Inquiry Practice: Questions

Questioning in science

Common misunderstandings: You can do inquiry about anything. All questions are good science inquiry questions.

When scientists talk about questions, they are referring to a very different type of question than those typically asked in school. In school, teachers ask questions that they know the answer to and that they expect their students to be able to answer. Scientists, in contrast, do not know the answers to the questions they ask. These puzzling questions guide their work in developing increasingly better answers to a continually growing list of questions. Thinking about the kinds of questions that scientists pursue in their research can help us think about good questions for students to pursue in school.

What is a good scientific inquiry question?

First, it is true that you can inquire about anything, but you cannot do scientific inquiry about just anything. Scientific questions focus only on events in the natural world (and not the spiritual world, for example). The questions are about objects, organisms, and patterns and they are questions that can be answered through empirical investigations that allow data to drive the explanations.

Consistent with the National Science Education Standards (1996) and Hammer & van Zee (2006) definitions of scientific inquiry you read about in the Introduction folder, good science questions seek an explanation or mechanism for something that can be observed either directly or indirectly. Of course, scientific questions that seek to describe or to identify patterns, and not to explain, are also important in science, especially in certain areas of inquiry and in the beginning phases of some fields. The first questions studied after the discovery of long-buried skeletal remains or a new species of plant in the Amazon, for example, typically ask for descriptions of what has been found rather explanations of how the remains fit with evolutionary theory or how the newly-found plant interacts in its ecosystem. But the questions that are at the core of science seek out explanations—they go beyond asking what is this and ask the more challenging why and how questions.

There are many questions that meet these basic criteria—they are about the natural world, they can be answered through some kind of empirical investigation, and they are seeking explanations. But still, some questions are better than others. Scientists carefully select from many possible questions to pursue in their work. They choose questions that show the most promise in terms of pushing forward scientific understanding in a given area of research and questions that are possible for them to study in a meaningful way, given their resources. To secure funding for their work, they must develop a strong argument to support the importance of the question they have chosen.

1 Empirical means dependent on evidence or consequences that are observable by the senses.
Implications for inquiry science teaching

Common misunderstandings
- All questions are good science inquiry questions.
- You’re not really doing inquiry science teaching unless the students are generating and pursuing their own questions.

In thinking about the science questions in K–8 classrooms, there are two main issues to consider:
1. What makes for high quality inquiry questions in the science classroom?
2. Who should generate the inquiry questions?

1. What makes for high quality inquiry questions in the science classrooms?

High quality questions for use in inquiry science teaching should first meet the criteria for good scientific questions. That is, they should be about the natural world and they should be answerable through empirical investigations. The best questions for science inquiry also seek an explanation of something in the natural world, rather than simply a description. Although descriptive inquiries can be interesting and informative, they do not give students the opportunity to practice building explanations from evidence—the core of scientific inquiry. Although many educators believe that younger students should focus primarily on descriptive work, there is growing evidence that even very young students are capable of doing explanatory work (Kuhn & Dean, 2005; Lehrer & Schauble, 2005; Metz, 2004; National Research Council, 2007; Warren, Rosebery, & Conant, 1994).

Good inquiry questions enable students to work on developing a key idea in science while also using and learning about scientific inquiry practices. They challenge students to move beyond what they already know from personal knowledge and experience, and they hold promise for helping students use and develop scientific practices and reasoning in the pursuit of an important, key conceptual understanding. The conceptual idea and the scientific reasoning required to investigate it are challenging yet attainable for the particular grade level of students. If students can answer the question prior to investigating, the question will not be productive for student learning or of interest to students. The goal is to find a question that will generate a variety of student responses prior to investigating. Look for a question that will immediately stimulate a lively student discussion with different points of view and different modes of reasoning.

