Chapter 5

Questioning and Discourse

Dear Coach,

Here is support for you as you work with teachers on questioning and discourse.

In the **COACH'S DIGEST . . .**

Overview: A review of high-level questioning and facilitating discourse, including a discussion of talk moves. Also available as a download to share with teachers.

Coaching Considerations for Professional Learning: Ideas for how to support a teacher or a group of teachers in learning about questioning and discourse.

Coaching Lessons From the Field: Mathematics coaches share how they use a tool or idea related to support questioning and discourse.

Connecting to the Framework: Specific ways to connect selected *Shifts* and Mathematical Practices to questioning and discourse.

Coaching Questions for Discussion: Menu of prompts for professional learning or one-on-one coaching about questioning and discourse.

Where to Learn More: Articles, books, and online resources for you and your teachers on where to learn more about questioning and discourse!

In the **COACH'S TOOLKIT . . .**

Ten tools focused on questioning and discourse, for professional learning or coaching cycles.

Coach's Digest

In the Coach's Digest, we begin with an overview of questioning and **discourse**, written to teachers (and to you, the coach). As you read the Overview, the following questions might help you reflect on this topic in terms of your role as a mathematics coach:

- How might I use Bloom's Revised Taxonomy to help teachers ask good questions during instruction?
- How might I provide experiences for teachers in analyzing the patterns of their questions during a lesson?

Overview of Questioning and Discourse

To download the Chapter 5 Overview, go to **resources.corwin.com/mathematicscoaching.**

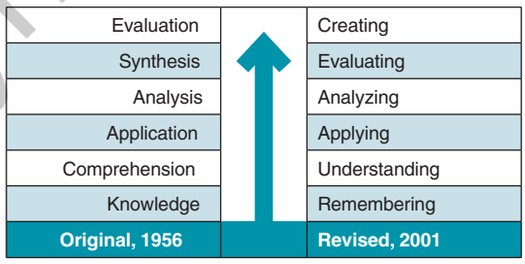
Crafting and posing questions are both critical aspects of a teacher's practice, which is why "Pose purposeful questions" is one of the eight Effective Mathematics Teaching Practices in *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014). The first part of posing a question is to craft one that has the potential to elicit high-level thinking. The second aspect, posing the question, may seem like a routine act, but it also requires purposeful actions. In fact, crafting and posing questions both require explicit attention on the part of the teacher in order for this complex process to be effective.

Crafting High-Level Thinking Questions

Teachers ask many questions every day. Research from the early 1980s suggested that teachers asked between 300 and 400 questions daily (Leven & Long, 1981), a number that is probably even greater today. However, most questions asked by teachers do not support students in high-level thinking. Mid-continent Research for Education Learning (McREL) collected data from 23,000 classroom observations and found that 60 percent of questions posed were at the lowest two levels of Bloom's Taxonomy (McREL, 2009). Stigler and Hiebert (2009), focusing specifically on mathematics classrooms, found that middle school mathematics teachers in the United States posed fewer high-level questions than teachers in other countries.

Bloom's Taxonomy is probably the best-known framework for identifying the level of cognitive demand of questions (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). In 2001, a revised version of Bloom's Taxonomy was published in an attempt to update the taxonomy to be relevant in the twenty-first century (Krathwohl, 2002; see Figure 5.1). Asking students questions from the upper end of these frameworks (Application/Applying, Analysis/Analyzing, Synthesis/Evaluating, and Evaluation/Creating) supports students in high-level thinking.

Figure 5.1 **Bloom's Taxonomy**



Source: Krathwohl, D. R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory Into Practice, 41*(4), 212–218.

Crafting high-level thinking questions for the lesson's learning objectives requires preplanning. To support teachers in planning effective questions, it can be helpful to consider the *purposes* questions might serve. These purposes include: (1) gathering information, (2) probing thinking, (3) making the mathematics visible, (4) encouraging reflection and justification, and (5) engaging

with the reasoning of others (Huinker & Bill, 2017; NCTM, 2014, pp. 36–37). Once high-level thinking questions are crafted, the focus can change to posing questions in ways that ensure that *all* students are thinking.

