Inquiry, Science Workshop Style

A model for spurring inquiry in primary students

By Daniel Heuser
Dinnertime at my house renews my belief in the power of scientific inquiry. My five- and seven-year-olds pepper us with questions from appetizers through dessert: What's in hot dogs? How did they make this table? If I put catsup in milk would it turn red?

Few people are more curious about their worlds than young children. Why, then, do so many science lessons begin with questions supplied by adults rather than kids? In many published programs, lessons revolve around set questions, with step-by-step directions provided for children to follow. This approach seems to say that young children are not yet ready for inquiry.

An alternate approach is to capitalize on children's curiosity by letting them ask and answer their own questions. Since birth, children have been engaged in their own brands of inquiry. Therefore, letting students run their own investigations in the classroom lets them continue this natural development. Inquiry in this approach is more holistic and helps children refine their natural inquiry abilities. This view is at the heart of an instructional model I call the science workshop.

Science Workshop
Science workshop inquiry is designed to help children learn science concepts at the same time they are refining their inquiry abilities. Three elements support primary-aged children:

• Students get considerable choice in the questions and procedures of their investigations. This helps ensure that each will be motivated to learn and that the investigations make sense to them.
• Students are given adequate hands-on experiences. Hands-on work, like choice, is a tremendous motivator, and it also helps children generate worthwhile questions.
• Students' firsthand experiences are accompanied by discussion and writing that help process their thoughts from the investigations.

Each workshop consists of a minilesson, a time for student activity, and a period for reflection. The minilesson is a time for the teacher to spur interest and prior knowledge in the workshop topic, to explain the activity, and to go over safety issues so that the activity period goes smoothly.

During the activity period students are either working hands-on or are involved in discussion. The teacher's roles during the activity period include questioning, observing, and assessing students, as well as monitoring the activity so that the classroom is safe and orderly.

In the reflection period, students build knowledge from their activities by talking and/or writing.

Workshops are arranged in three phases: exploration, investigation, and reflection (Figure 1), and there are several workshops completed in each phase.

The following vignettes from my first- and second-grade multiage classroom illustrate how science workshop inquiry works. During these and other workshops I used a rubric to help me assess what students were learning from the hands-on activities (Figure 2, page 34).

Exploration: Digging into Seeds
In this inquiry students are learning about living things through the study of seeds. Today's workshop is the third and last in the exploration phase for this inquiry. In the two prior workshops, the students went outside and hunted for seeds to collect from our school garden and then dissected, examined, and sketched lima bean seeds. These beginning activities helped to generate excitement and background knowledge about plants so that students are able to ask worthwhile questions.

In today's minilesson I show the class a lima bean, asking: "If you wanted this seed to grow into a lima bean plant, what would you have to do with it? Let's make a list of the things that this seed needs..."
Rubric for assessing hands-on activities.

In this workshop, students collected seeds from our school garden to help them think about where seeds come from and what they look like. I used the following rubric to assess and guide student learning.

Student shows evidence of...

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<thead>
<tr>
<th>Level</th>
<th>Content</th>
<th>Examples</th>
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| **4**  | Understanding of observable characteristics or phenomena from the activity AND In-depth understanding of scientific "big ideas" behind the activity by including TWO OR MORE other pertinent comments (explanation, application, generalization, or justification) | “There are so many seeds out here!”  
“I didn’t know you can get seeds from plants.”  
“Look at these seeds. I got them from that plant!”  
Explanation  
• “Plants need seeds to make new plants.”  
• “This seed is different than this one because their plants are different.”  
Application  
• “If plants didn’t have seeds they would all die out.”  
• “Did you know that we eat seeds? Like corn and sunflower seeds!”  
Generalization  
• “I think that all plants must have seeds.”  
• “Seeds all grow from the fruit and flower.”  
• “Seeds are all different shapes.”  
Justification  
• “I know that these are seeds because I’ve planted them before.”  
• “Plants have to have seeds or there wouldn’t be any new plants!” |
| **3**  | Understanding of observable characteristics or phenomena from the activity AND Understanding of scientific “big ideas” behind the activity by including ONLY ONE other pertinent comment (explanation, application, generalization or justification) | “There are so many seeds out here!”  
“I didn’t know you can get seeds from plants.”  
“Look at these seeds. I got them from that plant!”  
(See above) |
| **2**  | Understanding of observable characteristics or phenomena from the activity | “There are so many seeds out here!”  
“I didn’t know you can get seeds from plants.”  
“Look at these seeds. I got them from that plant!” |
| **1**  | Little or no understanding of observable characteristics or phenomena from the activity. | “There aren’t any seeds out here!”  
“These seeds won’t grow. Real seeds come from the store.” |
in order to sprout." Students quickly volunteer that the seed would have to be planted in soil, that it would need to be kept watered, and that it should be kept by the window to get some light. "What about temperature?" I ask. "It will be pretty warm by the window," replies one child. "Seeds need to be warm to grow."

