TEACHER'S GUIDE TO THE SAN FRANCISCO SCIENCE FAIR

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INTRODUCTION

The Randall Museum invites your participation in the Annual San Francisco Science Fair. This event encourages students in grades 6 to 8 to conduct an original scientific investigation, making a best guess about the outcome and verifying its accuracy using good scientific procedures. The goal of the Science Fair is to encourage *participation*, not competition. The three subject categories are:

1) BIOLOGICAL SCIENCES: e.g., plant growth, cell structure, molds, preservatives, growth and development, animal behavior, ecology;

2) PHYSICAL SCIENCES: e.g., airplanes, probability, crystals, evaporation, solar power, electricity, computers, photography;

3) BEHAVIORAL, SOCIAL AND HEALTH SCIENCES: e.g., product tests, diseases, exercise, perception, aptitude tests, human behavior, medicine.

Students must follow the procedures presented in this booklet in order to have their project accepted into the San Francisco Science Fair. Please pay particular attention to project format and display, safety rules, and humane laws.

Some projects from grades 7 and 8 will pass on to the regional Bay Area Science Fair (BASF) held at the California Academy of Sciences the week of March 17. IF YOUR SCHOOL IS IN SAN FRANCISCO, YOU MUST ENTER OUR FAIR BEFORE GOING ON TO THE BASF. Our rules are designed so that projects qualifying for the S.F. Science Fair can generally go on to the BASF without revision. **Note: Students whose projects involve live animals, human subjects (including surveys!), controlled substances, or pathogens MUST submit proposal forms BEFORE BEGINNING THEIR EXPERIMENTS,** absolutely no later than February 1. Please see the BASF website, **http://home.pacbell.net/sfbasf/**, for complete guidelines, forms, and addresses.

This guide is intended to augment the accompanying STUDENT'S GUIDE TO THE SAN FRANCISCO SCIENCE FAIR. These guides should answer your questions regarding scientific methods and display format. If you have further questions, please feel free to call 554-9604.

WHAT IS A SCIENCE FAIR PROJECT?

A science fair project is a logical and careful investigation of a scientific problem. Your students will begin with an idea or question of interest to them, experiment to test their best guess (hypothesis) at the answer to the problem, and conclude by writing up their methods and results and displaying them.

HOW DOES A STUDENT DO A SCIENCE FAIR PROJECT?

MAKE SURE THE PROJECT IS A DISCOVERY, NOT A DEMONSTRATION.
A project that shows how rubbing a plastic comb through cat fur creates static electricity, causing things to cling to the comb, is a *demonstration* of an established scientific fact. An investigation of which materials best conduct static electricity, on the other hand, is a *discovery*. The difference is that in a discovery, the student did not know the answer, and could not have found it easily by looking in a textbook. **The following guidelines will clarify the differences for you.**

1. FINDING A PROBLEM TO SOLVE

A. WHAT INTERESTS THE STUDENT? All scientists (students included!) work on things that they find interesting. As you know, if students are disinterested, their work will show it. Have them choose topics that they enjoy and could investigate.

EXAMPLE: A student may be interested in human behavior patterns. This is too large and unspecific to handle, so the student must:

B. NARROW IT DOWN. The students need to limit their projects to single problems they can solve with the time and resources that they have. Students need to do RESEARCH using libraries, teachers, the Internet, and professionals in the sciences (e.g., a doctor) to find out what has been done (so they don't investigate something too obvious or trivial).

EXAMPLE: Most students have probably been told that listening to rock music makes studying more difficult. That may be, but the topic is still too general to do experiments on. Studying involves reading comprehension, memorization, problem-solving, etc. Thus, the student should select one factor, such as short-term memorization. Now the project is narrowed down to one tractable problem.

C. WRITING A HYPOTHESIS. The student must state the problem precisely and make a best guess at the answer, or HYPOTHESIS. It should be phrased so that it can be answered either "yes" or "no." Reassure them that a hypothesis is simply a statement to prove true or false by scientific research; it is not important that they guess "right." They will be judged on the basis of the originality, thoroughness, and clarity of their work, and you should not give a lower grade to work because the hypothesis proves to be incorrect.

EXAMPLE: One hypothesis could be: "People can perform a simple task of memory more accurately in silence than they can while listening to loud rock music." The hypothesis could also be that there is no effect, some effect, or the opposite effect. The student must select ONE possible outcome to test.

2. EXPERIMENTING

A. DESIGNING A TEST FOR THE HYPOTHESIS. The student must examine his/her best guess, WRITE IT DOWN, and design experiments to test it. All factors that could affect the results must be kept the same, or CONTROLLED, in all experimental trials, except for the factor being tested in the project. This can be difficult, because many factors that aren't obvious at first can skew results. Students must try to think of everything that could go wrong and figure out ways to avoid problems.

