

Beal Bank^{USA}

Southern Nevada Regional Science & Engineering Fair

Science Project Guidelines for Elementary & Middle School Teachers & Science Fair Coordinators

The following information should help you help your students have a successful science fair project experience. If you are unsure why it is important for students to complete a science fair project, you might be interested in reading about some good reasons at the International Science and Engineering Fair website (<http://www.societyforscience.org/impact>). High school sweepstakes winners can compete at the International fair.

Above all — a Science Fair Project should be fun for students. So, they should keep that in mind when they start thinking about what they want to do.

The Nature of Science

The history of science reveals both evolutionary and revolutionary changes. With new evidence and interpretation, old ideas are replaced or supplemented by newer ones. While science and technology do impact each other, basic scientific research is not directly concerned with practical outcomes, but rather with gaining an understanding of the natural world for its own sake.

Science, by definition, is limited to naturalistic methods and explanations and, as such, is precluded from using supernatural elements in the production of scientific knowledge. Therefore, science methods, explanations and generalizations should be the sole focus in the classroom to the exclusion of all non-scientific or pseudoscientific methods, explanations, generalizations and products. (National Science Teachers Association (NSTA) (<http://www.nsta.org/about/positions/inquiry.aspx>))

The Scientific Method

Through use of the "Scientific Method," scientists attempt to develop an accurate, reliable, consistent and non-arbitrary view of the world.

Although procedures vary from one field of science to another, recognizable characteristics distinguish scientific inquiry from other approaches for obtaining answers to questions. Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use *evidence* to answer them. In the process of learning the strategies of scientific inquiry, students learn to *conduct an investigation* and *collect evidence* from a variety of sources, develop an *explanation* from the data, and communicate and defend their conclusions. Although no single step-by-step scientific method captures the *complexity* of doing science, a number of shared values and perspectives characterize a scientific approach to understanding nature. These shared values may include:

- explanations supported by *evidence* that is testable
- evidence must be *observable*
- arguments must be rational
- conclusions must be drawn from *observations*
- conclusions should include some element of skepticism
- conclusions must be subject to peer review (scientists review each other's data before it is published)
- methods must be repeatable (other scientists must be able to repeat the experiment and obtain very similar evidence)

Regarding students' abilities to do scientific inquiry, NSTA recommends that teachers help students (red by SNRSEF):

- "learn how to identify and ask appropriate questions that can be answered through scientific investigations;" **[Scientific Method: Question]**
- "design and conduct investigations to collect the evidence needed to answer a variety of questions;" **[Scientific Method: Hypothesis, Methods]**
- "use appropriate equipment and tools to interpret and analyze data;" **[Scientific Method: Results]**
- "learn how to draw conclusions and think critically and logically to create explanations based on their evidence;" **[Scientific Method: Conclusions]**
- "communicate and defend their results to their peers and others" (publish in a journal).

(National Science Teachers Association (NSTA) (<http://www.nsta.org/about/positions/inquiry.aspx>))

Design and Plan a Science Project

STOP! Are any of your students using animals or human subjects?



Review possible risks in your students' proposed projects and discuss them with your students. If any student is working with *animals* or *humans*, they must have their methods reviewed and **preapproved** by your school's Institutional Review Board (IRB) **BEFORE** they begin work on their project. In fact, it's **FEDERAL LAW** that they do this. See the requirements for an Institutional Review Board on this website.

Create the Science Project Logbook

Before students begin their projects, they should start their Science Project Logbook, which will be a very important part of the project. You are encouraged to ask your students to use a "Composition Book" for the logbook (right). These can be found at any store carrying office or school supplies.



Students should leave the first page of the logbook blank so that they will have room to write a Table of Contents on this page after they finish their project. Students should keep the logbook nearby to record all ideas, thoughts, experiments and activities. The notebook serves many purposes:

- the place to keep notes while they plan their project;
- the place to keep notes while they perform their experiments;
- illustrates the quality of work they perform and shows the amount of time and effort that went into their project.

Students should handwrite everything into this book that pertains to the project, no matter how insignificant it might seem. You never know when that piece of information will come in handy. They should write in ink and not erase or tear out pages just because they made a mistake.

When students enter notes in their logbook, they should try to:

- be as complete and clear as possible;
- write neatly enough that other people can read it;
- use correct grammar and spelling;
- enter the date and time of day every time they have ideas, at the time they think of them, or when they are working on their project;
- have their entries witnessed at least once a week, either by the you or a parent, depending on where they are performing the experiment.

This logbook must be included with the Science Project Display Board and if the project is sent forward to the regional fair, the quality of the logbook will be part of the judging criteria.

Project Design

Students should begin to design their project using the Scientific Method as a guide, and record everything in their Science Project Logbook as they proceed. The following is very important:

- This is the student's project. That means that the ideas and the work must be THEIRS—not their parents. Age-appropriateness will be part of the judging criteria.
- Originality counts. Students should use their imagination to think of a science project themselves. Originality will be part of the judging criteria.

