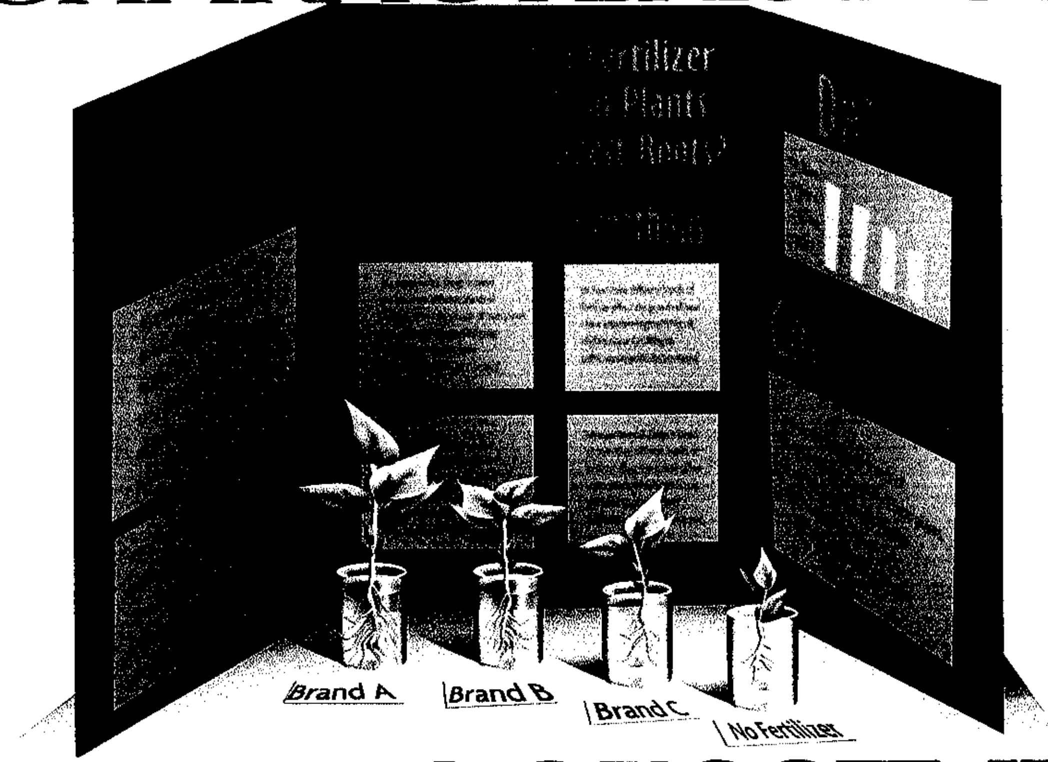
NON-TRADITIONAL CHARACTERISTICS



# of a SUCCESSFUL SCIENCE FAIR PROJECT

by William Sumrall and Don Schillinger

Science fairs offer students the opportunity to develop skills in inquiry, writing research proposals, working with peers, verifying results, and sharing experimental findings. However, the science fair itself does not necessarily translate into a student's attainment of such skills. Project quality and a student's successful achievement of good inquiry skills vary greatly from fair to fair. Participation in a science fair should not be viewed as the "one shot" opportunity for teachers to involve their students in inquiry, but rather it should provide both extensions and reinforcements to skills that were developed over time through a variety of classroom activities. Furthermore, science fairs should offer students the opportunity to transfer both scientific knowledge and acquired inquiry skills to new situations that allow them to solve problems and answer questions.

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While there is much information available on experimenting and following the process of science for fair projects, there are many issues to be addressed regarding ways to improve a student's success in a science fair. Understanding proper technique is certainly important to having a good project, but it does not necessarily guarantee one. More specifically, many projects, while following good experimental procedure, lack in other areas. These "non-traditional project weaknesses" should be avoided in order to improve a student's science fair project and their skills at performing inquiry. While there are numerous things that could lead to a poor project, here are six specific characteristics for students that are essential to the completion of a quality project:

1. Research and have a rationale for the project.
2. Research safely.
3. Go the extra mile in collecting and presenting data.
4. Make data quantitative.
5. Parent or guardian help may be fine, but know the project.
6. Work on demeanor and presentation skills.

