examples of how teachers are overcoming the challenge.

Throughout these chapters, we encourage you to actively engage with the content. Toward this end, we have created three types of opportunities for engagement: *Pause and Consider* questions (reflection), *Analyzing the Work of Teaching* activities (analysis), and *Linking the Five Practices to Your Own Instruction* assignments (implementation). The Pause and Consider questions give you the opportunity to think about an issue, in some cases drawing on your own classroom experience, prior to reading more about it. The Analyzing the Work of Teaching activities engage you in analyzing aspects of teachers' planning for and enacting of grade-level lessons. The Linking the Five Practices to Your Own Instruction assignments provide you with the opportunity to put the ideas discussed in the chapter to work in your own classroom.

Throughout the book we have included a range of different types of examples drawn from elementary classrooms to illustrate aspects of the five practices and the associated challenges. The video excerpts and related classroom artifacts—featuring the three teachers who are introduced later in the chapter—provide vivid images of real teachers using the five practices in their efforts to orchestrate productive discussions. The narrative examples that appear in the book are based on our experiences working with elementary school teachers through professional development initiatives and teacher education courses. These examples are intended to provide insights into specific challenges teachers face when engaging in the five practices and are not exact representations of a specific teacher's practice. Each of these teachers has been given a pseudonym (e.g., Jada Turner, Carmen Ortiz, Michael McCarthy, and Jesse Samson featured in Chapter 2). The video and narrative examples are not intended as exemplars to be copied but rather as opportunities for analysis, discussion, and new learning.

If you are coming to the five practices for the first time, you might find it helpful to start with *5 Practices for Orchestrating Productive Mathematics Discussions* by Peg Smith and Mary Kay Stein (2018). Smith and Stein's book offers a wonderful, easy-to-read introduction to and overview of the five practices. The book you are reading now takes a much deeper dive into the five practices, asking you to stop and think, watch videos of the practices in action, and consider what is challenging about each practice. While you can certainly start here, the overview of the five practices provided by Smith and Stein (2018) may help you get the big picture before taking a deeper dive!

This book will be a valuable resource for looking closely at what it takes to be successful with the five practices. For each practice, we offer key questions, which identify the essential components of the practice. We suspect these questions will enhance your understanding of the practices and perhaps provide new information about the goals and expectations for each practice. This book also describes challenges associated with each practice that teachers we have worked with have encountered, as well as specific suggestions for successfully addressing these challenges. If you have already been using the five practices, we suspect that some of these challenges may be familiar to you and that these discussions will be particularly useful.

Classroom Video Context

In identifying teachers to feature on video, we felt that it was important to select a school district that would feel authentic to readers—one that faced challenges of diversity, poverty, and student performance but was working hard to improve mathematics teaching and learning. We selected Metro Nashville Public Schools (MNPS) for several reasons—the district met our authenticity criteria. Victoria Bill, the second author, had been working in the district for several years, and the district was willing to be featured in this book.

MNPS is an urban district located in Nashville, Tennessee. MNPS has a diverse student population K–12 (as shown in Figure 1.3) with 50.6 percent of students qualifying for free or reduced lunch and 15.68 percent of students classified as English Language Learners. The nearly 85,000 students attend 76 elementary schools, 31 middle and K–8 schools, and 17 high schools. In addition, there are also 31 charter schools and 17 nontraditional and Special Education schools.

Figure 1.3 • Race/ethnicity of Metro Nashville Public Schools students

American Indian/Alaska Native	0.4%
Black	43%
Hispanic	23%
Asian/Pacific Islander	4%
White	29%

Source: Tennessee Department of Education, 2018.

As stated on its website (https://www.mnps.org/about-mnps/), MNPS is committed to becoming "the fastest-improving urban school system in America, ensuring that every student becomes a life-long learner prepared for success in college, career and life." The mathematical mission for the district is for students to have the opportunity to reason mathematically, communicate their ideas with others, and learn to value mathematics through rigorous instruction on a daily basis.

Jessica Slayton, director of mathematics for MNPS, explains what it will take to make this vision a reality in classrooms:

> *Students need opportunities to communicate their ideas and this means teachers have to be able to facilitate classroom discourse. So we're providing structures and supports for our teachers so that they can effectively facilitate these conversations in their classrooms. The five practices are so essential because discourse is at the heart of our mission.*

A District Engages in the Five Practices

Video Clip 1.1
In Video Clip 1.1, Jessica Slayton, director of mathematics, explains the district's efforts to support teachers in facilitating classroom discourse through their use of the five practices.