Posing High-Level Thinking Questions

An important aspect of posing high-level questions is thinking about the *patterns* of questions. There are (at least) three patterns of questioning that typically occur in mathematics classrooms (Herbel-Eisenmann & Breyfogle, 2005). Most common is the **initiation–response–feedback** (IRF), in which the teacher asks a question ("What is … ?"), a student responds ("Fifteen"), and the teacher provides or evaluates the response ("Good"). Typically, this questioning pattern does not engage students in high-level thinking. A second questioning pattern is **funneling**, wherein the teacher leads students through a series of questions to the teacher's desired end. In this pattern, the teacher is doing the high-level thinking of making connections; the students are merely supplying quick responses to questions as the teacher pushes toward a conclusion. The third pattern, **focusing**, is a subtle but significant shift in questioning in which the teacher asks questions based on the students' thinking to support them in thinking at high levels. For example, after hearing a student respond, a teacher might say, "Tell me more about why you …" or "Look at Amy's equation and tell me how each variable and number connects to the story situation." Questions such as these probe into student thinking and ask them to make predictions, compare, classify, evaluate, analyze, or estimate.

Classroom Discourse

Posing effective questions is just one aspect of a larger concept: **classroom discourse** (also one of the NCTM Effective Mathematics Teaching Practices). The role of the teacher in supporting meaningful mathematical discourse is complex (Chapin, O'Connor, & Anderson, 2013; Hufferd-Ackles, Fuson, & Sherin, 2015; NCTM, 2014; Smith & Stein, 2011). Discourse involves various teaching actions, including the following:

- Asking questions to understand and deepen students' thinking
- Listening to students' responses to gauge their learning
- Encouraging students to listen and respond to their peers
- Requiring students to explain their thinking
- Encouraging students to use multiple representations
- Allowing students to engage in productive struggle

Chapin and colleagues (2013) identify **talk moves** and tools that teachers can use to orchestrate classroom discussions that support increased student participation, as seen in Figure 5.2(a). These talk moves are used in various discourse situations, illustrated by the example scenarios in Figure 5.2(b). Taking time to focus on crafting and posing high-level thinking questions is critical to facilitating productive discourse; making this a focus of collaborative work in PLCs can save everyone time. And the increased student involvement in classroom discourse will lead to increases in students' understanding of mathematics.

Figure 5.2 **Talk Moves and When to Use Them**

5a. Talk Moves and Prompts

To understand students' contributions:

1. You used the hundreds chart, tell me more about that. (*Revoicing*)
2. How might you repeat [Ava's] thinking in your own words? (*Repeating*)

To deepen students' contributions:

1. How do you know that you are correct? (*Reasoning*)
2. What do other people think? (*Adding on*)

5b. Talk Move Map

Source: Developed by Cathy O'Connor and reprinted with permission of SERP.serpinstitute.org

Coaching Considerations for Professional Learning

Improving your skills at questioning and facilitating discourse is a career-long endeavor. It is important to help teachers distinguish among the many ideas surrounding questioning. For example, the following types of questions are often confused as the same:

- Open-ended
- High-level thinking
- Conceptually-focused

Yet questions can be open-ended and still low level. Or a high-level question can be focused on procedural knowledge. These aren't good–bad, right–wrong distinctions, but it is critical to make these distinctions when working on questioning so that everyone is focused on the same aspect of questioning. Here are some ideas for supporting teachers:

1. ***Plan for questioning.*** Planning for questioning can take time, but the effort is worth it in the long term. Making this the focus of a PLC can be a valuable way to collaborate to benefit all teachers (see Tools 5.2, 5.3, and 5.4). For example, focus on a unit and brainstorm misconceptions that students typically have related to the topic (see Smith & Stein, 2011). Then together, create high-level thinking questions that might address those misconceptions. As teachers use the questions in class, reflect on the outcomes in terms of students' thinking (see Tools 5.9 and 5.10).
2. ***Analyze questions.*** Volunteer to script questions during an observation (see Tool 5.5) and then work with the teacher to classify them in terms of Bloom's Taxonomy. Alternatively, provide time for a teacher to observe another or watch videos of classroom teaching to evaluate the types of questions and questioning patterns (see Coaching Lessons From the Field to see how one district did this).
3. ***Track wait time.*** A still prevalent issue related to asking questions is the amount of **wait time** teachers provide. Most questions are answered in less than one second (Rowe, 1972). Uncomfortable with silence, we jump in with an answer, a comment, a prompt, or another question. Increasing wait time to three to five seconds can lead to positive outcomes (Rowe, 1972; Stahl, 1994). Encourage your teachers to track their wait time by audio- or video-recording their lessons (see Tool 5.8). Alternatively, you can record wait times during an observation. Support teachers in creating strategies to increase their wait time and then track the changes in student thinking. Keene (2014) and Roake (2013) offer practical strategies for implementing wait time in the classroom (see Where to Learn More).
4. ***Post questions.*** Because good high-level thinking questions or conceptually-focused questions are tough to "wing," encourage teachers to post frequently-used good questions in the classroom. This has the added benefit of helping students pose questions of their peers (supporting Mathematical Practices such as 1, 2, and 3). Developing Mathematical Thinking With Effective Questions on PBS Teacherline (www.pbs.org/teacherline) provides a strong list. You can create bookmarks of these questions to give out to teachers and/or invite them to select key questions from this list to post in their rooms.

Coaching Lessons From the Field

In working with our teachers, we created a large "questioning grid" in their planning room based on Tool 5.10. During grade-level planning sessions, teachers visited classrooms to observe and record on sticky notes the first three questions they heard posed by the teacher. Each teacher analyzed the questions and placed them on the questioning grid and justified her or his thinking. The math coaches then selected some of the reflecting questions from Tool 5.10 to guide the group discussion.

The math coaches described the activity as an "eye-opener" in their schools because it allowed teachers to see that many of their questions were on the lower end of Bloom's Taxonomy. This activity supported teachers in focusing on asking high-level thinking questions.

—Sandra Davis, Rita Hays, Maria Leaman, Natasha Crissey, and Tracey Beck, Brevard Public School, Viera, FL

		Level of Thinking (Bloom's Taxonomy—Revised)					
Mathematical Knowledge		Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
	Conceptual	• How would you explain the difference between probability and odds? • What is a negative number? • Which number is the denominator in this fraction? • What are the attributes of your shape?	• How many cubes do you think it will take to equal your rock? • Which of these triangles are similar? • What is the difference between supply and demand? • Which graph represents the data?	• Classify these triangles as scalene, equilateral, or obtuse.	• What are some ideas you have to classify these aliens?		• How could you create a playground given these parameters?
	Procedural	• What is the next step? • What is 12 take away 3? • What is the formula for the area of a circle? • What do you do first in this problem?	• Explain the steps for completing the order of operations. • How many lines do you need to draw?	• What is the perimeter of this triangle? • How much will it cost to have electricity, housing, and water?		• How might you know if your answer is correct?	

Connecting to the Leading for Mathematical Proficiency (LMP) Framework

As teachers focus on questioning and discourse, it is important for them to make explicit connections to the *Shifts in Classroom Practice* and the Mathematical Practices. The brief paragraphs that follow provide ideas for making these connections. You and your teachers can continue to add to these ideas! Tool 5.1 also focuses on connecting questioning and discourse to the *Shifts*.

Connecting Questioning and Discourse to *Shifts in Classroom Practice*

Shifts	1	2	3	4	5	6	7	8

Shift 4: From show-and-tell* toward *share-and-compare

Teacher has students share their answers. → Teacher creates a dynamic forum where students share, listen, honor, and critique each other's ideas to clarify and deepen mathematical understandings and language; teacher strategically invites participation in ways that facilitate mathematical connections.

Over recent years, many teachers have gotten better at asking students questions like "How did you solve it?" and "Who has solved it a different way?" This is a start, but questioning and discourse must not stop here if students are to think at a high level. Inserting questions such as "What do others think of this strategy?" "How do these strategies compare?" and "When might you use this strategy?" strengthens student understanding and helps students make mathematical connections. The talk moves (see Figure 5.2) and various tools can support this focus on share-and-compare (see Tools 5.3, 5.4, 5.5, 5.8 and 5.10).