Research and have a rationale for the project

Often, a project appears to have no experimental purpose. For example, one student used petroleum jelly rather then cooking oil to bake biscuits. If there was a rationale for the experiment, it was not apparent to either the judges or the student. The better projects are the result of a student actually doing research. While he or she may not know everything about the project to start, research usually gives them a solid rationale for doing it. With that said, teachers need to assist students in understanding what research really means. Unfortunately some students have the impression that finding a science activity in a book and following a written procedure is research.

Overcoming this problem is probably the most difficult of the six items, and the solution of requiring several references is probably nothing new to most teachers. However, with the advent of the Internet, getting information on a subject has become easier (though students need to be careful about a source's accuracy), and thus students should be able to form a rationale for a project more effectively based on what they find (see Figure 2 on page 23 for research ideas). Having a rationale generally relates to the project having a basis in scientific theory and/or law when developing the idea. For example, the development of an experiment related to motion that is generated from an understanding of Newton's Laws of Motion should be founded upon accepted principals. Thus an experiment that relates to one of these laws is a good starting point and project rationale. However, projects that include applied science and offer a purpose will typically receive higher scores at a science fair. The project's purpose should, and more than likely will, be observed during a student's presentation. If students are intrinsically motivated to investigate a phenomenon, test a product, or design an invention, their interest and excitement will be exhibited to the judge(s).

Researching safely

Safety should be a consideration for the successful design and implementation of science fair projects. The inclusion of safety in investigations is prerequisite to all endeavors within the science classroom and associated events outside class boundaries. All participants should be expected to follow nationally developed rules and regulations that ensure safety for the experimenter, other humans, and animals. This concept extends into science fairs where subjects may be involved that are not typically present in the classroom. Since parents are usually the supervisors, their awareness of rules/regulations and the completion of proper paperwork is essential to avoid disqualification. However, supervision could involve other individuals (e.g., a veterinarian) as well, so adherence to the written rules and regulations is essential to avoid problems at a fair. Students should be made aware of proper safety rules and procedures through adequate classroom instruction, while other individuals involved with the projects should be informed through letters that are sent home (and returned with appropriate signatures) or through mandatory science fair project meetings to be attended by any parties involved (see Resources for safety guidelines).

Go the extra mile in collecting and presenting data (particularly if the idea is not unique)

Frequently, students cut corners when collecting data and doing a substantive experiment. Comparing the effects of different fertilizers on a plant and drawing conclusions is a weak project, particularly if the student relies on only two plants and one fertilizer to draw conclusions. Obviously, the more data points (e.g., plant growth comparisons) collected, the less experimental error there will be. Furthermore comparing two fertilizers placed on two of the same type plants is a very simple and common experiment that will not get high marks at a fair. The best projects are those that use multiple samples, contain well-defined variables, have treatments that are measured over a considerable period of time (weeks), and illustrate the process of retesting to provide experimental reliability. Specifically, if you want to determine which fertilizer works best, there are a number of variables that may be used to answer a variety of questions. Many successful science fair projects are designed to answer related questions such as: "Which plant type works best with which fertilizer?" "What is the relationship between the stages of plant growth and different fertilizers?" or "Is there an optimal ratio between fertilizer and water that should be fed to different plants?" This approach demonstrates that a student actually has an interest in which fertilizer is most effective for growth enhancement, has a real enthusiasm for what they are doing, and illustrates the student's understanding of a scientifically-based investigative process. Despite any errors that may be found in a project of this type, most judges will look favorably upon a student who shows passion and willingness to go the extra mile. Much like "degree of difficulty" in diving or ice-skating, the depth of a student's project is an important factor when determining placement at a fair.

