Lesson and Rubric on Writing Hypotheses

Writing Hypotheses: A Student Lesson

Purpose: to learn when and how to write hypotheses.

Most students believe that they are going to be experimenting anytime they are given a laboratory assignment in science. However, more often than not, students are doing something other than experiments. This is not necessarily bad. A good deal of science is observational and descriptive. For example, the study of bio-diversity usually involves looking at wide variety of specimens and maybe sketching and recording their unique characteristics. However, there are other times when we science teachers are trying to teach students how scientists work and how we can verify things which others may say or believe is so without any proof.

To learn about what is not known or to verify a notion, the so-called "scientific method" might be carried out and an actual experiment may be conducted. It does not matter that your experiment has been done a thousand times before or that your teacher already knows the results. What matters is that you don't know the results and that you can independently find a verifiable answer. In real experiments, real hypotheses should be written before the actual experiment.

What Is a Real Hypothesis?

An hypothesis is a tentative statement that proposes a possible explanation to some phenomenon or event. A useful hypothesis is a testable statement which may include a prediction. An hypotheses should not be confused with a theory. Theories are general explanations based on a large amount of data. For example, the theory of evolution applies to all living things and is based on wide range of observations. However, there are many things about evolution that are not fully understood such as gaps in the fossil record. Many hypotheses have been proposed and tested.

When Are Hypotheses Used?

The key word is testable. That is, you will perform a test of how two variables might be related. This is when you are doing a real experiment. You are testing variables. Usually, an hypothesis is based on some previous observation such as noticing that in November many trees undergo color changes in their leaves and the average daily temperatures are dropping. Are these two events connected? How?

Any laboratory procedure you follow without an hypothesis is really not an experiment. It is just an exercise or demonstration of what is already known.

How Are Hypotheses Written?

1. Chocolate may cause pimples.
2. Salt in soil may affect plant growth.
3. Plant growth may be affected by the color of the light.
4. Bacterial growth may be affected by temperature.
5. Ultra violet light may cause skin cancer.
6. Temperature may cause leaves to change color.

All of these are examples of hypotheses because they use the tentative word "may.". However, their form is not particularly useful. Using the word may does not suggest how you would go about proving it. If these statements had not been written carefully, they may not have even been hypotheses at all. For example, if we say "Trees will change color when it gets cold." we are making a prediction. Or if we write, "Ultraviolet light causes skin cancer." could be a conclusion. One way to prevent making such easy mistakes is to formalize the form of the hypothesis.

Formalized Hypotheses Examples

If skin cancer is **related** to ultraviolet light , **then** *people with a high exposure to uv light will have a higher frequency of skin cancer*.

If leaf color change is **related** to temperature , **then** *exposing plants to low temperatures will result in changes in leaf color.*

Notice that these statements contain the words , **if** and **then**. They are necessary in a formalized hypothesis. But not all if-then statements are hypotheses. For example, "If I play the lottery, then I will get rich." This is a simple prediction. In a formalized hypothesis, a tentative relationship is stated. For example, if the frequency of winning is **related** to frequency of buying lottery tickets. "Then" is followed by a prediction of what will happen if you increase or decrease the frequency of buying lottery tickets. If you always ask yourself that if one thing is related to another, then you should be able to test it.

Formalized hypotheses contain two variables. One is "independent" and the other is "dependent." The independent variable is the one you, the "scientist" control and the dependent variable is the one that you observe and/or measure the results. In the statements above the dependent variable is blue and the independent variable is red.

The ultimate value of a formalized hypothesis is it forces us to think about what results we should look for in an experiment.

Rewrite the first four hypotheses using the formalized style shown above. Single underline the dependent variable and double underline the independent variable in the If clause of each hypothesis. When you are done, write one more original hypothesis of your own using this form.

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Anecdotal Information

This is a writing lesson to lay the foundation for using hypotheses in lab activities throughout the course. The lesson is guided practice and my approach to it is "guided lecture." In this technique, I use randomly selected cards with student names on them to answer questions about what they have read up to the section called "Formalized Hypotheses." Questions I ask include the meanings of key vocabulary, give examples, and the meaning of selected passages. In this way I check their understanding as well as develop the foundation for the why and the how of writing formalized hypotheses. Students then examine and discuss the models, after which I prompt them to rewrite the first four hypotheses using the model as a guide.

I cruise the classroom and check every student for progress and provide guidance and clarification for those who struggle. The final product is an original student hypothesis of their choosing. About two-thirds of the students get it the first time. The others struggle with it sometimes well into the first several labs in which hypotheses are featured. The most common problem is that students write a simple statement that is a cause and effect relationship that makes a prediction (example: "If I eat chocolate, then I will get pimples."). They have to be reminded that what makes an hypothetical statement is the idea that two things might be, but not necessarily related. In other words they failed to state a proposed relationship before making the prediction. Literally speaking, cause and effect statements are based on unstated assumptions. In models for scientific research, minimizing assumptions first and then stating your hypothesis is how variables are controlled. A lot of difficulties in writing hypotheses can be traced back to the simple lack of writing skill. I don't let this deter me because students need to learn how to write in all subjects. Hypothesis writing is just one more contribution to overall literacy.

Process Skills Rubric

Hypothesizing

Consider if the experimental design:

• Develops an insightful, testable hypothesis that considers **all** the variables involved and the relevant supporting evidence • Questions the relevance of the hypothesis by considering the accuracy of the control and testing methods • Communicates the results of the experiment in a clear, accurate way	4
• Develops an insightful, testable hypothesis that considers **some** the variables involved and the relevant supporting evidence • Considers the accuracy of the control and testing methods • Communicates the results of the experiment reasonably accurately	3
• Develops an hypothesis but needs help • Considers some aspects of the problem • Communicates the results of the experiment in a partially accurate manner	2
• Develops an hypothesis that is confusing or untestable • Uses a testing method that is weak and does not relate to the problem • Communicates the results of the experiment incompletely	1

Sites for further study:

http://www.ehow.com/how_4548847_writing-hypothesis.html

http://www.wikihow.com/Write-a-Hypothesis