Assessing Questions	Advancing Questions
• Based closely on the work the students have produced • Clarify what the students have done and what they understand about what they have done • Provide information to the teacher about what the students understand	• Use what students have produced as a basis for making progress toward the target goal of the lesson • Move students beyond their current thinking by pressing them to extend what they know to a new situation • Press students to think about something they are not currently thinking about
Teacher STAYS to hear the answer to the question.	*Teacher WALKS AWAY, leaving students to figure out how to proceed.*

Fig. 5.4. Characteristics of assessing and advancing questions (Developed by Victoria Bill and Margaret Smith 2008)

During the whole-class discussion, Ms. Bassham's questions moved students' thinking forward toward the two main goals of the lesson. Many of these questions exemplify the *making the mathematics visible* type of questions. First, Ms. Bassham asked questions to focus students' learning on the goal of "exploring the meaning of multiplying functions by use of tables and graphs." She asked students to explain how they determined the values for $g(x)$ and highlighted the "inverse" relationship between multiplication and division (lines 91–98, 166).

Second, Ms. Bassham asked questions to focus students' learning on the goal of "understanding that the x-intercepts of a quadratic function (when they exist) consist of the x-intercepts of the two linear functions whose product defines it." Students were asked to examine "key points" on the graph, especially those with "special names" (lines 111, 118–21). Ms. Bassham wanted students to conclude that each x-intercept of the quadratic function provides the x-intercept of each of the linear functions. Students articulated that connection through the teacher's questions. Ms. Bassham continued to ask students to consider the relationship between the equations and the graphs, with particular attention to where the graphs cross the x-axis (lines 130–31, 144–46). Toward the close of the lesson, she also asked a question to *encourage reflection and justification*: "Why do you think this is $g(x)$?" (line 152).

- Lines 56–58: "Is there a pattern that you're noticing if there's more than three points? Be ready to tell me about what pattern do you see. If there's more than three points, what can you tell me about the pattern of seeing those three points?" (*making the mathematics visible*)

Ms. Campbell used a consistent pattern of question types. She began with questions to probe thinking or gather information. Once she understood students' thinking and strategies, she asked questions to encourage reflection and justification or to make the mathematics visible. For example, we see this pattern in the first interaction with students in the video. Ms. Campbell began by asking questions to probe students' thinking and gather information about the group's strategy of drawing a square (lines 1–11), such as "How did you draw a square? Where's your square at?" (line 11). She followed up with questions to move students' thinking forward by encouraging reflection and justification (lines 14, 17–18). Once she asked the group an advancing question, "Could you prove to me—I'm going to come back and see if you guys can prove to me that there could be more points?" (lines 17–18), she then left to interact with the next group. (Although Ms. Campbell used the phrase "Could you prove . . . ?" she was asking for a justification rather than an argument that meets the higher standard of proof.)

Ms. Campbell's pattern of questioning (e.g., beginning with probing thinking or gathering information questions and then moving to questions that encourage reflection and justification or make the mathematics visible) enables a teacher to elicit and use students' thinking. Questions serve to make a student's thinking visible for the teacher, the student, and other students in the group. In the process of responding to probing thinking or gathering information questions, students often "see" a next step, make a connection, or realize an error on their own as they respond to the question. Questions that encourage reflection and justification or make the mathematics visible support students in taking the next step toward the goals of the lesson on the basis of their current mathematical work and thinking, using ideas and strategies that make sense to them. In this way, as described by the research presented in the next section, teacher's questions can serve to support students' mathematical engagement, understanding, and achievement.

Pose Purposeful Questions: What Research Has to Say

The questions a teacher asks as students work on a task (individually or in small groups) and during a whole-class discussion can shape the mathematical content in which students engage during a lesson and the ways in which students engage with that content. Teacher's questions can support high-level thinking, prompt for explanations and connections, and encourage students to delve more deeply into mathematics. Teachers' questions can also serve to elicit facts, procedures, or calculations.

As noted in *Principles to Actions*, research has identified the importance of *types of questions* and *patterns of questioning*. Several frameworks have been developed to categorize types of teachers' questions (e.g., Boaler and Brodie 2004; Chapin and O'Connor 2007; Sorto et al. 2009; Wimer et al. 2001). These frameworks call attention to ways that teachers' questions elicit different levels and types of students' mathematical knowledge and thinking and prompt students to engage with mathematics in different ways. For example, consistent with ideas in *Principles to Actions* that teachers' questions should prompt students to "explain and reflect on their own thinking," Wimer's (2001) categories of higher-order and lower-order questions identify differences in the cognitive processes elicited by different types of questions. Higher-order questions ask students to think deeply about mathematics (e.g., these questions often contain the word "why?"), make mathematical connections, or provide mathematical reasoning. Lower-order questions ask students to demonstrate recall of facts, properties, or procedures. Similarly, the framework featured in *Principles to Actions* (NCTM 2014, pp. 36–37) and discussed throughout this chapter identifies different purposes for questions (e.g., gathering information, probing thinking, making the mathematics visible, and encouraging reflection and justification).