Solutions for this situation include requiring that students use a minimum of 5–10 testing samples for every question answered in their experiment and requiring that a project answer a minimum of three experimental questions. Any exceptions to these two requirements should be discussed

FIGURE 1 **Science fair presentation rubric**

Category	Excellent (4 points)	Good (3 points)	Satisfactory (2 points)	Needs improvement (1 point)
Enthusiasm	Facial expressions and body language generate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language sometimes generate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language are used to try and generate enthusiasm, but do not seem genuine.	Very little use of facial expressions or body language. Did not generate much interest in topic being presented.
Speaks clearly	Speaks clearly and distinctly all the time and does not mispronounce words.	Speaks clearly and distinctly all the time, but mispronounces one word.	Speaks clearly and distinctly most of the time. Mispronounces several words.	Often mumbles or cannot be understood or mispronounces several words.
Posture and eye contact	Stands up straight, looks relaxed and confident. Establishes eye contact with everyone in the room during the presentation.	Stands up straight and establishes eye contact with everyone in the room during the presentation.	Sometimes stands up straight and establishes eye contact.	Slouches and/or does not look at audience during the presentation.
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem prepared to present.
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Uses complete sentences	Always speaks in complete sentences.	Sometimes speaks in complete sentences.	Rarely speaks in complete sentences.	Never speaks in complete sentences.
Stays on topic	Stays on topic all of the time.	Stays on topic most of the time.	Stays on topic some of the time.	Hard to tell what the topic was.

RUBRIC CREATED THROUGH RUBISTAR, A FREE WEB-BASED TOOL AVAILABLE AT *RUBISTAR.4TEACHERS.ORG.*

FIGURE 2 Science fair resources

- The Science Explorer—*www.exploratorium.edu/science_explorer/index.html*
- The Science Club: Kid's Science Projects—*www.halcyon.com/sciclub/kidproj1.html* (This site contains various types of science projects and activities organized by level of difficulty.)
- The Science Fair Idea Bank—*www.scifair.org/ideas/index.shtml* (From *Scifair.org* and sponsored by the Society for Amateur Scientists, it provides project ideas.)
- ScienzFair Project Ideas—*members.aol.com/ScienzFair/ideas.htm* (This is a wonderful website for locating project ideas and associated activities.)
- BrainPop.com—*www.brainpop.com/science/scientificinquiry/scientificmethod* (This site contains a clever video which describes the steps and importance of the scientific method.)
- EurekAlert Reference Desk—*www.eurekalert.org/links.php* (This site contains links to glossaries and/or dictionaries from different scientific areas, provided by various research-oriented organizations.)
- MadSci Network—*www.madsci.org* (Represents a collective cranium of scientists providing answers to your science questions.)
- The Parent or Guardian's Responsibilities in Science Fair Competition—*schoolnet.connectok.com/science/rspns_p.html* (This site provides a list of science fair responsibilities for parents or guardians to consider, as well as tips and tricks on writing a paper, making an exhibit, and preparing a presentation.)
- Science Fair Studio—*school.discovery.com/sciencefaircentral/scifairstudio* (This site provided by *DiscoverySchool.com* provides information from Janice VanCleave's *Science Fair Handbook.*)

with the teacher prior to the start of experimentation. Doing multiple experiments within a project is a difficult task for some younger students. This challenge may be overcome by assigning groups of students to investigate different aspects of the experiment or project. Because most regional fairs now allow elementary and middle school students to do team projects, this process should not be a problem.

Make data quantitative

Another way of emphasizing this concept is "scientists prefer objectivity rather than subjectivity." Recently while judging a middle school fair in the category of chemistry, a colleague and I were astounded at the number of projects that failed to use any form of instrumentation to collect data, represent data in a quantitative fashion (numbers), present metric data in a graphical or tabular form, or provide any methods of verifying results. One student, who did the common project of determining which detergent cleans the best, had only one visual assessment (her own) of cleanliness. Basing conclusions on one, potentially biased visual observation without the assistance of any instrumentation obviously lends multiple weaknesses to a project. Be skeptical of a student's conclusion if there is no objective evaluation of data that can be displayed graphically.

Some ways to overcome this issue include requiring that:

- all projects have data that can be displayed in a graphical format,
- all projects use a minimum of one scientific instrument to collect data,
- students verify their results through repeated trials and/or the use of outside observers (use non-biased external evaluators/experimenters to get additional opinions rather than using one, possibly biased, researcher), and
- students associate observations with a system of ranking that provides a means to quantify their results. In the case of the "best detergent," a scale of one to five could be used (specific criteria should be developed so other evaluators could get similar results).

