Inquiry Made Easy

You can include inquiry learning in the classroom!

By Wendy Pierce

According to the *National Science Education Standards,* all children should have the ability to do scientific inquiry by fourth grade (National Research Council 1996). They should be able to ask questions; plan and conduct simple investigations; employ simple equipment and tools to gather data; use data to construct reasonable explanations; and communicate investigations and explorations.

Several years ago, I attended the Exploratorium Institute of Inquiry through the Keystone Science and Technology Grant (a NSF local systemic change grant based in Montana). In this workshop, teachers experienced inquiry and the underlying structure involved in using inquiry in the classroom. I became convinced that using inquiry as a teaching method was valuable and that content as well as inquiry could be taught in this manner.

"Doable" Inquiry

During the 1999–2000 school year, I was a teacher on special assignment with the Keystone Grant. One of the grant's goals was to help teachers model inquiry techniques using science kits. Participating teachers had attended summer workshops that emphasized inquiry, but many were hesitant to teach an actual inquiry unit. In conversations with teachers I found their hesitancy centered around issues such as:

- Inquiry takes too much time.
- When students develop their own questions, the questions don't relate to the required curriculum.
- Teachers are uncomfortable sorting questions (Harlen 1997).
- Teachers feel unprepared to help students with difficult questions, due to a lack of background knowledge.

In general, I found that teachers were looking for more structure than an entirely open-ended inquiry. In "How to Make Lab Activities More Open Ended" (Colburn 1997), Colburn writes about varying levels of openness in instruction ranging from a level 0 (the problem, instructions, and answer are all given) to a level 3 (the problem, instructions, and answers are all open). Although I believe students should have the opportunity to experience open-ended inquiries, I understand the complexities of teaching. Approaching new teaching strategies slowly will likely create lasting science reform.

While working with classroom teachers, we developed a "doable" format for inquiry. This format emphasizes using a question wheel as a tool to help students identify independent and dependent variables that drive the underlying structure in inquiry. The format is not entirely open ended, but it allows students to ask questions driven by their own curiosity, make predictions, develop procedures, participate in experiments, collect data, and make conclusions based on evidence. This format worked particularly well in first- through fifth-grade classrooms; with a few adjustments, it can work well in middle school classrooms.

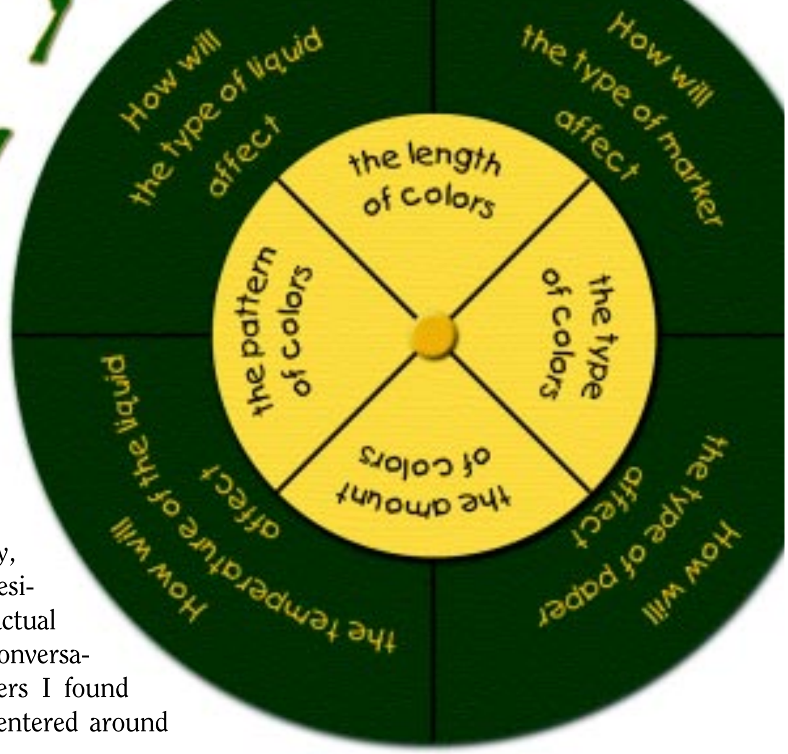

FIGURE 1. Question wheels help students formulate inquiry questions.

Steps to Inquiry

Each step takes between 45–60 minutes in a classroom. The example used throughout this article relates to a chromatography experiment, though the format can be easily adapted to suit your students' needs.

