What's in a name: A proposed science fair typology.

Not all science fairs are the same. A quick exploration of various project-based means reported for teaching science can be grouped into five distinct categories. Although a full examination of each isn't possible here, a science fair typology should help focus future discussions on the distinctions, advantages, and disadvantages inherent in these forms.

True experiments

This is the classic test or "gold standard" of science. In a true experiment, there are at least two situations: a control and an experiment. The control is typically the normal or nonmanipulated situation, which is compared to the experimental or manipulated situation. Ideally, there is only one variable changed from the control to the experimental setting. If the experiment reveals something of interest when compared with the control, the difference between the two groups is most likely the cause.

True experiments lend themselves to the use of a research hypothesis. For example, a true experiment might explore the impact of vitamin C on the growth rate of paramecium. The null hypothesis would be that vitamin C does *not* impact the growth rate of these microorganisms, using an experimental and control setting to test this notion.

Nonexperimental investigations

In these explorations it is not possible—or even desirable—to control or account for all the possible variables. Typically, these are holistic studies of some phenomenon designed to provide background information that might later be used in a true experiment. Jane Goddall's classic work with chimpanzees in Gombe National Park is a good example of such a study. During her

years watching these primates and taking notes, she was careful *not* to manipulate the animals or change their environment. This resulted in a report of chimpanzees' lives in the wild. Her research notebooks eventually filled with observations—many of which were turned into conjectures that could be tested using true experiments. Nonexperimental investigations do not lend themselves to research hypotheses in advance but may result in the formation of future testable hypotheses.

Both the experimental and nonexperimental investigations are classic formats for science fair projects and permit students to fully experience all elements of the arc of science. The expectation that students' projects be guided by research hypotheses should be examined because the nonexperimental research technique is typically best served if such "educated guesses" are not imposed in advance—as there is no assertion to be tested in this study type.

Product testing

In this type of project, students are challenged to design a plan by which products—or procedures—with a similar goal are compared to one another. Among the countless examples of this technique are questions such as

- Which insect repellent is most effective?
- Which type of vanilla ice cream tastes best or melts most slowly?
- Which brand of toilet paper breaks apart most quickly in water?

Although students don't experience all elements of the arc of science, they must still develop and defend their choices for a method; they must wrestle with the issue of sample size and develop ways to communicate their results.

Technological or engineering challenges

Here, students are typically provided with an assortment of supplies and asked to solve a particular problem, using just the materials provided. The most entertaining of these challenges occasionally appears on TV, in which multiple teams of students, each using the same set of supplies, builds some device to accomplish a given task.

In several recent televised engineering competitions, student teams were asked to design and construct a machine that moves balls from one side of a playing field to a small basket on the other side. Occasionally, the machines from two teams were pitted against one another, introducing an additional level of strategy. For instance, one group focused on the speed and accuracy of transport, but the other designed their machine, in part, to block the basket of the opposing team and could take considerably more time to move balls.

Again, some elements of the total scientific process aren't evidenced here, but others are emphasized to an extraordinary level. Both product testing and engineering challenges typically involve groups of students, introducing an authentic element of science that may be lacking in classic science fair designs.

Modeling scientific phenomenon

In this type of project, students design, build, and ultimately explain some aspect of science. In the best examples of this strategy, students make working models of phenomena using materials

that closely approximate the real scientific principle in question. For instance, students might make a model of the human eye that contains a real lens, gelatin to simulate the optic fluid, and a laser beam to show the passage of light through the optic system. This would make the modeling as authentic as possible.