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Five Strategies to Support all Teachers: Suggestions to Get Off the Slippery Slope of "Cookbook" Science Teaching

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[ILLUSTRATION OMITTED]

Many teachers shudder at the thought of implementing an inquiry curriculum. Perhaps they envision a rowdy classroom with little learning. Maybe they wonder, "How will this connect to all the standards?" Fortunately, these legitimate concerns can be addressed, and all students can engage in thoughtfully constructed inquiry science experiences. In this article, we outline five strategies that we have used with elementary school teachers as they moved from a "cookbook" approach in science to an approach that is inquiry-based. Having presented these five strategies in a linear format, we know that on the surface this may seem close to the slippery slope of cookbook science teaching, but we also know that thoughtful practitioners working in classrooms across the country will see these strategies as interactive, overlapping, and nonsequential.

What Is Inquiry?

As teacher educators who consistently work with pre-service and inservice elementary teachers, we have found that it helps to clarify inquiry before looking more closely at specific cases of inquiry-based teaching. Because inquiry has been defined in many different ways (e.g., Banchi and Bell 2008; Martin-Hansen 2002; Settlage 2007), teachers can quickly become overwhelmed and frustrated. We use the National Science Education Standards as a guide (NRC 1996). The NRC describes inquiry "as a step beyond the process skills," (p. 105) in which content, process, and reasoning are synthesized as a way for students to learn. Although this definition can be helpful, it does not offer concrete suggestions for how to engage students in these kinds of experiences--let alone how to make the jump to open inquiry.

Because of this, we align ourselves closely with those who write about an inquiry continuum (e.g., Ansberry and Morgan 2007; Banchi and Bell 2008). An inquiry continuum assists teachers in envisioning the many types of experiences they can provide for their students. Typically, the continuum consists of three levels of inquiry: structured inquiry, guided inquiry, and open inquiry. Structured inquiry consists of teacher-generated questions that students explore through predefined procedures. This type of inquiry is typically used as a transition for teachers and students as they begin to move away from more traditional forms of teaching and learning in the science classroom. As they become more comfortable with inquiry-based teaching and learning, teachers and students engage in more collaborative inquiry processes. Guided inquiry provides teachers and students with opportunities to work together to define questions for study and the procedures for exploring those questions. In open inquiry situations, the learners typically formulate their own questions, develop the procedures for collecting evidence, and define the ways in which the data will be analyzed to answer the questions under study. We have seen each type of inquiry in the classrooms we have visited, and we believe that teachers all over the country are effectively using each type of inquiry in their classrooms (see Figure 1 in the Guest Editorial on p. 9).

To investigate quality teaching practices, we started by asking some general questions: What kinds of activities encourage reasoning and synthesizing? How do we include process skills and content? In our work with elementary teachers we have tried to answer these questions by identifying strategies that support learning while considering student choice and decision making, each a central tenet of inquiry-based teaching. For us, inquiry experiences allow students to develop rich questions, to take lead roles in decision making, and offer opportunities for physical and mental messing around (Hawkins 1965), all as a way of making sense of the natural world.

Strategy 1: Use "Thinking Starters"

In some cases it is feasible for teachers to solicit topics for investigations from students at the beginning of a unit of study. However, in most cases, teachers are asked to teach certain standards as part of their required curriculum. This requirement need not force a teacher to abandon an inquiry approach. As described, a structured inquiry approach is often a feasible starting point for many teachers and their students. The first strategy we recommend encourages students to ask questions, work with physical materials, and become devoted to an investigation in order to collect evidence that will allow them to reason through the possible answers to the questions they are pursuing. Although a more traditional activity may carefully list steps to follow, a thinking starter activity should be intentionally open-ended and encourage students to generate questions about the topic under study. In this way, even if the teacher has preselected the topic, then students are given an opportunity to share ideas, generate questions, and develop ownership in the investigations to come.

Strategy 2: Listen to Children's Ideas

To facilitate inquiry, it is critical to identify children's thinking and encourage them to share their ideas. When a teacher better understands her students' thinking and ideas, she is better able to develop experiences that will resonate with the children. We suggest two highly successful ways for teachers to hear children's ideas. One is through listening in on small-group discussions. The other is by recording whole-class discussions in which students share ideas from the work in which they have been engaged. Although it may take time for children to get the hang of a whole-class discussion, it has been our experience that once they become comfortable, they relish the opportunity to share. Obviously, it will take time to build this culture of sharing, but teachers with whom we have worked have shown great persistence. In doing so, they have been able to dismantle some of the children's beliefs about "how we do school." When possible, a circular sitting arrangement--with the teacher as part of the circle--works well.

A first-grade teacher that we worked with routinely used the science circle to listen to her students discuss their ideas. During one robust discussion the class was wondering how the pond behind its school was formed. Students had already made many observations at the pond. They had generated topics of interest based on these observations and researched to find out more information. As a result of these investigations, the question "Where did the pond come from?" emerged. The children brainstormed ideas to find out. These ideas included: researching text sources, making more observations, and asking experts. Ultimately, the children asked the principal (an "expert" who the children viewed as knowing the history of the school well) to share his expertise about the history of the pond. By listening to her students' questions and thoughts, and by providing a space for those discussions to occur, the teacher was able to successfully support her children.