Make sure to emphasize that scientists choose questions because they are ***interested*** *in the questions.*

Day One: Developing Questions

1. Brainstorm independent and dependent variables on the board to help students generate two lists:

- The factors that we can change—the *independent variable* (e.g., types of markers, type of paper, and type of liquid)
- The factors that we can count, measure, or observe—the *dependent variable* (e.g., types of colors, length of colors, and pattern of colors)

2. Use question wheels (Figure 1, page 39) to help students devise inquiry questions. To make one, cut out two circles, one 12.5 cm and 7.5 cm, from two different-colored pieces of paper. The large (outer) circle represents the independent variable. The smaller (inner) circle represents the dependent variable. With lines, divide both circles into quarters, thirds, or halves (depending on the age and abilities of your class and the number of variables you are working with). On the outer circle, write the phrase, "How will ________ affect. . . ?" in each divided section of the circle. Leave the inner wheel blank. Attach the circles together with a brad in the middle. Then, using the items generated on the lists, students can

- fill in the independent variable on the outer wheel.
- fill in the dependent variable on the inner wheel.

3. Next, using the wheel, have students choose two questions and write them on a sentence strip. On a wall, hang questions by category: types of markers, type of paper, and type of liquid.

4. Have a "question walk." Students walk around the room and read all the questions. Once they have read the questions, students go to the category that interests them and choose a question from the wall. Make sure to emphasize that scientists choose questions because they are **interested** in the questions.

Continued Learning

Day Two or Three: Develop a Prediction and Make a Data Sheet

Depending on your class and topic, students can begin the inquiry investigation either by developing a prediction or by making a data sheet.

Prediction:

- Using the inquiry activity sheet as a guide (Figure 2), the students write down their questions. The students should examine their question and then underline the independent variable and circle the dependent variable (e.g., How will the type of paper affect the length of colors?).
- The students fill in their prediction and circle what they are keeping the same for their experiment (everything except the variable with which they are working).
- Students can illustrate what they think will happen if they change one variable and keep the rest of the variables the same.

FIGURE 2. Prediction sheets help students understand the difference between independent and dependent variables.

Chromatography Investigation

Question:

How will the type of paper affect the length of colors?

We are changing the type of paper.

We will keep the circled words the same.

Color of markers   Type of markers
Paper   Liquid

Prediction:

This is what we think will happen:

When I dip the different paper in water, I think that some colors won't spread and some colors would take the whole space.

FIGURE 3. Inquiry Data Sheet.

Length of Color

Type of Paper	Trial 1	Trial 2	Trial 3	Average
copy paper	0 cm	0 cm	0 cm	0 cm
white construction paper	3.5 cm	4 cm	5 cm	4 cm
newsprint	4 cm	4 cm	4.5 cm	4.25 cm
coffee filter	5.5 cm	5 cm	6 cm	5.5 cm

This is what we discovered:
The marker spread more on the coffee filter than on any other paper.

Data Sheet

Sometimes it works for students to create a data sheet (Figure 3) before recording their predictions so the children can focus on what they are trying to measure, count, or observe. The students use the data sheet to

- write down their question(s);
- look at their question(s) and underline the independent variable and circle the dependent variable;
- record (on the top of the data sheet) the variable that they have circled (the dependent variable);
- and record (on the side of the data sheet) the variable that they have underlined (the independent variable).

I usually model creating a data sheet on the board or an overhead, discussing at this time the idea of multiple trials. Also, I discuss how many ways they might want to change their variable and how many spaces they will need on their data sheet. Typically, I model a few experiment scenarios and then walk around the room to answer questions as students create data sheets for their own experiments.

FIGURE 4. Sample chromatography investigation Materials and Planning Sheet.

Materials we will need:

1. different types of paper
2. water
3. container
4. purple markers, rubber bands, paper clips

Plan:

1. Put the water in the container.
2. Put the rubber bands on the container.
3. Put the color on different papers.
4. Put different papers with color on it in the water.
5. Measure the length of the color.

Experimenting and Beyond

Day Four: Plans and Materials

During this period, have the students do quiet work while you talk with individual students about their questions. Review each student's question and discuss what materials will be needed for the experiment. Help students learn how to write a plan so anyone could follow it just as scientists do.

Figure 4 is an example of one student's plan for a chromatography experiment investigating the question, "How will the type of paper affect the length of colors?"

Day Five: Experiment Day

On this day, the children should be ready to perform their experiment. Walk around the classroom and question the children about their experiment and help them solve their problems.

Day Five or Six: Scientific Conference

Depending on how long the experiments take, a scientific conference can be held the same day or at a later date, but the children should always share what they've discovered; this is what scientists do.

The Structure of Inquiry

Teachers who used this format and adapted it to fit their classroom experiences found it very useful. The questions were controlled enough that the teachers felt comfortable helping the children, and the inquiries had a definite timeframe in which teachers could work.

My hope is that as teachers use this format, they will become comfortable with content and the structure of inquiry. As students become more experienced with using inquiry, they will ask richer, higher-level, more meaningful questions and become independent science learners. That is the goal!

Resources

Colburn, A. 1997. How to Make Lab Activities More Open Ended. *California Science Teachers Association Journal* (fall): 4–6.

Harlen, W. 1997. *The Teaching of Science in Primary Schools.* London: David Fulton.

National Research Council. 1996. *National Science Education Standards.* Washington, D.C.: National Academy Press.

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