EXAMPLE: In the experiment testing the effect of loud rock music on memory, everyone has to hear the same music at the same volume; look at the same objects from the same distance, over the same amount of time, under the same lighting, and at about the same time of day; and so on. Everything should be identical, except that half of the test subjects will hear music (the EXPERIMENTAL GROUP) and half will hear no music (the CONTROL GROUP). Subjects should all have the same amount of time to think, and they should not be able to talk to each other during the experiment (that would probably change the results and ruin the experiment).

In this example, the student will need forms for the subjects to fill out, a stopwatch, music, and a box of objects to memorize. All materials necessary to do the experiment correctly should be ready before beginning.

B. MULTIPLE TRIALS

Students should do their experiments as many times as they can. Good science means examining a lot of information. If they do too few trials, unusual circumstances will have a greater effect on their results and thus decrease the value of their findings.

EXAMPLE: Maybe some kids are more used to rock music and can concentrate better with it playing, so the student should test a lot of kids to make sure that a few who can memorize better than most don't change the overall results too much. Remember: the more trials, the better, to ensure a more universal and useful conclusion.

C. QUANTIFYING OBSERVATIONS.

Students must design a way to put their information into unambiguous numerical or quantitative form. They must be precise in order for their work to be repeatable, so a judge can tell exactly what they did and what they observed. Make sure that students are not tempted to make their data fit their hypotheses -- this is not good science! <u>Stress that good scientists are OBJECTIVE and do not try to make their experiments turn out a certain way</u>.

EXAMPLE: The student should record exactly how many objects were recalled accurately by each subject. These numbers should be separated into music vs. no music groups and tabulated.

E. KEEPING A PROJECT NOTEBOOK FOR THE HARD DATA.

Have your students record ALL DATA and everything that happens during their work in a PROJECT NOTEBOOK, even if the data seem to contradict their hypotheses. Record-keeping is crucial because science is the attempt to understand what happens.

F. EXAMINING RESULTS AND COMING TO A CONCLUSION.

When they have finished their experimental work, students must ORGANIZE the information. Charts, graphs, tables, and diagrams are useful in organizing data clearly. Now that they have interpreted their experimental information, **do their results support their hypotheses? If not, reassure them that they should not feel bad. DON'T let anyone change a hypothesis to fit the data** (that's cheating!). A negative outcome to a hypothesis (the guess was incorrect) is just as important and illuminating as a positive one. If they have the time, they can make new hypotheses, experiment, and see what happens. This is the way science often works: with trial and error leading to further discovery.

EXAMPLE: Tabulate how many objects each person was able to recall and calculate averages for the two groups: music and no music. If the people who heard music remembered more objects on average, what are some possible reasons for this? These reasons should go into the report. Were the controls not good enough, or is something else happening? Maybe there were more girls in the music group, and girls might be better at memorizing (this is unlikely but should not be ruled out). Such thinking will lead to new questions.

3. COMMUNICATING THE RESULTS

A. WRITING A FINAL REPORT

Many students doing science projects have good ideas and do accurate scientific work, but fail to explain their projects carefully. The students should communicate everything necessary for another person to do the same experiment again. They should not assume that anything is too obvious to write down. Good science means good communication! Everything must be clearly explained in a FINAL REPORT, which should be connected to the finished display with a string or placed in a pouch along with the project notebook full of data. (Do not glue the report directly to the display.) The report should include:

TITLE
INTRODUCTION, including library/Internet research and interviews
HYPOTHESIS
PROCEDURES AND MATERIALS
DATA recorded during the course of experiments
RESULTS
CONCLUSIONS, including whether or not the hypothesis was correct.

B. MAKE SURE THAT THEY ARE THOROUGH. A thorough scientist always points out weaknesses or alternative interpretations of the data and suggests research strategies for further study. If they wish, your students can include a title page, table of contents, graphs, charts, and a bibliography in their final reports to make them look more "professional." Furthermore, be sure they use correct spelling and grammar.

EXAMPLE: There could be many uncontrolled factors that affected the results (age, sex, musical preference, etc.). Other interpretations may occur to the student: perhaps classical music at the same volume would not have the observed effect; or perhaps the lyrics in the sample, rather than the music itself, were distracting. New experiments can be done to test these new hypotheses. In this example, please note that the student did NOT prove that music makes it harder (or easier) to study. Rather, he or she obtained inferential evidence indicating that music probably makes it harder (or easier) to study.