Shift 5: From questions that seek expected answers* toward *questions that illuminate and deepen student understanding

Teacher poses closed and/or low-level questions, confirms correctness of responses, and provides little or no opportunity for students to explain their thinking. → Teacher poses questions that advance student thinking, deepen students' understanding, make the mathematics more visible, provide insights into student reasoning, and promote meaningful reflection.

A purposeful question strikes a delicate balance of being clear and being complex. A question might be clear but low level or focus on trivial mathematics. Or it can be complex but incomprehensible to students. A well-designed question, clear and high level, elicits important mathematical thinking and talking (see Tools 5.2, 5.3, 5.4, and 5.5). Focusing on the patterns of questions in a lesson can move teachers toward the right end of this *Shift* (see Tool 5.6).

Shift 7: From mathematics-made-easy* toward *mathematics-takes-time

Teacher presents mathematics in small chunks so that students reach solutions quickly.	→	Teacher questions, encourages, provides time, and explicitly states the value of grappling with mathematical tasks, making multiple attempts, and learning from mistakes.

Posing good questions is a great strategy when encouraging students to persevere in problem-solving. As students begin to struggle, a good question can provide the just-in-time support needed to encourage a student to keep going (see Tool 5.4). Asking students about their attempts, mistakes, and processes also communicates that doing mathematics is a journey, not just a destination—in other words, making multiple attempts, noticing and correcting errors, and continuing to seek a solution pathway is critically important in doing mathematics (it is not just about getting an answer).

Shift 8: From looking at correct answers* toward *looking for students' thinking

Teacher attends to whether an answer or procedure is (or is not) correct.	→	Teacher identifies specific strategies or representations that are important to notice; strategically uses observations, student responses to questions, and written work to determine what students understand; and uses these data to inform in-the-moment discourse and future lessons.

An important aspect of posing questions and productive classroom discourse is *listening* to students' responses. Using students' responses can inform in-the-moment classroom discourse as well as plan for future instruction. The distinctions between IRF, funneling, and focusing effectively capture this distinction (see Tool 5.6).

→ Engage teachers in thinking about the *Shifts* related to questioning and discourse by having them think about specific teacher moves they can make along each of the continua (see Tool 5.1). For example, in *Shift 5,* the focus is on high-level questioning. After using Tool 5.5 to script questions for the teacher, follow up by placing the questions from the lesson along *Shift 5*. If questions tend to fall toward the middle or left end of the *Shift*, consider with the teacher what adjustments can be made so that the questions lie more to the right on the continuum.

NOTES

Connecting Questioning and Discourse to Mathematical Practices

MPs	1	2	3	4	5	6	7	8

One of the purposes of asking high-level thinking questions is to model for students the kind of thinking in which they need to engage. The goal is for students to be self-directed in asking themselves these questions as they solve mathematics tasks. Several of the Mathematical Practices include opportunities for students to engage in high-level thinking by questioning themselves and others (see Chapter 12 for a PD activity matching high-level questions with all of the Mathematical Practices).

1. ***Make sense of problems and persevere in solving them.*** In order for students to make sense of problems, they need to know the right questions to ask. Students learn how to ask questions of themselves when that has been modeled for them by their teachers. Asking questions such as the ones listed here can assist students in making sense of problems and persevering when dealing with tasks they find difficult:

   - How is this task similar to a previous task you have completed?
   - How might you solve a simpler task to help with this?
   - What helped you be successful in solving the problem?

2. ***Reason abstractly and quantitatively.*** This Practice embodies Bloom's high-level thinking. When students are evaluating an equation or expression to determine whether it is equivalent to an equation or expression written in a different form, they are reasoning abstractly. When students contextualize, they are creating examples for the abstract equations. For students to become proficient in this Practice, significant use of high-level questions must be incorporated into solving problems. Examples include the following:

   - What is the relationship between the data/situation and the equation?
   - How are these answers alike? Different?
   - What might be an example that would fit this expression?

3. ***Construct viable arguments and critique the reasoning of others.*** The only way for this proficiency to be developed is if teachers pose focusing questions and facilitate discourse in ways that push students to describe their own solutions and evaluate or add to those shared by their peers. This involves analyzing and evaluating—two of Bloom's high-level thinking categories. Students can ask questions of their peers when assessing their work, such as

   - What was your thinking about using [a graph] to solve this task?
   - How did you get [that equation]?
   - How is that answer the same as [Nick's]?

