Questions are powerful tools that are central to scientific inquiry. Learning how to generate investigable questions—those that can be answered through empirical investigations—is identified as an important skill for all K–8 students (NRC 1996).

However, many of the questions students ask are not investigable questions that lend themselves to practical investigations (e.g., “Why does a mealworm become a beetle?”). A noninvestigable question does not lead students to collect data or firsthand evidence that will answer the question. Alternatively, students can answer an investigable question through systematic observations and interpretation of their data (e.g., “When do mealworms look like beetles?” “What does a mealworm look like before it begins to look like a beetle?” and “Do all worms become beetles?”).

Given the importance of investigable questions to scientific inquiry, what can teachers do to help students learn how to generate them? Possibilities I explore in this article are (a) demonstrating to students that we value their questions, (b) providing students with opportunities to explore natural phenomena, (c) modeling asking investigable questions and providing examples of question stems, and (d) providing explicit practice identifying and refining questions.

Valuing Their Questions

Explcitly inviting students to raise questions in class and offering them positive reinforcement when they do helps create a question-asking culture in the classroom. Harlen and Qualter (2009) identified several types of questions that children ask:

1. Those that cannot be answered by science (e.g., metaphysical or philosophical questions);
2. Those that teachers do not know the answers to and are too complex for children to understand even if the answer were explained to them; and
3. Those that are simple requests for facts or definitions.

In Figure 1, I present Harlen and Qualter’s (2009) suggestions on how to deal with children’s different questions that I have found helpful.
Because we encourage students to record ideas we consider important, providing them with multiple methods for recording their questions is another practice that demonstrates to students that we value their questions. Question boxes strategically placed in a science center provide an easy way to obtain students’ questions, and because they can be anonymous, the boxes can capture a wider range of questions. A “Questions to Investigate” board that students are encouraged to contribute to provides a record of students’ questions visible to all members of the classroom. Science notebooks provide students with a more private and personal record of their questions that they can refer to throughout the year and use to design independent or small-group investigations.

Natural Phenomena

Providing students with opportunities to explore a wide range of natural phenomena can stimulate their curiosity and inspire them to raise questions. For example, before a unit on plants, students can go on a nature hike, science journals in hand, and choose one or two plants to observe and record their observations. Examples of other topics commonly covered in the elementary curriculum that easily lend themselves to student exploration and observations include (a) characteristics and changes in animals, (b) everyday structures and movement, (c) properties of liquids and solids and rocks and minerals, (d) light and sound, and (e) daily and seasonal changes.

At the beginning of the year, encourage students to generate questions through a range of simple strategies:

- Invite students to make observations and then record questions that emerge from their observations. Some teachers ask students to form two columns in their science notebook; one with the heading, “Observations,” and the other “Questions…” or “I notice” and “I wonder….”
- Elstgeest (2001) suggested asking attention-focusing questions such as “What do you notice about…?” to encourage students to make qualitative observations (e.g., shape, color, behavior) and “How many/long/often…?” to invite students to make quantitative observations.

Figure 1.

Helpful suggestions from Harlen and Qualter (2009) on how to handle students’ questions.

Philosophical questions
(e.g., Why do we have animals?)
Validate student’s question by acknowledging how interesting it is and pointing out that this is not a question that scientists can answer. This helps children begin to appreciate that science has limits; there are questions that scientists do not have the tools to answer.

Complex questions
(e.g., Why does the magnet stick to the nail?)
Turn the questions into related investigable questions by identifying variables you think may be relevant. In the above example, two variables involved include (a) the magnet and (b) the material the nail is made from. This is what Harlen and Qualter (2009) refer to as a variable scan.

Model turning students’ “Why” question into “What would happen if” questions that involve changing one of the variables at a time. You can point out to the student that you are doing this because you want to think of things you can do to learn more.

For example, by changing the first variable (various characteristics of the magnet) one might come up with the following questions:

- What would happen if we put another object/metal close to the nail?
- What would happen if we put a small magnet close to the nail?
- What would happen if we put a magnet covered with masking tape close to the nail?

By changing the second variable (material the nail is made from) one might come up with the following questions:

- What would happen if we put a plastic nail close to the magnet?
- What would happen if we put paper next to the magnet?
- What would happen if we put a wet nail close to the magnet?

These questions model asking questions that lead to developmentally appropriate practical investigations and ones which broaden a child’s understanding of factors that affect how magnets interact with different materials.

Questions requesting facts, names, etc.
(e.g., What is the name of this animal?)
Depending on the context, either encourage the student to find the answer in appropriate reference material or tell the student the answer.
Modeling and Question Stems

The questions we ask serve as models for our students. Students will develop a feel for what an investigable question sounds like when they hear a variety of investigable questions modeled for them by teachers. Krajcik, Czerniak, and Berger (1999) identified three categories of investigable questions: descriptive, relational, and cause–effect. Figure 2 outlines examples of each and possible question stems that can function as scaffolds for students new to posing investigable questions. Tell students that they should not feel restricted by these or other question stems because it is difficult, if not impossible, to create question stems that cover all possibilities and that are exclusive to each category.