Ask Questions

Students should think about their areas of interest and questions within that area that might be worth exploring. They should narrow their ideas down to define one question that they want ask concerning their interests.

Students should formulate a question. As an **example**, let's say a student is thinking about the environment, and then perhaps about the effects of acid rain on buildings. Since many buildings are made of brick, they decide their question will be: "How does acid rain affect brick buildings?"

Do Some Research

Getting information from existing sources helps students develop their ideas. Here are some suggestions:

- Students should talk to lots of people, including teachers, parents and friends, or experts in their area of interest. They should read scientific magazines and books, and other written material.
- Students should research the Library and the Internet to see what is currently being done in the area of their question.
- Refer students to the Librarian for help in their research.
- Students should write down your sources ("citations") in their logbook.

In our **example** above, the student should do some research in the library to find information on acidity, acid rain, and the effects of acid rain on the environment, including buildings.

Students should record their thoughts, investigations and citations in their Science Project Logbook. Then they are ready to form a Hypothesis.

Develop a Hypothesis

Scientists create hypotheses as early attempts to explain patterns observed in nature or to predict the outcomes of experiments. (Wikipedia <http://en.wikipedia.org/>) Students form their hypothesis based on the information that they found in their research. **Student's Hypothesis should be age appropriate.**

A hypothesis consists of a reasonable suggestion of a possible

- explanation for something students observe, or
- a correlation between many things they observe.

Remember from our previous discussions above, the scientific method requires that students test their hypothesis, and confirm or disprove their hypothesis; if they can't test their hypothesis, then they can't use the Scientific Method.

Typical hypotheses are statements, and often they are presented in the form of an "IF-THEN" statement. Using our previous **example**:

- "IF rain water is more acidic, THEN bricks in buildings will fall apart faster;" **OR in the alternative,**
- "IF rain water is less acidic, THEN bricks in buildings will take longer to fall apart;"

Don't forget — if the student's results show their hypothesis to be false that is perfectly acceptable. False hypotheses still give us information. Scientists frequently find their hypothesis is false.

The "Hypothesis" should be recorded in the students' Science Logbook and included on the final Project Display Board. Now they are ready to think about their methods.

Plan the Methods

Students should develop Methods to test their hypothesis. They should think about their Methods in an organized way, and write them so that someone who reads the logbook could repeat the methods.

Student's Methods should be age appropriate. Here are some considerations:

- Students should think about the actions that they will take in their experiment, and how they will measure the results of these actions.
 - In our **example**, students could decide that their actions will be to use water with different acidities, and see if there are any differences in the effects on brick.
 - They might want to measure the difference in brick break-up by measuring the weight of the bricks after the treatments.
- Students should determine what their actions will be under "normal" conditions."
 - In our **example**, students would make water samples with a neutral pH (about 7.0).
 - This is called the "**control group**".
- Students should determine what their actions will be under "changed" conditions."
 - In our **example**, they would make up water samples with differing pH.
 - This group is called the "**experimental group**." Their actions are the same as under normal conditions: apply water to the brick. The acidity of the water is different in the "experimental group."
 - The student decides what acidities to use, and how to measure the results of applying this water to the brick.
 - Students must also decide how often to expose the bricks to acidic water and measure brick break-up over time.
- What tools and materials do they need to use to complete the experiment? In our **example**, they might need water, vinegar, pH paper, bricks and containers to hold them, and a scale to weigh them.
- The student must decide how to record these measurements in their Science Logbook. They might want to use a table and maybe draw pictures to illustrate their methods.
- Remember, students should record the methods that they PLAN to use in their experiment. When they actually perform the experiment, they will write down the methods they actually perform as they perform the experiment.
- Students must decide how they will compare the measurements for the experimental group to the control group.
 - They should draw a plan for a template to record their data in their Science Logbook.
 - Charts and graphs should be hand-written or drawn directly in the Science Logbook.

Test the Hypothesis (the Experiment)

Students should begin the experiment by carefully following their Methods. **Student's Testing (experiment) should be age appropriate.** They should:

- record the dates and time of day of each step, and the acidity used;
- record any mistakes or unusual observations; use more detail rather than less detail; illustrate results — take photographs or make drawings of the methods and materials if desired and tape, glue or otherwise fix into the Science Logbook; they might want to also use these pictures on their Project Display Board; if so, they need two prints each; record the data or results.

Analyze the Results

Students should think about the data and what it means. **Student's Analysis should be age appropriate.**

- Do they see differences between the experimental group and the control group for the phenomena measured?
- If they didn't get the results they were expecting, is the hypothesis false, or do they need to re-examine the experimental method, the hypothesis or redefine the original question? For **example**, what if the bricks don't fall apart when treated with acidity? How can they change their methods?

