The Value of a Science Fair Project

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With the jam-packed schedules of today's families, why would either a student or a parent want to add one more major activity? Clearly, any school project assigned to a student should meet a stringent test for usefulness. Surprising to some, a science fair project is one of the best learning experiences a student can undertake. And, if it is taken seriously, it can be an excellent way to earn significant prizes, qualify for scholarships, and distinguish a college application.

Conceptually, a science fair project is very straightforward. A student chooses a scientific question he or she would like to answer. Then, library and Internet research on the question give the student the background information he or she needs to formulate a hypothesis and design an experiment. After writing a report to summarize this research, the student performs the experiment, draws his or her conclusions, and presents the results to teachers and classmates using a display board. Most students do their projects for a school science fair, but in many cases, students can enter that same project in fairs at the city or county level. This is the first step in competitions that lead up to the international level, where prizes total over $3,000,000 and the top winners take home $50,000 scholarships.

What makes a science fair project such a great learning experience is that it involves so much more than science. If the student is in middle school, the research report will most likely be the longest paper the student has ever written. Indeed, California curriculum standards call for papers of only 1-2 pages in length through the 8th grade, and any decent research report will be at least that long. The bibliography for the report will also be the first ever for some students. And, while library research is still important, these reports are a great way to hone computer research skills, as well as to learn the ins and outs of common office programs, such as word processors and spreadsheets. Most projects also involve a good deal of math, and all students get an opportunity to enhance their presentation skills when they prepare their display boards and discuss their projects with the judges.

A science fair project will also have a longer duration than any other assignment a student has done. In contrast to the typical school homework due the next day or perhaps a week hence, a science fair project requires a student to learn to plan over two or three months, a skill of immense importance in adulthood. Procrastination is definitely not rewarded.

Savvy students, especially those who work their way up to higher levels of competition, learn even more about communications skills. They learn the importance of selecting topics and fine-tuning their presentations in ways that will make them most likely to impress science fair judges. While some may bemoan this lack of purity in the pursuit of science, the fact is that even a professional scientist must compete for funds to continue his or her research. When better to learn how to persuade others than before your livelihood depends on it?

A science fair project even provides an opportunity for the discussion of ethical issues, such as plagiarism and falsification of data. Indeed, such a discussion is highly recommended. The ease of copying information from the Internet is hard to resist, and many students are far ahead of their teachers in understanding what is possible.

Of course, learning about science is at the heart of a science fair project. Our society relies more on science every day, and science fairs are a great way for students to become more knowledgeable about how the world around them works. Every citizen needs sufficient science literacy to make educated decisions about what he or she reads in the media, about health care, and about other every-day problems.

Preparing a science fair project is an excellent example of what education experts call *active learning* or *inquiry* (also "hands-on" learning). It is a very effective instructional method; indeed, it is recommended as a cornerstone of successful science teaching. Yet, according to the National Research Council, active learning is not employed often enough in the classroom and its absence is seen as one of the key factors behind kids losing interest in science and not performing to their potential.

Colleges want to see what students have done with the opportunities they had available to them, and science competitions are a fantastic opportunity. Typically, 2–4 percent of science fair entrants at the high school level move on to the top level of science fair competition, the Intel International Science and Engineering Fair (ISEF). While the competition is stiff, those odds are a lot better than the lottery. And clearly the state of New York is on to something. Students from Long Island came home from the 2003 International Science and Engineering Fair with prizes and scholarships totaling $114,500.

2008, North Carolina - State and National Level Science Fair Achievement Summary
260 Youth Participating at North Carolina State Science and Engineering Fair
Grades 3 – 12, and equivalent aged youth
$7,000 in awards presented
College Scholarships were given by

- Meredith College
- North Carolina State University
- and Ohio Wesleyan University

17, 5^{th} – 8^{th} grade youth were nominated for

- the Society for Science and the Public Middle School Program
- and the Discovery Education Young Scientist Challenge

North Carolina winners went on to the International Sustainable World Energy, Engineering, and Environmental Project Olympiad (I-SWEEP) – Houston Texas
52 Countries, 38 States
Awards Earned:

- one Gold
- two Bronze
- Special Award for Environmental Friendly Engineering Design

North Carolina winners went on to the Intel International Science and Engineering Fair (ISEF) – Atlanta Georgia
1550 High School aged youth
51 Countries
Awards Earned:

