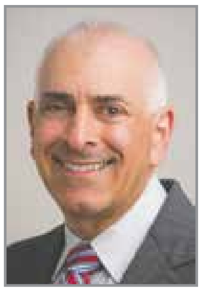
COMMENTARY: **Matt Bobrowsky**

Science Projects Are More Authentic With No 'Hypothesis'

By Matt Bobrowsky



Matt Bobrowsky

How do you define the term *hypothesis*? Apparently some teachers still incorrectly teach that a "hypothesis" is a prediction of the outcome of an experiment. They may call it a "guess," or even an "educated guess," but either way, it's a prediction of the expected result. Many teachers use the term that way in online discussions and on lab worksheets. Whenever I judge science fairs, I frequently see a student's poster stating something like, "Hypothesis: I think that…[possible experimental result]." Unfortunately, various sources, including some textbooks and popular websites, perpetuate this misconception.

The truth is, scientists rarely guess at an answer. For example, let's say I want to know how large a red blood cell is. It won't help to first guess at its size. That won't help me discover the answer, and it doesn't help me learn anything. All I need to do is make the measurement, and then I'll know. Please consider not requiring a "hypothesis" in students' science fair projects or in labs. Stating a research question or an engineering challenge is perfectly good. Incidentally, the Intel International Science and Engineering Fair does not require a hypothesis; a good research question is sufficient.

For most physical scientists, a hypothesis is not an "if...then…" statement or a prediction. It is a *tentative explanation* for some observed phenomenon. A good hypothesis will have two properties: (1) It will explain the observations, and (2) it will make predictions—that can be tested. If it's not testable, it's not a *scientific* hypothesis.

To clarify, I'm not discussing the "hypothesis" referred to in statistical analyses, as in the "null hypothesis." (This would not be needed unless the investigation includes a statistical analysis that requires such a hypothesis.) Rather, I'm referring to the hypotheses used by most physical scientists, as defined earlier. Some teachers have students write an "if-then-because" statement. In this case, the hypothesis follows "because." That's where the possible explanation is stated.

Here's an example of a hypothesis: Suppose you observe that the Moon goes through phases, and you hypothesize—incorrectly—that this is due to Earth's shadow on the Moon. (As a hypothesis, this is a possible explanation, not a prediction about any particular experiment.) A prediction from this hypothesis is that part of the Moon should appear dark only when the Moon is in the Earth's shadow. So then you observe the Moon for a month and discover that part of the Moon appears dark even when the alignment of the Sun, Earth, and Moon does not place the Moon in the Earth's shadow. You then must reject the hypothesis.

There are several reasons why we should not ask students to make guesses or predictions of the outcome of an experiment. (Please don't call these predictions *hypotheses!*) My top three are

1. Making a prediction introduces bias, as the experimenter—consciously or unconsciously—acts to increase the likelihood that the experiment will have the predicted outcome.
2. Students incorrectly think it's important that their prediction be correct, which may lead them back to Reason 1. In fact, the rejection of incorrect hypotheses—based on testing predictions—is one of the main ways that science advances. (Frankly, my favorite science fair projects are often ones in which the outcome differs from what was expected. When that happens, real learning occurs, and students experience that delightful "Aha!" moment.)
3. Scientists usually don't make predictions in this way, so why do we ask students to do it? After all, aren't we trying to teach them how science is actually practiced?

Want to teach about real hypotheses? Give the students a gadget (with complexity somewhat above their current level), and ask them to develop a possible explanation for how it works. That possible explanation is a hypothesis. However, especially at the lower grades, you don't need to use the word *hypothesis*; just ask them to say or write what they think is happening. To be scientifically useful, the proposed explanation should include what evidence would support it and what evidence would refute it. Then ask how they might test their proposed explanation. This gets them thinking in ways that are much more creative than following an arbitrary checklist of science project "requirements." Instead they experience science the way scientists do, as fascinating explorations and discoveries. It is this latter, more engaging way of learning that forms the basis of Phenomenon-Based Learning. ●

Matthew Bobrowsky, PhD, at Delaware State University, is a nationally recognized science educator and recipient of multiple awards for teaching excellence. He is the lead author of the Phenomenon-Based Learning series, published by NSTA Press. He has taught various scientific subjects, carries out scientific research, and engages in numerous public speaking events. He writes and lectures on both science pedagogy and content. He has also conducted professional development workshops on the nature of science, as well as on physics and astronomy content, and he has been a featured presenter at conferences of state science teachers associations.

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National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3092
703-243-7100
nstareports@nsta.org

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