Ideally, inquiry questions are closely linked to subjects of high interest and meaning to students. Sometimes the questions can come from the students themselves, and this will likely make them of high interest to students. But more often, you as the teacher will select the subjects of inquiry. To do this, look at the various standards required by your state or district, and pick one that will lend itself to inquiry in the classroom. Keep in mind that not all standards can or should be taught through an inquiry process; in fact, the realities of time and curriculum requirements will make this an impossible goal. Next look for inquiry questions that are closely matched to the selected learning goal—that is, investigating this question will help students understand the learning goal. If you find an interesting question that will be fun to investigate but it doesn’t match the learning goal or standard, throw it out (or change your learning goal)!
Examples of two types of science inquiry questions

<table>
<thead>
<tr>
<th>Examples of description-seeking questions</th>
<th>Examples of explanation-seeking questions</th>
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<tbody>
<tr>
<td>How does a seed grow?</td>
<td>How does a seed get the food it needs to grow?</td>
</tr>
<tr>
<td>Which ball will bounce the highest?</td>
<td>Why does the tennis ball bounce higher than the handball?</td>
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<tr>
<td>What kinds of things float?</td>
<td>Why do some things float and some sink?</td>
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</tbody>
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In sum, high-quality questions for inquiry science teaching:
- are about the natural world
- can be answered through empirical investigations within the limitations posed by classroom time, space, and resources
- seek explanation rather than simply description
- are closely matched to a standard or learning goal
- are productive in terms of student learning about scientific inquiry practices
- are productive in terms of student learning about an important science concept
  - students can’t answer the question before investigating
  - students have lots of ideas about the question before investigating
- tap into students’ personal experience, interest, or imagination

2. Who should generate the science inquiry questions?

Some teachers get the impression that “true inquiry teaching occurs only when students generate and pursue their own questions” (National Research Council, 2000 p. 36). While it is important that students get some opportunities to practice generating and investigating their own questions, the more important issue is the quality of the question that is being investigated. For example, if you want students to develop certain science ideas from their inquiries, you need to choose a question that will support that learning. It is not likely to emerge from student-generated questions. Teachers should be on the lookout for appropriate places to investigate questions generated by students, but should also recognize that it is likely that many inquiry questions will need to come from the teacher or the curriculum materials.

There are many special challenges when using student-generated inquiry questions. While the questions may be of high interest to the students, they may be of less interest scientifically and they may end up being less interesting to pursue than those planned by the teacher or curriculum materials. It is important to listen to children’s questions, to be selective about which questions are worth instructional time to pursue, and to help children improve the quality of their questions. In addition, a question of interest to one student may not be of interest to another student. Will you let each student pursue his/her individual question? If so, how will you manage the demands that will put on you in supporting each student’s unique investigation? How will you manage the different materials needed for each inquiry? If you select one student question for the class to investigate together, how will you make the question of interest to everyone?
EXAMPLES OF STUDENT- AND TEACHER-GENERATED INQUIRY QUESTIONS

Angie Putz (Lehrer, Carpenter, Schauble, & Putz, 2000) asked her first graders to bring in apples, which they used to describe the variety of colors and shapes. But one student noticed that apples change colors as they ripen. Ms. Putz asked how that might happen, and students suggested that the sun might be the cause. Ms. Putz then asked students if they could think of a way to test out their idea about the sun and the apples. This led to a year-long exploration of decomposition, generated by observations from students.

Kathy Roth taught a unit about photosynthesis to her fifth graders (Roth, 2002). The inquiry question was “How do plants get their food?” The class engaged in a number of plant-growing experiments and activities to get evidence to address this question. The question and the activities were designed by the teacher, but as a result of these investigations the students began to generate their own related questions. Ms. Roth communicated the value of these questions by having students record them in a class Question Notebook. When their questions could be answered by simple investigations (and when there was sufficient class time), she provided the materials and time for students to carry out these investigations. For example, in one of the experiments that Ms. Roth had presented to students, they found out that the seed embryo by itself will not grow when placed on a wet paper towel. Instead of generalizing that the seed embryo will not grow if it is attached to the rest of the seed, the students asked “Will the seed embryo grow if you put it in soil (and give it water)?” Ms. Roth saw this as a great question and a way to further explore their naïve idea that the soil provides food for the plant. So the class repeated the entire experiment using soil instead of paper towels.

References