Strategy 3: Use Standards as a Guide

Teachers, often under intense pressure to cover the standards, can get trapped in a mentality of squeezing in content. This can result in step-by-step activities that often lack student input and leave little space for student reasoning and questioning. We have found that children's ideas often connect to big ideas that are part of most state standards.

For example, an inquiry investigation using worms as a thinking starter encouraged students to generate many complex questions (see Thinking Starters on p. 36) that connected with the state standard of interdependence. Keeping an expert ear open to the questions that students were developing, the teacher was able to connect strongly to the standards without sacrificing student input or reasoning. Supported by the strategies, students developed questions such as, "How does the anatomy of a worm affect soil?" and "How are other animals living in the soil impacted by the worms?"

Strategy 4: Develop Complex Questions

In one classroom that we visited, students were asked to examine Pop Rocks candy and to document things that they noticed that were interesting to them. At first the questions that the students developed were pretty basic, such as "Who invented them?" and "What year did they come out?" But after mixing the Pop Rocks with water, students began to notice additional things and generated questions such as: "Why do they pop?" "Do they pop in other liquids?" and "Why do they sound like Rice Krispies?" These questions prompted the teacher to focus on the popping component of the candy and the students began an inquiry that helped them make sense of the carbon dioxide in the candy (by investigating the packaging in more detail and generating even more questions) and the pressure necessary to create the candy in the first place. If the teacher had stopped the children after the first round of questions were developed, the inquiry would not have become as complex. Instead the teacher continued to supply materials for further investigation (water, oil, Rice Krispies) and the students were able to develop questions around the chemistry of the candy.

Strategy 5: Document and Reflect

When teachers want to engage students in thinking beyond the facts, they often struggle. It is all too easy to fall back on predetermined lessons that ask students to fill in the blank. Even when thinking starters are used, teachers and students can get stuck determining how to make sense of all the different ideas that students might have. Teachers may wonder, "How do these seemingly disconnected ideas come together to help a child understand?" We have found that documentation (using science notebooks or specific prompts) and reflection (through writing, talking, and drawing) are critical. Most important, documentation honors the ideas that children have and allows them to return to these ideas over again. Strong documentation skills teach children to listen carefully and to find multiple ways to capture ideas that they and others put forth. Reflection further supports learning as teachers revisit students' ideas and ask them to think deeply about them as they work to identify connections that make sense.

In another classroom we visited, the teacher engaged his fifth graders in a unit on oceans--a state standard he was expected to cover as a fifth-grade science teacher. Because no oceans were readily available for the students to explore, the teacher encouraged the children to examine the school's pond. The class devised a tool to measure the depth of the pond. The classroom teacher collected the measurement data for the students using the student-designed tool. Using this data, students created 2-D and 3-D representations of the pond. Intrigued by their documentation, the teacher in charge of maintaining the school's outdoor lab (where the pond was located) alerted the class that they had "rescued the fish." The winter months were approaching. Based on the children's measurements, the water was not deep enough to sustain life underneath the sheet of ice. Because of their documentation, students and teachers were able to reflect on the situation, devise a solution, and continue the inquiry cycle.

Conclusion

It is our hope that teachers will see these five strategies not as a recipe to be followed, but rather, as suggestions to explore, discuss with colleagues, and inspire experimentation. This flexibility requires teachers to know their students, understand the broader ideas within the field of science, and to constantly assess the teaching and learning taking place in the classroom.

Teachers who engage their students in successful inquiry projects are deliberate in their planning, in their listening and questioning, and in the pursuit of resources that will support their children's inquiry projects. We look forward to the day when the cookbooks are replaced by the ideas, questions, and inquiries of the creative individuals in classrooms across the country.

Thinking Starters

In one fourth-grade classroom the teacher wanted to start an inquiry unit on composting. As a way to generate questions, she developed a thinking starter that asked the children to make observations while looking at a small teacher-created compost bin. The children generated many questions and were able to develop a two-month-long study that far exceeded the teacher's expectations. In this case, thinking starters were further supported by supplying the children with written or oral prompts that always included statements such as: What do you wonder about? What would you like to understand better about this? What would you do next if you could choose?

Connecting to the Standards

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

Teaching Standards

Standard A:

Teachers of science plan an inquiry-based science program for their students.

Standard B:

Teachers of science guide and facilitate learning.

Content Standards

Grades K-8

Standard A: Science as Inquiry

* Abilities necessary to do scientific inquiry

* Understanding about scientific inquiry

National Research Council (NRC). 1996. National science education standards. Washington, DC: National Academies Press.

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Banchi, H., and R. Bell. 2008. The many levels of inquiry. Science and Children 46 (2): 26-29.

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Martin-Hansen, L. 2002. Defining inquiry. The Science Teacher 69 (2): 34-37.

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Internet Resource

Learning Science Through Inquiry

www.learner.org/resources/series129.html

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