Another Classroom Demo: The Scientific Method

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I am reminded of a teaching experience I once had once while teaching in the Peace Corps in Mozambique, this time regarding the scientific method and hypothesis testing. It might be nothing particularly exciting to those of you who habitually teach pre-college level science, but I was surprised at how well it worked.

My secondary-level students were extremely good at memorizing facts, but they had a hard time learning and applying the scientific method (as many do, I think). Since the method is at the root of what makes science actually scientific, and I don't want them to have the view that science was just a disconnected collection of trivia, this was deeply problematic – all the more frustrating to me because I could see that, in real life, they used the scientific method routinely. We all do, whenever we try to explain people's behavior or solve any of the everyday puzzles that confront us. The trick was to demystify it, to make them see that as well.

One day, I brought in an empty Coke bottle. It's not vital that this be done with a Coke bottle; in fact, I imagine if you have more choice of materials than I had in Africa, you could find something even better. Basically, I wanted something that was very familiar to them, to underscore the point that scientific reasoning is something they did all the time.

I held up the empty Coke bottle. "What do you suppose had been in it?" I asked. This was the PROBLEM. "Coke!" everyone replied. "Okay," said I, "but I could have used it after the Coke was gone for something else, right? What else could it have held?" Once again, people had no trouble suggesting possibilities – water, gasoline, tea, other kinds of soda. I pointed out that they had just GENERATED HYPOTHESES, and wrote them on the board, along with Coke.

Now, I asked them, how could you find out if your hypothesis was correct? They'd ask me, they said, and I pointed out that this was one way of TESTING the hypothesis. But suppose I wasn't around, or lied to them; what else could they do? One student suggested smelling it, and another (thinking about the gasoline hypothesis) suggested throwing a match in a seeing if it caught fire. "Both of those are good tests," I said, "and you'll notice that each of them is good for certain specific hypotheses; the match one wouldn't tell the difference between tea and other kinds of soda, for instance, and smelling it wouldn't help if it were water."

Then I asked a volunteer to come up and actually perform the test – to smell it, since we didn't have any matches. He did, and reported back that it smelled like Fanta even though it was a coke bottle. This, I said, was the RESULT, and it enabled the class to draw the CONCLUSION that I had put Fanta in the bottle after drinking all of the original Coke.

The best part of this demo came when a student, seeking to "trap" me, pointed out that I could still have had water or tea in the bottle, just long enough ago that the Fanta smell was stronger. "Exactly!" I replied. This points out the two limitations of the scientific method – the validity of your conclusion depends on your hypotheses and on how good your methods of testing are. There are always a potentially infinite number of hypotheses you haven't ruled out, and therefore we cannot draw any conclusion with 100 percent accuracy. Plus, if our test can't tell the difference between two hypotheses, then we can't decide between those two. For this reason, it's very important to have hypotheses that you can test, and to work to develop better methods of testing so that you can eliminate more plausible hypotheses.

This led to a good discussion about the pros and cons of the scientific method and how it compared to other ways of understanding the world. If I had had more time, equipment, or room, I had hoped to make it more interactive, with stations where they had to apply the method to lots of simple real-world problems; but even as it was, it was valuable.

I was surprised at how well this demo worked: not only did they immediately understand how to apply the scientific method, but they also understood its limitations in a way that I think many people don't, even by college age. As the semester advanced, I found myself referring back to the lesson often ("remember the empty Coke bottle") when I'd try to explain how we knew what we knew. And I think it was very freeing for them to realize that science wasn't some mysterious system of rules passed down from high, but rather the best explanation we had so far (and the best way we knew how to get that explanation). My favorite result of this demo was their realization that scientists were people just like themselves, and that they too could do it – in fact, they already were.