   And teachers facilitate such questioning by asking such things as

   - What do the rest of you think about Ann's strategy?
   - Are these strategies different or alike?
   - Which of these strategies would you pick if you had a problem like this, but more difficult numbers? Why?

4. ***Model with mathematics.*** Determining a mathematical model for a situation requires analyzing the situation and determining the symbolic representation for the situation. Students need experiences connecting symbols to situations as early as kindergarten and extensively in middle school and high school. Questions focused on making these

connections support their ability to model with mathematics. Examples include the following:

- How does your model (equation) connect to the situation?
- Where can you find [the rate] in the situation? The table? The equation?
- Are these two equations equivalent? Which (if either) is more efficient?"

7. ***Look for and make use of structure.*** Focusing discussions can help students see structure in equations. For example, asking young children whether 3 + 5 is the same as 5 + 3 and asking older students to compare mathematical models can help them see the distributive property in action. Questions that focus on structure include these examples:
   - How is this problem similar to another problem you have solved before?
   - What patterns did you notice across these problems?
   - What are possible answers (range of values) for this problem? What information tells you this?

Ask your teachers to connect the Mathematical Practices to questioning and discourse by asking these questions:

- What connections do you see between high-level thinking and the selected Mathematical Practices?
- What adjustments have you made in your questioning that support students in demonstrating the selected Mathematical Practices?
- How does the discourse during your lessons influence the opportunities for students to engage in these Mathematical Practices?

NOTES

Coaching Questions for Discussion

Questions Related to the Focus Zone: Questioning and Discourse

1. Knowing the benefits of wait time, what might be some strategies you could use to increase your wait time?

2. How might you take a low-level question and adapt it to be a high-level question?

3. What are some ways to incorporate high-level thinking questions into homework? Into reviewing homework?

4. What do you know about students' misconceptions in _____ that could influence the questions you could use in this lesson?

5. What might be some questions you can plan for this lesson to address those misconceptions?

6. How might you monitor your questioning patterns?

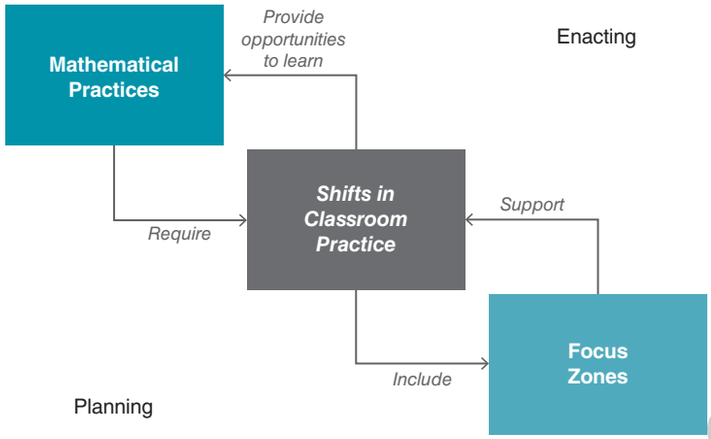
7. How might you incorporate the talk moves into this lesson? What might be the benefits?

8. What is your thinking about orchestrating the discourse in this lesson?

9. In what ways do you monitor who participates in classroom discussions?

10. What strategies might you use to be sure *all* students are thinking of the answers to the questions you ask?

Questions Related to the LMP Framework



1. As you enact the ideas of questioning and discourse, what do you see as related *Shifts in Classroom Practice*?

2. As you enact the ideas of questioning and discourse, what do you see as opportunities to learn and, in particular, to develop the Mathematical Practices?

NOTES

Where to Learn More

Books

Chapin, S. H., O'Connor, C., & Anderson, N. C. (2013). *Talk Moves: A Teacher's Guide for Using Classroom Discussions in Math* (3rd ed.). Sausalito, CA: Math Solutions.