To read a QR code, you must have a smartphone or tablet with a camera. We recommend that you download a QR code reader app that is made specifically for your phone or tablet brand.

online resources

Videos may also be accessed at
resources.corwin.com/5practices-elementary

As a result of the professional development in which teachers have engaged, Mrs. Slayton has seen many changes in teachers' practice. She explains:

> *The first thing that comes to mind is their belief in the students. We had a lot of timid teachers at first, and they didn't know if the students were actually capable of the mathematics for their grade levels. We said, "Give this a try. Try the five practices, see if you can anticipate, and determine how to support the students." Now that they've done that, they see it: "Oh yes, my students are capable." It doesn't matter if it's a student with limited English; we know how to support them because we've anticipated what some of the struggles might be.*
>
> *Another change that we've seen is really the self-awareness in planning. If I want to get this out of my students, if this is my mathematical goal, I need to be able to press students towards that goal, which means I need to plan how to do that. It's not going to happen by accident. Planning on your own is challenging. One person might not be able to anticipate five different solution strategies, but working with peers in a grade-level team there are different perspectives and they're able to collaborate, and they can build lessons together that are more meaningful for their students.*

Meet the Teachers

The video recordings and related classroom artifacts featured in this book are drawn from the work of three Grade K–5 teachers in MNPS—Olivia Stastny, Andrew Strong, and Tara Tyus. The lesson taught by Tara Tyus will be used in Part One of Chapters 2 to 6 to unpack the focal practice. By focusing on the same teacher across chapters, you will have a coherent picture of instruction in her classroom and a better understanding of how the practices provide synergy. The lessons taught by Olivia Stastny and Andrew Strong will be used in Part Two of Chapters 2 to 6 to provide illustrations of how specific challenges can be addressed.

Olivia Stastny has been teaching at Una Elementary School since she began her career four years ago. She has a bachelor's degree in elementary education and a master's of education in curriculum and instruction. She wanted to become a teacher so she could help all students grow to their fullest potential—academically, socially, and emotionally.

Olivia believes that her third grade students should have daily real-life, rigorous opportunities in the mathematics classroom, allowing them to achieve their greatest abilities. Toward this end, she feels it is important to pick a task for which there is a low floor so that students can enter the task and a high ceiling so that there's the potential to really accomplish something that is mathematically important. Embedded in this is the

notion that students could solve the task in multiple ways, because students come to class with different knowledge and experiences, while making it possible for them to also advance their learning.

Olivia sees the five practices as playing a vital role in preparing for instruction. She explains:

> *I can choose the best task for my students and plan, plan, plan, which is one of the biggest parts of doing the five practices. Planning is everything! The teacher needs to know the goals of the lesson, anticipate the solutions, think about possible sequencing, and how it is all going to connect, all before the lesson even starts.*

Andrew Strong has been working in Metro Nashville since he started teaching 16 years ago. He has a bachelor's degree in film production and a master's degree in elementary education. He is currently teaching fifth grade mathematics at West End Middle School (Grades 5–9), where he has been for the past two years. He became a teacher because he believes there is nothing more important to which one can dedicate their life, and he "enjoys the heck out of it."

Andrew feels it is his mission to love his students, instill in them a confidence and joy for the learning process, and provide them with tools they will need to find success wherever they seek it. He wants his students to learn to think and to take responsibility for their own learning so that they will become responsible adults who can think for themselves. This, he feels, is desperately needed in the world, and it gives him a deep sense of purpose.

Andrew sees the five practices as a guideline for organizing his thinking about a lesson. He explains: "This is a solid way to get kids to grapple with their thoughts and then to actually come away with the understanding that they need."

Tara Tyus teaches at Una Elementary School, a position she has held since she started teaching six years ago. She has an undergraduate degree in early childhood education and a master's degree in curriculum and instruction, with a focus on elementary education. Tara believes her mission is to help students become their best selves by engaging them in lessons that make them think.

Tara wants her first-grade students to develop an understanding of the concepts underlying the procedures they are learning so that they are not mindlessly following a series of steps. She explains: "It is necessary to use mathematical tasks so students can learn how to think critically when problem solving. In doing so, they learn multiple solution paths and are able to determine efficient strategies to help them solve problems successfully later. Thus, knowledge learned is retained and not simply regurgitated."

