The Art (and Science) of Asking Questions

By Meredith A. Park Rogers and Sandra K. Abell

"I struggle with facilitating science conversations in my classroom. Sometimes I ask a question and get only blank stares in return. How can I change my questioning to improve my students' science learning?"

Why do teachers ask questions in science class?

Questions serve as formative assessments that provide information to teachers about student learning in relation to curricular goals. For example, if a teacher wants to check to see if a student has retained a particular fact in science, she might ask a question that narrows answers down to the right one (e.g., "What gas is produced during photosynthesis?"). If a teacher wants to delve deeper to check for conceptual understanding, she might ask a question that requires higher-levels of thinking, "How do you think this little seed became that big tree? Where do you think all the extra mass came from?" (Harvard-Smithsonian Center for Astrophysics 1995). If a teacher wants to help students build conceptual understanding over time, she might tailor a series of questions that move students from recalling prior ideas, to focusing on a phenomenon, to predicting, applying, and explaining (Newton 2002).

In addition to helping students build science concepts, teacher questions can help develop scientific habits of mind. According to the National Science Education Standards, "Teachers ought to ask 'what counts?' What data do we keep? What data do we discard? What patterns exist in the data? Are these patterns appropriate for this inquiry? What explanations account for the patterns? Is one explanation better than another?" (NRC 2000, p. 18).

How do teacher questions promote student thinking in science?

The kinds of questions that teachers ask can open elementary classrooms to scientific thinking. Gallas (1995) worked with first and second graders to facilitate "science talks." She found that her open-ended questions helped spark discussion and the generation of more questions by the students. In a study of 600 elementary students in England, Newton (2002) found that children had a greater chance of understanding scientific ideas about light when they were asked a series of tailored questions that required them to reason about variables, see cause/effect relationships, and apply their understanding, than if they were asked factual questions alone. Van Zee and a group of teachers, including two primary teachers (van Zee et al. 2001), an upper elementary teacher, and a high school physics teacher studied teacher and student questioning in the science class. By examining the science talk in their own classrooms, they found that the kinds of questions teachers asked influenced the nature of student thinking. Teacher questions elicited student experiences with a phenomenon, helped students clarify their explanations and consider other points of view, and led students to make sense of their own and others' ideas. The teachers also found that "practicing silence" by refraining from asking questions helped students refine their science ideas.

What kinds of questions work best?

Elstgeest (2001) and Newton (2002) claim that the art of good questioning in science is knowing how to ask the right question at the right time. The right type of question helps students go beyond factual recall to use higher-order thinking skills as they see patterns, make predictions, evaluate evidence, and construct explanations. Elstgeest (2001) explains that the right question "asks children to show rather than to say the answer." This can be accomplished by asking *productive* questions that request students to think and do, not merely remember. The forms of productive questions Elstgeest recommends include: *attention-focusing* ("Have you seen?" or "Do you notice?"), *measuring and counting* ("How many, how long, and how often?"), *comparison* ("In what ways are these alike/different?", "How did you decide to classify these?"), *action* ("What will happen if ?"), and problem posing ("Can you find a way to?"). Newton (2002) suggests a tailored sequence of questions to help students understand a phenomenon. For example, in a study of light, the teacher might start by tapping into prior knowledge ("How does light leave a flashlight?"), move to drawing attention to significant variables ("What happens to the light as you move the flashlight closer to the wall?"), then ask students to reason causally ("Why do you think the light area gets smaller?") and to apply their thinking to a new situation ("Why might a driver not see a deer in front of the car?").

How can you become a better questioner?

In addition to knowing which questions to ask, there is also an art to delivery modes that engage a majority of students and get them thinking. Tobin, Tippins, and Gallard (1994) reviewed many research studies and found overwhelming evidence that giving appropriate wait time after asking questions can promote higher-level thinking and get more students involved in answering. Using the ideas from the research cited in this column, here are a few key steps toward becoming a better questioner.

- Consider your learning outcomes for the science lesson and think about the *right* kind of question to help you reach those outcomes.
- Practice asking *productive* questions that are *tailored* to promote higher levels of thinking.
- Create opportunities for students to ask their own scientific questions by asking more open-ended questions.
- Ask students to answer questions in their notebooks or small groups to give more students a chance to respond.
- Practice wait time and silence.

Adding these steps to your science teaching repertoire will lead to the kind of communication the National Science Education Standards recommend for inquiry-based science classrooms (NRC 2000). Doing so will involve students in higher levels of thinking that have been shown to improve science learning (Treagust 2007).

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