Although modeling for students the skill of posing investigable questions can take place throughout a unit of study, I find the beginning of a unit a particularly good time to strategically model this skill. After exploring material related to the unit and recording observations and questions in their science notebooks, I invite students to share their ideas with the class. At this time, I take the opportunity to contribute some of my own questions—descriptive, relational, and cause–effect questions. Once students have experience hearing the teacher’s model turning complex questions into testable or investigable questions, they can be provided with the opportunity to practice doing the same. For primary students or those with limited experience asking investigable questions, teachers will likely need to provide more guidance or scaffolding and guide students through the process of writing good questions in small groups or with the entire class. Upper elementary students or those with more experience can be given a worksheet with a series of questions in nontestable form and in an adjacent column, one or two possible relevant variables they can use to

Figure 2.

Three types of investigable questions.

1. **Descriptive Questions:** Produce qualitative or quantitative description of an object, material, organism, or event.

   **Examples of possible question stems:**
   - What are the characteristics of ______?
   - How many...? How often ..? How much...?
   - What happens when ____________? (natural context implied; change not imposed)
   - What happens if _______? (when you change something).

   **Examples of descriptive questions:**
   - What kind of food do birds eat?
   - Does brown sugar dissolve in water?
   - What happens to leaves of maple trees when it snows?

2. **Relational Questions:** Identify associations between the characteristics of different phenomena. These can include:
   - Identification and classification questions: identify phenomena and put them into meaningful groups;
   - Focused comparison questions: rank a group of materials based on a specific characteristic; and
   - Correlational questions: examine the extent that the presence of one variable is related to that of another variable (do not confirm cause-effect relationship).

   **Examples of possible question stems:**
   - How are _____ similar/different to ___________?
   - How can these _______be organized into groups?
   - Which _____ (material/organism/etc.) is the most ______ (absorbent/strongest/best conductor/etc.)?
   - How is ______ related to ________?

   **Examples of relational questions:**
   - Is it easier to generate static electricity in a dry or humid room?
   - Which material is more absorbent?
   - How are these leaves similar and how are they different?
   - How is the height of a plant related to the number of leaves? Do taller plants have more leaves?

3. **Cause–effect questions:** Determine whether one or more variables cause or affect one or more outcome variables.

   **Examples of possible question stems:**
   - Does _____ cause/affect ______?
   - How does _______ affect_______?

   **Example of cause–effect questions:**
   - Does sunlight affect the growth of a plant?
   - How does temperature affect the rate at which salt dissolves in water?
produce a testable question. These variables can provide students with the necessary scaffolding they need until they develop the ability and confidence to independently identify variables that lead to good, testable questions. In the example below, the noninvestigable question (preferably taken from a list generated by the class or by students) is provided for students on the worksheet alongside the variables, temperature, and surface texture. Students are then encouraged to use the variables to write a question that could lead to empirical investigations. For example, for the question “Why do mealworms move so slowly?” students could be asked to consider the variables of temperature (At what temperature do mealworms move more slowly?) or surface (Do mealworms move more slowly on smooth or rough surfaces?).

**Identifying and Refining Questions**

Developing investigable questions is a skill that requires practice. Upper elementary students can benefit from classifying different questions written on index cards based on (a) whether they are investigable and (b) the type of investigable question. Provide students with a chance to independently and in small groups practice refining their questions or converting them into good investigable questions (e.g., the variable scan described in Figure 1). Challenge students to come up with two or three investigable questions related to a noninvestigable question they choose or pick out of a bag (e.g., Why does snow melt? Why do leaves fall off trees in the fall? Where do shadows come from?).

Although it may be more familiar for students to work on questions stemming from units they have already covered, students also enjoy working on questions listed on the class Questions to Investigate board to which they contributed. Students can also generate, with teacher guidance, a list of good criteria that they can use to evaluate their investigable questions (Figure 3).

**Achieving Awareness**

By encouraging students to raise all kinds of questions and modeling good questioning skills in science class, we demonstrate to students how important questions are to scientific inquiry. And by asking students to refine and evaluate their questions, we promote the idea that asking good science investigation questions is a skill that requires careful thinking and editing and is a process—not something they should expect to accomplish instantaneously. Hopefully, this awareness will help students persist in their quest to improve their scientific-questioning skills.

**References**


**Connecting to the Standards**

This article relates to the following *National Science Education Standards* (NRC 1996):

**Content Standards**

**Grades K–4**

**Standard A: Science as Inquiry**

- Abilities necessary to do scientific inquiry


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