Frameworks can help teachers analyze their own questioning types, raise awareness of the types of questions they are asking, and identify which types of questions are asked to which students. Frameworks can also help teachers analyze their *patterns of questioning*. Different types of questions might occur in patterns that help teachers understand and respond to students' thinking (Walsh and Sattes 2005). For example, a question intended to gather facts or information, while considered a lower-order question, might help a teacher assess a student's prior knowledge or current understanding *before* the teacher is able to ask a deeper conceptual question. Similarly, as presented in this chapter, teachers may need to ask a number of assessing questions before asking advancing questions that move students' thinking forward. Research indicates that assessing and advancing questions are particularly beneficial in supporting students during small-group work and in preparing students to engage in mathematical discourse during whole-group discussions (Smith and Stein 2011; Stein et al. 2008; Stein et al. 2009).

Traditionally, mathematics lessons featured a questioning pattern of "Initiate-Response-Evaluate" or I-R-E (Mehan 1979), where the teacher *initiates* a question intended to elicit a specific answer, a student provides a *response*, and the teacher *evaluates* the response as correct or incorrect. The I-R-E questioning pattern leaves little room for students to express ideas or explain their thinking. Incorporating the open-ended types of questions discussed in this chapter (e.g., probing thinking, making the mathematics visible, encouraging reflection and justification) can help teachers move beyond the I-R-E pattern and create space for student-generated ideas, strategies, and representations in mathematics lessons.

Promoting Equity by Posing Purposeful Questions

Through the use of questioning, teachers can create equitable learning opportunities in mathematics classrooms. The questions a student is asked, and how a teacher follows up on the student's response, can support the student's development of a positive mathematical identify and sense of agency as a "thinker and doer of mathematics" (Aguirre, Mayfield-Ingram, and Martin 2013).

By making an effort to listen to and understand students' thinking (by asking assessing questions, probing students' thinking, and encouraging reflection and justification), teachers indicate that students' thinking makes sense. Communicating a respect for students' thinking, even thinking that is still in development or only partially correct (such as when Ms. Culver asked the student who agreed with $y = 3x$ to explain her thinking), invites more students to participate and to feel capable of participating.

In contrast, classrooms characterized by I-R-E patterns of questioning reward correctness and often position students who are quickest to achieve the correct answer as "smart" mathematically. Funneling patterns of questioning can also position "smart" students as those who use strategies similar to the one being advocated by the teacher (often the most mathematically efficient strategy) at the expense of strategies that develop conceptual understanding or serve as "stepping-stones" to procedural fluency.

Asking questions that provide space for students' ideas, strategies, representations, and explanations expands opportunities for students to be positioned as capable in a mathematics lesson. This does not imply that "anything goes" or that mathematical correctness or precision does not matter. Instead, teachers ask questions that support productive struggle and honor the thinking process *as well as* the final result. Teachers can sequence the questions they ask and the order in which ideas and strategies are shared to build toward the mathematical goals of the lesson (e.g., the focusing pattern; using questions that make the mathematics visible). Students' efforts to think through a problem and explain and justify their own thinking come to be seen as characteristics of "smartness" in the mathematics classroom. Furthermore, teachers can follow up with students' contributions in ways that assign competence (Cohen et al. 1999) to particular students, such as verbally marking a student's ideas as interesting, noting a student's effort, or identifying an important aspect of a student's strategy (e.g., Ms. Culver refers to ideas offered by Angela and Chris).

While the suggestions regarding purposeful questioning throughout this chapter would serve to benefit all students, we encourage teachers to pay particular attention to *who* is being asked which types of questions, *who* is being positioned as competent, and *whose* ideas are featured and privileged. Supporting a strong mathematical identity and sense of agency and belonging in mathematics is especially important for our students of historically underserved populations (e.g., black, Latino/a, American Indian, or members of other minorities; students of poverty; students who are English language learners; students who have not been successful

in school and in mathematics; and students whose parents have had limited access to educational opportunities [NCTM 2014]). Equitable opportunities for participation and the sense of being capable, valued, and valuable in the mathematics classroom can support students' engagement and success in mathematics.

Key Messages

- Questions should go beyond gathering information to probing thinking and requiring explanation and justification.
- Questions that build on students' thinking, but do not take over or funnel students' thinking, serve to advance student understanding.
- Assessing questions allow the teacher to determine what the student knows and understands about key mathematical ideas, problem-solving strategies, or representations. Advancing questions move students toward the targeted goal of the lesson.
- Anticipating questions should be part of the lesson planning process so that teachers can highlight possible strategies, representations, and misconceptions and support student learning and engagement without taking over the thinking for them. (Chapter 7 will provide additional opportunities to consider the importance of lesson planning.)

Taking Action In Your Classroom: Analyzing Questions And Responses

In Taking Action in Your Classroom 5.1 and 5.2, we invite you to explore the questions you asked during a lesson and to consider what insights these questions give you about students' understanding of mathematics.