4. MAKING A DISPLAY

Each project must:

1) Be on a three-sided, self-supporting poster structure. (See diagram)
2) Summarize the report with the headings listed.
3) Take up no more than 44 inches of space in front.
4) Be able to stand on its own for at least one week. Our staff will not repair flimsy displays. Foam core is the most durable display panel material. If mat board or thin cardboard are used, they should be reinforced on the back and sides.
5) Show the student's name and other identifying information only in one corner of the display, small enough to be covered with a 3"X 5" card during judging.

The students may also:

1) Place any equipment or materials they would like to show in front of their displays. However, **items from the following list are NOT acceptable and should be shown in photographs instead:**

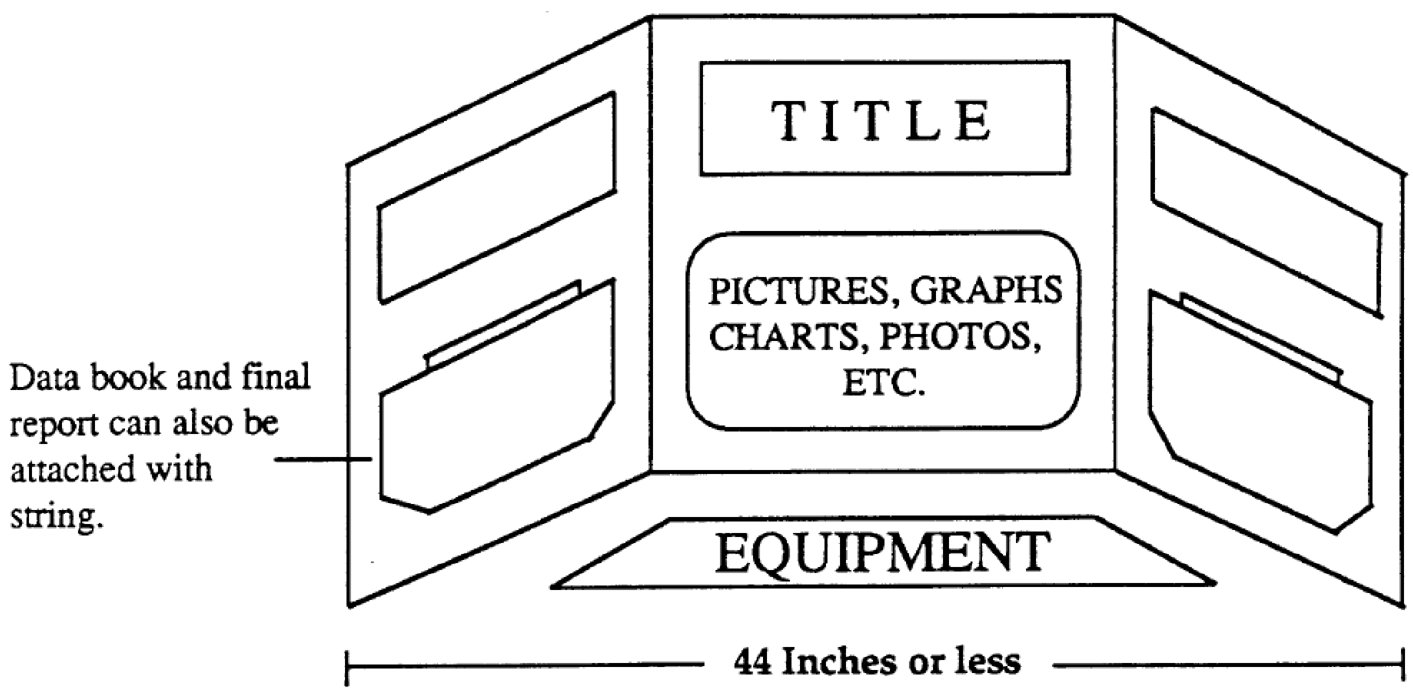
- ✘ LIVE OR DEAD ANIMALS (including insects), PLANTS, OR SOIL
- ✘ CULTURES (bacteria, molds, or fungi)

- ✘ ANY FOOD PRODUCT (including candy, gum, grains, popcorn, etc.)
- ✘ LIQUIDS of any kind
- ✘ SHARP OBJECTS, CHEMICALS, FIRE, or other potentially hazardous items
- ✘ Anything else that might spill, rot, or attract pests!

2) Liven up their displays with colorful graphics, drawings, photos, unusual type-styles -- anything to make them more dramatic, fun to look at, and fun to build!

In keeping with BASF guidelines, electricity will no longer be provided. Any working electrical apparatus may be powered only by batteries.