With those four conditions on the board, I ask if seeds really need these conditions, or could others do in their place? The previous year the second graders had inquired into "watering" plants with different liquids (Heuser 2002), so some suggested that other liquids might work in place of water. A boy reported that he once saw a weed growing out of a crack in the sidewalk, so maybe soil wasn't necessary. Could seeds sprout in sand, or in water, ask others?

I write the guiding question on the board, "What does a seed need to sprout?" This helps focus questions on the important curriculum. Then I take new suggestions. "Would a seed sprout in moving water, like under a waterfall?" another child asks. Soon, we have a whole list of questions about different sprouting conditions.

The prompt for the reflection period today is, "Choose three questions that interest you and write them down." Just as it is difficult for a child to learn when he is not interested, it's rare for a child to not be excited and engaged when he is allowed to follow his own curiosities. Students eagerly share their questions with their neighbors. Then they write them in their learning logs as I walk around and help. Later I will review their selections, pairing children who chose the same question and concentrating on those questions that are most likely to lead to significant learning about living things.

**Designing, Doing, and Presenting**

In the first workshop of this phase, teams of students who had chosen the same question planned how their question could be answered. They showed me their procedure using drawings and words, and I used the plans to gather each team's materials. Students performed their investigations in the phase's second workshop. Several parents were on hand to help as they eagerly planted their seeds in different conditions, such as in the freezer, in the dark, and under running water (we used an aquarium pump to make a miniature waterfall). Over the next week we had no formal workshops, but students checked on their seeds every chance they got.

Today is the day students present the results of their investigations. During the minilesson I set some ground rules: We are there to learn as much from our classmates as we can, and because an important part of science is presenting and discussing findings, students are encouraged to ask for clarification or to discuss the presenters' methods and conclusions following each presentation.

A spirited discussion soon begins. The team that had planted their seed in dry soil reported their seed had not sprouted and pronounced that that means that seeds need water to grow. A child from another team quickly disagrees. "We didn't give our seed water, we gave it cola, but it still sprouted," she says. "So seeds don't need water to sprout." Here it is tempting to guide students—But cola is made out of water!—but no child volunteers this, so I let the debate continue. I know that teacher comments such as this tend to end a conversation (and thinking), so I let the children continue to exercise their inquiry skills by synthesizing their present knowledge with the results of their inquiries to form scientific explanations. These presentations take a long time, but this is how inquiry is perfected. These children expect to share, debate, and negotiate conclusions—that is, to inquire.

After the presentations, I have students reflect by writing the answer to their personal investigation question in their log ("Seeds cannot grow in a freezer") and to make a conjecture about why ("It is too cold and the seed gets hard like an ice cube"). Would a botanist give this same explanation as to why seeds can't sprout in a freezer? No. This understanding is good for this child at this point in time; it will be refined through maturity and further experience. This is how children build understanding.

It is important to note, however, that this does not mean that "anything goes." Children are expected to learn the most important science concepts, and inquiry is an excellent way for them to do this. However, children are individuals, and each child will develop understandings that vary in emphasis and sophistication and that reflect individual experiences, intellect, and interests.

Children do, however, draw conclusions that are grossly inaccurate from time to time. These are often cleared up during the reflection phase.

**Reflection: What Did We Learn?**

This phase will include two workshops. Today is the first, and we will be busy discussing our investigations. The main purpose of these discussions is to synthesize students' individual knowledge around the larger concepts of the unit. One of my roles is that of facilitator, keeping the discussion focused on two prompts that I think will help children learn the important concepts.
Connecting to the Standards

This article addresses the following National Science Education Standards (NRC 1996):

Content Standards
Standard A: Science as Inquiry
Grades K–4
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Science Teaching Standards
Standard A:
Teachers of science plan an inquiry-based program for their students

mind a limitation of our investigations: we studied only pea seeds. "Do you think all seeds will sprout in the refrigerator? Think about a banana seed—bananas only grow in places that are always warm." A new flurry of discussion centers on different types of seeds.

After much fine-tuning, we eventually agree on this statement about the first prompt: "Pea seeds need different things to sprout. They need some kind of liquid like water or tea. The temperature has to be warmer than freezing. We think that they might sprout faster when it is warm, but we didn't test that out so we don't know for sure. They can sprout in soil and light, but they don’t need them. Seeds from different plants probably need different things to sprout."

Students will conclude this inquiry tomorrow, extending the knowledge gained through their investigations by conducting library research.

So, Who's Ready for Inquiry?

How do children learn about their worlds before they go to school? Their sense-making processes seem naive and incomplete to adults. Yet, they are the first steps on a continuum to inquiry as described in the National Science Education Standards: “asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments” (NRC 1996, p.105). Why not let children continue this development in school science?

From this perspective, no one—short of professional adult scientists—is more ready for inquiry than young children. Science workshop helps children build on their informal yet considerable inquiry expertise. Choice motivates as children select their own questions and their own way of answering them. Students construct their own knowledge as hands-on investigations are supported by reflection. Through the science workshop, children perfect their inquiry abilities by doing inquiry.

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Resources