Overall:

- 3rd in Energy and Transportation
- 1st in Medicine and Health Services
- 3rd as a team award

Special Awards:

- 1st - US Air Force
- 2nd - American Institute of Aeronautics and Astronautics
- Full scholarship - Drexel University
- 2nd - American Association for Clinical Chemistry
- 1st - Ashtavadhani Vidwan Ambati Subbaraya Chetty (AVASC) Foundation
- 1st - National Anti-Vivisection Society

Prizes and scholarships totaling more than $115,200

Science Fair Tips for Success

by Amber Hess

Highlights

- Choose An Exciting Topic
  - Choose a topic that will interest and challenge you.
  - Do not be afraid to try something new—you will learn about it along the way.
  - Remember that complicated-looking projects do not guarantee a win!
- Learn Cool Theories
  - After picking a topic, spend a lot of time gathering background research.
  - Look for important concepts and equations that will explain how and why your experimental results turn out the way they do.
  - Find equations that will help you predict the outcome of your experiment. Learn all the important math, physics, chemistry etc. in order to fully understand your project.
- Be a True Scientist
  - Keep a detailed and up-to-date lab notebook with you regularly.
  - It will help you organize your thoughts and if you ever need to go back to see how you did something, you can find out.
  - Judges will want to see a lab notebook during the judging period.
- Trudge Onward!
  - During the experiment, do not get discouraged if you run into a lot of problems.
  - Do not stop if your experiment does not turn out the way you think it should.
  - It's okay if your hypothesis is proved incorrect.
  - Judges like to see persistence, so keep at it! Ask for advice if you need help. Judges love to talk about the problems you ran into and how you solved/tried to solve them.
- Use Your Brain (it's not as hard as it seems!)
  - Look at your results and ask yourself why they do/do not make sense.
  - Apply your background research to your results to help you figure out what happened during the experiment.

The Details

Choose an Exciting Topic

- Choose a topic that will interest and challenge you.
    - Easy topics like "How long does the flavor of bubble gum last?" will not impress the judges unless you study the molecular structure of each type of gum by using NMR. (If you have no idea what I'm talking about, that is precisely my point. Look up what NMR is.) Besides, you will not learn any cool science doing an easy project.
- Do not be afraid to try something new—you will learn about it along the way.
    - A lot of top science fair participants explore new areas, and they do just fine in science competitions.
    - You might find you enjoy an area you never would have picked otherwise!
- Remember that complicated-looking projects do not guarantee a win.
    - Simple topics can actually turn into great projects. At most science fairs, a student with a simple project who "knows their stuff" will win over a student with a complicated project who is not as great a presenter (this is especially true at higher level fairs).
- Do not choose a topic that is so open-ended that you will not make much progress.
    - Focus on one aspect of a topic to narrow down what you will work on.
    - Example: Let's say you want to create the world's first extremely intelligent robot. There is no way you will be able to complete this project in a year! Instead, you might pick one small part of the programming to work on. You could then emphasize how your piece fits into the building of a robot.
- Do not pick a broad topic unless you are an expert in that field or plan on learning a ton of information. Judges could pummel you with questions about aspects of the subject you are unfamiliar with.
    - Example: Global warming is creating a huge discussion these days. If you want to study global warming, you should pick one potential cause of global warming to focus on, or one area that shows the extent of global warming.

Learn Cool Theories

- After picking a topic, spend a lot of time gathering background research.
- Your background research is one of the most important parts of your project. It is the basis for what you will be presenting to the judges. **I cannot over-emphasize the importance of understanding the correct background information.**
- What is the purpose of background research?
    - It will help you formulate a hypothesis. The more you understand your topic, the better you can predict what might happen.

- It will help you create a well-designed procedure that will save you more time than one that is less thought out.
- It will let you foresee some of the inevitable problems that will come up.
- Analyzing your results will be easier and your conclusions will be more detailed.

