NC COLLABORATIVE FOR MATHEMATICS LEARNING

NC²ML Research-Practice Brief #23

Supporting Student Thinking Through Questioning

WHY TALK ABOUT QUESTIONING?

"Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships." (NCTM, 2014, p.35)

We communicate with our students in many different ways, one of the most important of which is through our questioning. The questions we ask are central to the type of learning that takes place in the classroom (Manoucherhiri & Lapp, 2003). The *NC High School Mathematics Standards* call for understanding mathematical procedures, concepts and practices. It is through the questions we ask that we better understand student's thinking and help students to develop and connect their understanding of procedures and concepts, while also building their facility with mathematical practices. Effective questioning allows us to figure out what students know so that we can adjust instruction; helps students make important mathematical connections; and supports students in posing their own questions. All of which is instrumental to student learning.

Questions for Discussion

1. Why do we ask questions?
2. What types of questions promote thinking and reasoning? Give some examples.
3. What common mistakes to you tend to make when asking questions? What are their outcomes?
4. What can you do to help students feel safe to answer questions and ask questions of each other?

Good questions come in many different forms and can have many different goals. However, generally good questions: a) help students make sense of the mathematics; b) are often open ended; c) empower students to unravel their misconceptions; d) require the application of facts and procedures and encourage students to make connections and generalizations; e) are accessible to all students; and f) foster answers that lead students to wonder more about a topic and perhaps construct questions on their own (Kenney, 2012).

USING QUESTIONS TO FOCUS RATHER THAN FUNNEL

When engaging students in discussion, it is important to consider what happens as a result of the questions being posed. The questions you choose have the potential to either funnel or focus students' attention to the mathematics. Funneling is when a teacher asks a series of questions that guide students to a procedure or to a desired end. In contrast, focusing questions require teacher to listen to students' responses and ask additional mathematically focused questions to support them communicating their thinking (Herbel-Eisenmann & Breyfogle, 2005).

Notice the difference in the examples to the right. In the funneling example the teacher's questions led students to a particular strategy and solution. In contrast, in the focusing example the teacher followed the students' strategy. Generally, good questions focus on students thinking and allow for us to uncover and understand that thinking. Focus questions press students to communicate their thoughts clearly while also expecting them to reflect on their thoughts and those of their classmates.

Questions that Funnel vs. Questions that Focus

Teacher: (0,0) and (4,1) are two points on a line. What's the slope?
(long pause)
Teacher: What's the rise?
Students: 1
Teacher: What's the run?
Students: 4
Teacher: So the slope is…?
Students: 0.25 (in unison)

Teacher: (0,0) and (4,1) are two points on a line. What's the slope?
(long pause)
Teacher: What do you think of when I say slope?
Kara: The angle of the line.
Teacher: What do you mean by the angle of the line?
Kara: What angle it sits at compared to the x and y axis
Teacher: [to class] What do you think Kara Means?

In thinking about how to *focus* rather than *funnel* your questions, it is helpful to look to research and consider how others have become purposeful about engaging students in mathematical discussions. It is widely accepted that well-structured discourse promotes academic learning. It does not matter if that discourse is teacher guided or student directed. In their work with high school teachers, Herbel-Eisenmann, Steele, & Cirillo (2013) introduced a set of discourse moves that have been proven to develop "productive and powerful" classroom discourse (p. 181). These moves provide a helpful framework to

support purposeful questioning in any mathematics lesson. It is important to point out their emphasis on waiting. Not only does waiting allow time to think, but it provides a nonverbal invitation for others to respond or pose a question. It has been found that when teachers increase their wait time to at least 3 seconds, class participation increases and answers are more detailed (Shuster & Anderson, 2005).

Six Teacher Discourse Moves (adapted from Herbal-Eisenmann, Steele, & Cirillo, 2013, p. 183-184)

Teacher Move	Description of Move
Waiting	Waiting (i.e. using "wait time) to *provide students with time to process teacher questions and think about their responses* is critical to productive and powerful discourse. Although teachers are probably aware of the benefits of waiting after asking a question, a lesser known form of wait time involves waiting after a student responds.
Inviting	*Inviting student participation* takes on multiple forms and addresses many goals. For example, a teacher may solicit multiple solution processes or strategies for the same answer or seek to determine how students arrived at their answers.
Revoicing	Revoicing occurs when *a teacher restates or rephrases a students' contribution to make the students' mathematical thinking public to the class*. Full revoicing occurs when the teacher checks back with the original speaker and offers an explicit opportunity for students to respond to questions by using phrases such as, "did I get that right?".
Student Revoicing	This move is similar to the revoicing move described above except that students are asked to do the revoicing. It requires that students listen to each other and *gives them opportunities to revoice their classmates mathematical ideas in their own words*.
Probing	Probing a student's thinking is about following up with an individual student's solution, strategy, or question. The goal is *to have the student elaborate on their ideas*. Probing may stem from a teacher's genuine desire to know more about the student's thinking, or it could be used to make a student's thinking explicit for the benefit of other students.
Connecting	The goal of connecting is to *create opportunities for students to hear and engage other's mathematical reasoning*. One form of this move might be to ask students to add on to or revise another student's explanation or conjecture.

These discourse moves are useful in all talk formats (e.g. whole class discussion, small group discussion, partner talk). Most importantly, research has shown that teachers that use these moves have been able to create classroom cultures of respect and risk, so that all students might feel safe to make their mathematical ideas public for both the teacher and their classmates (Michaels & O'Connor, 2013).

SUGGESTIONS FOR INSTRUCTION

Based on their research with secondary math teachers, Manouchehri and Lapp (2003) offer several metacognitive strategies you can use as you engage with your students using purposeful questions. Consider the following questions as you plan your lesson and engage with your students in mathematics:

- What do I want students to know at the end of this lesson or unit, and how will I know whether they really know it?
- How does this new concept relate to previous concepts the class has discussed, and how do I assess whether the students realize the connections?
- What are some misconceptions about the concept that I am teaching, and how can I determine whether my students have these misconceptions?
- If my goal is to gauge differences in student's understanding of this concept, what questions should I ask them?
- What should I ask to help students focus on similarities and differences among various methods and techniques?
- What questions can I ask that will allow me to determine whether students can use the procedure in context? How do I determine whether they can use the procedure in a novel situation without explicitly telling them?
- How should I phrase the question to meet the needs of various learners? (Manouchehri & Lapp, 2003, p. 565)

References

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