Beal Bank USA

Southern Nevada Regional Science & Engineering Fair

Guide to the Scientific Method for Elementary & Middle School Students

THE NATURE OF SCIENCE

The history of science reveals both evolutionary and revolutionary changes. With new evidence, old ideas are replaced by newer ones. Science, by definition, is limited to *naturalistic* methods and explanations and is precluded from using *supernatural* elements in the production of scientific knowledge; therefore, science excludes all *non-scientific* or *pseudoscientific* methods, and explanations. Through use of the "Scientific Method," scientists attempt to develop an accurate, reliable, consistent and non-arbitrary view of the world.

CAUSE AND EFFECT

Scientists observe everything in the world from the viewpoint of cause and effect. Although observations may be breathtaking, there is no *magic* involved! Scientists believe that all events are the result of a collection of other earlier events. Watch something happen, like fireworks exploding, an alarm clock starting to ring, or a leaf twisting in the breeze. The events that happen before your observations are the "*causes."* The event you see is called the "*effect."* With the help of your family or classmates, pick a single event that is interesting to you. Try to name twenty or so other events that helped cause it.

THE SCIENTIFIC METHOD

Gaining new knowledge about our world means simply understanding how and why causes create a particular effect. Over the years, scientists have developed a step-by-step method to investigate events. It is called the "scientific method". The carefully studied event that you see (effect) is called an "experiment". If care and honesty are used, the scientific method will help you study and understand your experiment. You should be able to discover the correct cause and effect relationships.

Using the Scientific Method, you will learn how to ask questions about causes and effects, and use evidence you gather to answer them. In the process, you will learn to conduct an investigation and collect evidence, explain the data, and defend your conclusions. The Scientific Method requires evidence that is *observable*, explanations supported by evidence that is *testable*, arguments that are *rational*, methods that are *repeatable*, conclusions that are drawn from observations, conclusions that include some element of *skepticism*, and conclusions that are subject to *peer review* (other scientists review the evidence and conclusions, and tell the author what they think of them). In your case, your peer review will be by judges at the science fair! The following steps will lead you through the scientific method.

A. Pick A Topic. Before an event can be studied you must have some idea of what it is that you want to observe. Pick something that you are really interested in.

B. Limit Your Topic and Form a *QUESTION.* You have very little time and resources. You will only be able to study an extremely small topic. You must, therefore, limit your experiment to one or two specific questions that you have about your topic.

C. *RESEARCH*: Study, Observe And Gather Evidence. Read about your limited topic. Observe related events. Gather existing information concerning your limited topic from the library. Look for unexplained or unexpected events or results. You might need to change your questions. Also, you might need to learn something about the field of mathematics known as Statistics.

D. Generalize. Organize what you know about your topic. Make lists of known causes for specific events Describe what generally happens when you observe related events.

E. Causes and Effects (the *HYPOTHESIS*). Write a sentence stating what you think *might* happen if you do your experiment. This statement is called a "hypothesis." Your hypothesis should agree with observations already studied that you found in your research. Your have to be able to *test* your hypothesis by doing an experiment. State what you think would happen if some of the causes of events were changed. Causes that can change events are called "variables". What will your cause be under *normal* conditions? This *normal* variable is also called the "*control* group." The control is very important. It shows the normal results of your experiment if you don't try to change anything. What will your cause be under *changed* conditions? This *changed* variable is also called the "*experimental* group."

F. Plan Your Methods and Perform Your Experiment. (the *METHODS*). Design and do a series of experiments. You must design each experiment so you can observe the results if one and only one variable is *changed* (*experimental group*). Changing just one variable, allows you to determine that variable's effect on your chosen event. To see the real effect, you can change the single variable several times, or have more than one *experimental group*. Be careful, there might be *other* variables that might affect your experiment that you aren't expecting, such as room temperature, time of day, and relative humidity. You might want to keep these the same if you take measurements over several days or weeks. Other variables you can't do anything about, such as atmospheric pressure and how bright the sunshine is.

G. Examine Your *RESULTS.* Did your experiments give you the expected results? Why or why not? Be very honest! Reexamine your experiments. Was more than one variable changed at one time? Was your experiment done with the exact same steps each time? Are there other causes that you had not considered or observed? Were there errors in your observations? How large were the errors? If your physical skills were involved, how much better did you get at doing your job with each repeat? Remember that understanding errors and reporting that a suspected variable did not change the results can be valuable information.

H. Draw *CONCLUSIONS.* What variables are important? Was your theory correct? Did you collect the proper data? Did you collect enough data? Does more work need to be done or is your experiment finished? If your hypothesis was false, yet all your errors are explained, you must do more research and/or change your *Methods*.

I. Write an *ABSTRACT.* Write a one-paragraph summary of the steps in the project and record this in the Science Log Book and on the Project Display Board.

J. Prepare your P*ROJECT DISPLAY BOARD.* Prepare your board following the instructions also on this website. Include the Question, Research, Hypothesis, Methods, Results, Conclusions, and Abstract on your display.

Source: The Scientific Method, George Ochs, Western Regional Science & Engineering Fair, 2007.