Note that not all projects may lend themselves to each of these requirements, but any exceptions should be discussed between student and teacher prior to the start of experimentation.

Parent or guardian help is fine, but know your project

Some teachers and schools see science fairs as a wonderful partnering opportunity for students and their parents or guardians. Many projects done outside of school necessitate adult involvement because of issues such as safety and the need to travel. For many students, this cooperative experience is memorable.

There are several ways to encourage the student and parent or guardian to collaborate prior to the fair date. Establish a science fair timeline/checklist and distribute it early in the year to help keep the students on track, reduce teacher anxiety, and provide encouragement at home. Letting parents or guardians know exactly when certain things are due may reduce or even help prevent those late-night, last-minute trips to the discount store for project supplies.

While teachers should encourage parent or guardian support, three criteria should be kept in mind. First, students should be involved in projects that relate to something that interests them; it should be an undertaking that enables them to research a topic of their choosing or solve a problem that fascinates them. Second, students should be the major players in the development of their project. Although parents or guardians may be partners, students should always be the driving force of the endeavor. They should understand that they have ownership of the project—which introduces the third criteria. Students should be able to clearly explain their understanding of the science fair project and the content material included. Not understanding the science concepts that they are supposed to learn during their experimentation indicates more than expected parental involvement and is a major infraction that will more than likely result in low marks.

Address this concern in the following ways:

1. Early in the year provide the students and the parents or guardians with a science fair timeline/checklist.
2. Provide the students with access to resources (such as books, journals, and websites) to assist them in selecting a topic for investigation. Provide them adequate background content and guide them in the experimentation procedure.
3. Send a letter home to the parent or guardian describing their function in the science fair process. (Use e-mail, phone, and notes to notify parents or guardians of a student's progress according to the timeline, particularly if a student is falling significantly behind schedule.)

Work on demeanor and presentation skills

One area of science fair projects that seems particularly weak for many students is their ability to present in a professional and yet personable manner. Good verbal skills are very important, and the ability to communicate well in public is an essential skill for scientists. Similarly, having good oral skills is a requirement when interacting with judges and the audience at a science fair. Use of terms such as "ok," "like," and "you know" are examples of communication errors to be avoided. Furthermore, while good presentation skills and knowing your project are important, the student's enthusiasm and overall attitude toward the project are equally important. Recently while judging projects at a middle school science fair, one student gave my colleague the impression that she really did not want to be there that day. Slouching and looking as if her dog had just been run over, she said almost in a whisper, "Well, what do you want me to talk about?" A student's disposition and demeanor are factors to consider even if neither criterion is a direct part of the science fair rubric that is being used.

In order to appeal to this concern, have students practice their project presentations in front of the class, and encourage students to videotape themselves and do a self-critique prior to the science fair. Have them base their assessment on a concrete rubric. (See Figure 1 on page 22 for a sample science fair presentation rubric.)

Conclusion

Making a commitment to teach your middle level students through inquiry can be a major undertaking for any teacher. Classroom management issues related to the generation of testable ideas and the organization of materials/resources present a daunting challenge. A science fair held at your school offers the structure and opportunity for a teacher to succeed at teaching through inquiry. Having external evaluators (such as judges) review the student science fair projects provides them with excellent feedback on how well they are succeeding at learning inquiry skills. Seeing how students are able to transfer their inquiry skills into a new situation, and thus model what scientists do in the real world and work place, is a worthwhile goal. Through collaboration with teachers and parents or guardians, science fairs offer a support system for middle level students to engage in full inquiry. Applying the six essential characteristics identified in this article will allow your students to gain significant inquiry skills and succeed as researchers.

Resources

"Making the Connection" published by the Council of State Science Supervisors (CSSS)—*csss.enc.org/safety*

"Rules and Guidelines" from the Intel International Science and Engineering Fair (ISEF)—*www.sciserv.org/isef/primer/rules_regulations.asp*

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