- Look for important concepts, definitions, and equations that will explain how and why your experimental results turn out the way they do. Also research why your topic is important in today's society.
    - Example: if you were studying the fermentation of yogurt, you would need to study what bacteria are, what structures make them up, and what chemical processes they use to create yogurt. You would also need to learn why yogurt fermentation is important/ useful. Always answer the question: "Who cares?"
    - Example: if you were studying rockets, you would want to look up things like drag, how various models fly differently and why, physics equations to explain a rocket's behavior, etc. How rockets are used in the world is also important.
    - Example: if you were studying whether oranges lose or gain vitamin C after being picked, you would want to study the plant structure of oranges (including the structure of their cells); what vitamin C is used for in the plant; how humans use vitamin C; the chemical properties of vitamin C (its molecular structure, solubility, etc.); and titration, iodine, or starch techniques to measure the amount of vitamin C in the orange.
- Do not get discouraged if your research seems too difficult to understand. Start with the basics, and work upward. Sometimes you have to read an article a few times (or ten!) before you even begin to understand it. Push yourself to the limit of your understanding, and do not be afraid to tackle concepts you have never seen before (it is normal for much of your background research to look alien to you the first time you see it). One of the reasons people do a science project is to learn new information and challenge themselves.
- Go in-depth with your research. Try learning advanced concepts and be as detailed as possible. The more you know, the more the judges will be impressed.
    - Example: For the previous yogurt fermentation example, you would not just look up the definitions of the chemical processes that cause fermentation and write a few lines about how sugar is used to create lactic acid. Go further into the information! Study glycolysis, and go through each step in the cycle. Look up things like ATP, phosphorylation, oxidation, reduction, DPG, PEP, etc. These probably sound like complicated terms. But it's ok—you haven't learned them yet! Do not let something that sounds confusing halt your research. If you keep reading the information and ask questions, you will understand it eventually.

Be a True Scientist

- Keep a detailed and up-to-date lab notebook with you at all times.
    - It will help you organize your thoughts and if you ever need to go back to see how you did something, you can.
    - Judges will want to see a lab notebook during the judging period.
    - Write even the smallest detail in your notebook, because if you think you will remember a piece of information, believe me, you won't (I know from experience).
- Write up an organized plan. What do you think you will do each day during the experiment? What do you plan on doing?
- Try to think of all the possible problems you might run into during the experiment and rewrite your procedure to account for them. This includes possible errors in measurement, contamination, timing issues, etc.
- Do not cram your experiment into a short period of time unless your procedure calls for it.
- Do as many trials as possible (at the very least, do three for a longer experiment). The more trials, the more credible your data will be.

Trudge Onward!

- During the experiment, do not get discouraged if you run into a lot of problems.
    - Do not stop if your experiment does not turn out the way you think it should. Running into problems is not an excuse to quit your project.
    - It's okay if your hypothesis is proved incorrect. As long as you did an experiment, you will get credit.
- Judges like to see persistence, so keep at it! Always ask "why?" And "how?" Solving problems and repairing accidents may take a while, and the answer will only come with perseverance. If you just stop working, you will not accomplish anything. Do more research, walk through your procedure, and try to solve problems. These problems may lead to innovative solutions that you can describe during the judging interview. Try to fix the problems yourself first, but then ask a parent or advisor for advice if you are still stuck.
    - Example: Every single one of my projects had problems during the experiment. Instead of being embarrassed about it, I did more research, analyzed my procedure to find out what I did wrong, and I asked my mentor for help. In fact, an accident during my 2003 project turned into my 2005 project, which was the project that won the most prestigious awards!
    - Example: A scientist was investigating ways to make radars more powerful when he discovered that some waves melted a chocolate bar in his pocket. This led to the development of the microwave oven. If you pursue your

problems and accidents, you will end up with a great project. If you give up, you will not have anything.

- Judges love to talk about the problems you ran into and how you solved or tried to solve them. This shows them that you did not give up easily and that you pursued your problems. If you solved the problems, it also shows you were motivated to figure out a clever solution.

Use Your Brain (it's not as hard as it seems!)

- Examine your results and ask yourself why they do or do not make sense, and "what do my results mean?"
  - Look at the concepts/equations you researched earlier and apply them to your results.
  - Write in-depth explanations about your results and what you think happened during your experiment.
  - Discuss all the applicable equations/concepts and show how accurate they were.
  - Example: "Do Oranges Lose or Gain Vitamin C After Being Picked?" This is the same example as before. If your results showed that the amount of vitamin C increased if the oranges were left on the tree longer, why did this happen? How do oranges store vitamin C? What would be the benefit of storing more vitamin C?
- If you do not understand something, keep trying to find the answer. Search the Internet, ask a teacher or mentor, look through books or articles, etc.