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Making Science Relevant: Using Students' Interests to Teach the Art of Scientific Inquiry

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Students learn best when content is related to their interests. This is something they share with professional scientists; both like to ask their own questions about things they're interested in, and discover answers for themselves. For this reason, whenever possible, I try to find out what students are interested in, then help them to discover how their interests are related to the material at hand. The following question sequence rapidly gets my students using scientific thinking to help them perform self-guided inquiries into topics they are already interested in.

Are you a scientist?

I begin by asking students the question, "Are you a scientist?" This question and ensuing discussion eventually lead students to ask, "What is science?" as students consider what scientists do and whether or not students do it themselves. This helps students to define science in such a way that they see it in themselves.

During the questioning and discussion, students should be given time to respond. I wait for students to raise their hands or select students. I guide this discussion toward the main question: "What is science?" The answers that follow from this question should be questioned. For example, a student responds with the answer, "It's mixing things together." So I ask, "Is making tea science?" Then someone may say, "It's using a microscope." I would then ask, "If I look at my thumbnail under a microscope, is that science?" Students go on to say things like, "It's whatever is in the textbook"; "It's experiments"; "It's blowing things up." I ask "Is looking up the answer in a textbook science?" "Is deciding to take a new route home science?" "Is the Fourth of July science?"

Students usually experience a certain amount of confusion at this point, but it doesn't last. The goal is to get them to realize that science is something they can take ownership of, not something that simply takes place in laboratories and is recorded in textbooks. If you ask them to explain the purpose of an experiment, someone is likely to answer that it is designed to answer a question. Then you may ask, "Whose question?" The important point here is to get students to realize that scientists must know how to ask and answer their own questions. The power of this thought is that students can identify themselves with independent thinkers and can therefore begin to be scientists in their own eyes. It then becomes a matter of pinpointing what they want to know and helping them discover ways to find the answers for themselves.

What are you interested in?

Have students write down three things that they are interested in. Tell them it can be whatever they want. If they're having trouble, you might ask, "If you weren't here right now, what would you rather be doing?" Have them write down three things and then have them share with the class. Answers from my own classrooms have included reading books, horseback riding, playing computer games, skateboarding, fishing, and playing games.

This information is fuel for scientific inquiry. Students can now be enticed to use scientific thinking to find out more about things they are already interested in.

Have students write two questions about each of their three interests. The questions can be whatever they like. By walking around and checking students' answers while they're writing, I give myself the opportunity to think about how students can apply the next step to their questions, where they must formulate their questions as possible

relationships. This also allows me to help students who are having difficulty coming up with questions.

Now challenge students to rewrite these questions as "How" questions. Write the following on the board: "How does _____ affect _____?"

Ask students to write this question down and fill in the blanks. This creates a testable question. Do this in class and open difficult questions up to the class (maybe other students can help), as examples of how to wrestle a hard question into a testable form. This is not easy, so make sure students are able to see how other students are accomplishing this task, perhaps by writing notable examples on the board, or simply saying, "Here's a good one from [student's name]: How does [this] affect [that]?"

Some student questions are not easily simplified, like "How far is it to the moon?" It is unlikely that this can be answered more clearly in terms of a "How" question.

Part of science is asking questions that can be answered. If the question is "Can aliens speak English?" we can't presently answer that question. However, a scientist might change the question so that it can be answered. "To communicate with aliens, what is the simplest form of symbolic notation we might use?"

By asking questions as "How" questions, students formulate questions that identify important variables and juxtapose these variables in ways that suggest answers. Finding the important variables and proposing relationships between them is a common habit of scientific thinking and one of the first steps in the path to prediction.

Once students begin to understand the nature of the challenge, they often get very creative. "How does the material a saddle is made from affect comfort when riding a horse?" "How does my mood affect my score in a video game?" "How does the genre of the book I'm reading affect how long it takes me to read it?"

Can you draw a graph?

On the board, below where you have written "How does _____ affect _____?," draw and label the X and Y axes of the graph. Now write X and Y in the blanks to create a sentence that says "How does X affect Y?" Tell students that you want them to create empty graphs for each of their questions with the axes labeled with the Xs and Ys from their question.

There are two examples you will want to provide, the bar chart and the scatter plot, using questions from students. Which one students use will depend on whether their variables are categorical or continuous (i.e., qualitative or quantitative). Categorical variables include things that fall into natural categories, like gender, eye color, and breed. Continuous variables represent real numbers that can fall anywhere along a number line, like height, distance, and time. Two continuous variables are best plotted on a scatter plot. One continuous and one categorical variable will often be plotted on a bar chart. Two categorical variables should be represented on a table.

To demonstrate a scatter plot, use a question with two continuous variables. For example, a student asks, "How does the length of a skateboard affect how high I can jump?" On the X axis the student puts "Length of skateboard (meters)." On the Y axis "Height of jump (meters)" (see Figure 1).

Figure 1. How does the length of a skateboard affect the height of the jump? This is a reconstruction of a student's scatter plot showing the student's predictions for three tests each of seven different skateboards.

Ask students to draw graphs for each of their "How" questions and to be as specific as possible. Students label axes, put numbers on the axes, and predict the results of individual tests. By doing this, students are describing the experiments that would be required to generate these graphs.

What experiments would be needed to answer the question?

Graphs represent rough outlines for experiments. They define important variables along the axes, show how those variables are measured, represent hypotheses or outcomes, and, in some cases, suggest sample sizes. I ask students to roughly define an experiment in a few sentences to test their graph. How much data would they need? How would they measure specific variables? In more experienced classes, students construct proposals for experiments that they will eventually carry out at home or in the laboratory. In either case, the goal is to challenge students at whatever level they are capable of achieving.

Putting it into practice

I now provide students with opportunities to practice their new skills by giving them odds and ends and asking them to form "How" questions. I give students multicolored dice, suction cups, rulers, sand timers, digital timers, and balloons. Questions have included "How does gender affect preference for a color of dice?" "How does the length of a ruler affect how far it will catapult dice?" "How does the way a balloon is popped affect how many pieces it pops into?" "How does shaking or not shaking a sand timer affect how long it takes for the sand to fall through?" Once students have a question, they draw a graph and devise an experiment to test it. They then do the experiment and create a graph of the observed results. Teachers should use their own discretion in deciding what students can or cannot do in their classroom.

Beyond the classroom

Framing students' interests in science is a powerful and easy way to motivate an appreciation for scientific inquiry that goes beyond the classroom. In my experience, this activity empowers students by giving them the benefit of scientific thinking in their day-to-day lives. It can be followed up in many ways, including having students formally investigate their own interests, or using this method to explore new science material throughout the year.

The emphasis on discovering and using preexisting motivation in students is inspired by my work with science students and teachers, but it is also supported by a wealth of educational theory and research (Bruner 1966; Lave and Wenger 1990; Bransford, Brown, and Cocking 2000). The National Science Education Standards recognizes this and suggest that science be made "interesting, and relevant to students' lives..." and also that it "emphasize student understanding through inquiry" (NRC 1996, p. 212). Similarly, results from the National Assessment of Educational Progress and the Trends in International Mathematics and Science Study suggest that students learn most when instruction focuses on advanced reasoning skills used in the process of constructing their own solutions to open-ended problems (Wengling 2002; Stigler and Hiebert 1999).

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