The multimedia third edition of this popular book includes the talk moves and tools teachers can use in classroom discussions to support student learning in mathematics. New to this edition are 46 video clips showing math discussions in grades K–6 and more than 20 lesson plans ready for classroom use.

Francis, E. M. (2016). *Now That's a Good Question! How to Promote Cognitive Rigor Through Classroom Questioning.* Alexandria, VA: ASCD.

The author suggests eight different kinds of questions to support students in thinking at high levels and communicating depth of knowledge. Examples of good questions are provided across content areas and grade levels.

Parrish, S. (2014). *Number Talks: Whole Number Computation, Grades K–5: A Multimedia Professional Development Resource.* Sausalito, CA: Math Solutions.

This book explains the power of number talks and how they can support students' development of computation strategies. Guidance is provided on designing number talks, asking questions that build understanding, and developing grade-level-specific computation strategies. A facilitator's guide and streaming video clips of numbers talks in action are included.

Smith, M., & Stein, M. (2011). *Five Practices for Orchestrating Productive Mathematics Discussions*. Reston, VA: NCTM.

This book outlines a framework for orchestrating mathematically productive discussions based on student thinking. The five instructional practices are described and illustrated with examples from real classrooms. These practical suggestions will support teachers in orchestrating productive mathematics discussions that are responsive to students' thinking. A professional development guide is included.

Articles

Bahr, D. L., & Bahr, K. (2017). "Engaging All Students in Mathematical Discussions." *Teaching Children Mathematics, 23*(6), 350–359.

This article presents four strategies, aligned with NCTM's Effective Teaching Practice of "Pose purposeful questions," to ensure that students are actively engaged in mathematical discussions. The authors synthesized three different taxonomies to create a framework of cognitive complexity that includes the thinking level, a definition, and sample questions.

Ghousseini, H., Lord, S., & Cardon, A. (2017). "Supporting Math Talk in Small Groups." *Teaching Children Mathematics, 23*(7), 422–428.

This article highlights how to strategically use the launch phase of a lesson to support students' mathematical talk in small groups. The authors share three specific strategies with examples: (1) modeling for students what collaboration looks like in action, (2) creating opportunities for guided math talk, and (3) offering resources that support self-directedness in students.

Hodge, L. L., & Walther, A. (2017). "Building a Discourse Community: Initial Practices." *Mathematics Teaching in the Middle School, 22*(7), 430–437.

Hodge and Walther describe four initial practices that preservice teachers found beneficial in promoting mathematical discourse. They define each practice and provide examples of what the practice would look like "in action" using classroom tasks and discourse samples. These four practices provide foundational steps in creating an environment for a discourse community.

Keene, E. O. (2014). "All the Time They Need." *Educational Leadership, 72*(3), 66–71.

The author describes the benefits of wait time and shares practical tips for teachers. Although written from the perspective of a language arts classroom, the tips apply to all content areas.

Reinhart, S. (2000). "Never Say Anything a Kid Can Say!" *Mathematics Teaching in the Middle School, 5*(8), 478–483.

Reinhart describes his journey of going from a teacher that "explains things well" to a teacher that "gets kids to explains things well." He provides a useful list of questioning strategies that he developed as he transformed his teaching and created a classroom environment where students were actively engaged in learning mathematics.

Roake, J. (2013). "Planning for Processing Time Yields Deeper Learning." *Education Update, 55*(8), 1, 6–7.

Roake presents 10 tips for building think time into classroom discussions. She provides a brief overview of the importance of processing time with connections to brain research and then outlines the 10 practical strategies. A quick but powerful read!

Online Resources

Kathy Schrocks's Bloomin' Apps

www.schrockguide.net/bloomin-apps.html

This webpage has a collection of online apps aligned with the revised Bloom's Taxonomy.

Levels of Cognitive Demand

http://mdk12.org/instruction/curriculum/mathematics/cognitive_levels.html

Organized around Bloom's Taxonomy, this tool provides competencies and skills aligned with the levels of cognitive demand, as well as various question cues to help promote high-level thinking skills.

Developing Mathematical Thinking With Effective Questions on PBS Teacherline

http://www.pbs.org/teacherline

This resource provides questions for teachers to ask focused on various mathematical processes to support students when solving math tasks.