The five practices help Tara plan and facilitate discussions around high-level mathematical tasks. She explains:

> *Students love high-level tasks—to explore and have fun with mathematics. As a teacher, the five practices are so important because they help me get prepared for instruction and make sure I accomplish what I set out to do. Without the five practices, lessons could get very chaotic.*

These three teachers are making their teaching practice public so that others can learn from their efforts. Hiebert, Gallimore, and Stigler (2003) argue that we must respect teachers for being "brave enough to open their classroom doors" (p. 56). To honor their courage, as you read about and view excerpts from their classrooms, we encourage you to avoid critiquing what you see or discussing what the teacher "should have done." Instead, our goal is to use the access we have been given as an opportunity for learning—for serious reflection and analysis—in an effort to improve our own teaching in ways that open up new opportunities for our students to learn.

Using This Book

You will likely get the most out of this book if you are committed to ambitious teaching that provides students with increased opportunities to engage in productive discussions in mathematics classrooms. Through engaging with the ideas in the book, you will learn much about how to increase students' engagement in and learning from classroom discussions.

This book can be used in several different ways. You might read through the book on your own, stopping to engage with the questions, activities, and assignments as suggested. Alternatively, and perhaps more powerfully, you can work through the book with colleagues in professional learning communities, department meetings, or when time permits. The book would also be a good choice for a book study with a group of peers interested in improving the quality of their classroom discussions. You might also encounter this book in college or university education courses for practicing or preservice teachers or in professional development workshops during the summer or school year. We will explore more ideas about ways to make the five practices central to your instruction in Chapter 7.

Norms for Video Viewing

The video excerpts that accompany this book are intended to provide authentic examples from elementary classrooms on which to base discussions of the five practices. To take full advantage of these examples, we encourage you to consider the following three norms for video viewing. These norms are based on recent research that documents how video can support teacher learning and reflection (Sherin & Dyer, 2017; Sherin & van Es, 2009).

Focus on student sense-making. The majority of the video clips that you will watch in this book focus on students. That is intentional. While the five practices describe actions that you as the teacher will take, this work involves looking closely at what students do and say. The videos thus provide an opportunity for you to do just that outside of the immediate demands of teaching.

As you explore students' actions in the videos, we encourage you to look beyond simply whether a student's idea is correct or incorrect. Instead, examine what it is that the student understands. What is the student's idea? Where does it come from? Why is it sensible, given what the student understands? Focus on what it is that makes sense about the students' thinking.

Be specific about what you notice. Much of the value of video viewing is the sense that you can slow down classroom interactions and have the time to notice what is taking place in a detailed way. In addition, with video you can often focus on just a subset of events and look closely, for example, at what a particular student is saying and to whom, what gestures or drawings the student is making, and more.

As you view the video excerpts, we encourage you to be specific about what you notice. Provide detailed evidence to support your claims about what is happening. Explain what it is you see in the video that leads you to a particular interpretation.

Consider alternative interpretations. As you watch the video, you may find yourself quickly making assumptions about what is taking place and why. As teachers, we must often respond quickly, diagnosing student confusions, responding to student questions, and making changes in the direction of a lesson. Video, however, provides the luxury of time. Use this to your advantage!

Once you have an idea of what you think is taking place in the video, look for alternatives. How else might you understand what is happening? This is particularly important when examining students' ideas. Rather than assume you know the reason behind a student's strategy or statement, look for alternatives. Considering alternate interpretations is important because when we assume we understand what a student means, we often limit ourselves to what we have heard from students previously.

Getting Started!

You are now ready to begin a deep dive into the five practices. In the next five chapters, you will learn more about the practices. We encourage you to keep a journal or notebook in which you can respond to questions that are posed and make note of questions you have. Such a journal can be helpful in conversations with other teachers or in reflecting from time to time about how your thinking is evolving and changing.

> “Once you set a goal for instruction, you need to find a task that aligns with it. That is, a task that actually has the potential to accomplish what you’ve said you want to do during the lesson. So in the ideal, when you’re having a discussion, you want a learning goal that explicitly talks about what students are going to learn, and a task that is high level, that has the potential to get you there.”

—OLIVIA STASTNY, THIRD-GRADE TEACHER