<u>DISPLAY</u>



SUMMARY OF HOW TO DO A SCIENCE FAIR PROJECT

1) FINDING A PROBLEM TO SOLVE

Students should:

A. Choose scientific topics that INTEREST them.

B. Use books, the Internet, teachers, scientists, professionals, etc. to NARROW IT DOWN to something that is both possible and interesting to do.

C. State each problem as a one-sentence HYPOTHESIS that they will answer "yes" or "no."

D. Make a DISCOVERY. They should NOT DO A DEMONSTRATION.

2) DOING EXPERIMENTS:

Students should:

A. TEST THE HYPOTHESIS. Students must decide what materials and instruments they will need to conduct their work and measure their results.

B. Use GOOD SCIENTIFIC METHODS. Students must make sure their experiments are well-controlled, repeatable, objective, and that they really test the hypothesis.

C. Run MULTIPLE TRIALS of their experiments so there will be lots of data from which to draw conclusions.

D. Record their data in measurable, numerical form; that is, QUANTIFY the results.

E. Write down everything they observe in a PROJECT NOTEBOOK. Observations should be in some kind of numerical form for easy and unambiguous analysis.

F. Organize all information from the experimental trials in tables or diagrams, and then DRAW CONCLUSIONS. Did they substantiate or disprove the hypothesis?

3) COMMUNICATING RESULTS

Students should:

A. Summarize the whole process in a FINAL REPORT. Include title, introduction, hypothesis, materials and procedures, observations and data, results, and conclusions.

B. Be aware of both strengths and weaknesses in their work. Are they THOROUGH, and do they suggest further investigations?

C. Construct a three-paneled DISPLAY, no more than 44 inches across and 30 inches front-to-back when standing, which outlines the final report. The display should include a title and be straightforward and clear. Students must use correct grammar and spelling. The display must be neat and interesting to look at, and MUST be sturdy enough to stand on its own for at least a week. Use recycled foam core and display board materials from past projects whenever possible.

SOME HELPFUL HINTS ON RUNNING YOUR LOCAL SCHOOL SCIENCE FAIR

1) Steer students away from routine projects such as effects of fertilizers on plants or which paper towel brand is the most absorbent. Also, judges get tired of too many similar projects and may not give an unadventurous project the attention it deserves.

2) Make sure that students working with humans or animals, either by experiment or by observation, submit proposals to the Scientific Review Committee by the BASF deadline and comply with all humane regulations. To avoid this headache altogether, steer students away from live animal projects.

3) Use parents, educators, and community contacts to full advantage to provide support and publicity for your local fair.

4) Difficulties often arise in judging projects and determining awards. Make sure you have an adequate number of qualified judges to select winners. No judge should look at more than twenty projects -- beyond this point it is difficult for them to do justice to each project.

5) Be sure that all participants receive praise for their efforts and for what they have learned.

6) Try to ensure that similar projects are grouped together so that judging can be carried out fairly. At the San Francisco Science Fair, we sometimes will re-categorize a project if we feel it belongs in a different place. This will not affect the outcome of judging.

7) Help students construct projects that are freestanding and will not require fixing later. Displays that are sagging or falling apart are difficult to read and may divert attention away from good work.

8) **Please try to make sure your students, especially those who win awards, do attend our Awards Ceremony on Saturday, March 1 from 10:30 a.m. to 12:30 p.m.** We will contact your school on Friday, February 28 to let you know who your school's winners are.

JUDGING CRITERIA

1) SCIENTIFIC METHODOLOGY -- Does the experimental procedure test the hypothesis? Do the data support the conclusions? Was the work well controlled; were an adequate number of trials done; is the work repeatable; were good records kept? Does the student recognize the limitations of the project and suggest further ideas for research?

2) CREATIVITY -- Are there signs of insight and originality of approach? Is the project a discovery and not a demonstration? Do clarity of thought and imagination play a role in its development?

3) COMMUNICATION -- Is the problem easily understood and concisely stated? Is it logically presented? Is the display attractive, dramatic? Is the exhibit neatly constructed, with legible lettering? Are grammar and spelling correct? Do the title and report convey information that helps to develop the project idea?

SCIENCE FAIR RULES AND GUIDELINES

NOTE: These rules and guidelines have been designed such that any entrant into the San Francisco Science Fair at the Randall Museum will be eligible to go from there into the Bay Area Science Fair.

1) All work should be done by the entrant. Outside advising in the early stages from parents, teachers, or professionals is fine, but the student must do his or her own work.

2) Projects done by teams of more than one student will be accepted into the San Francisco Science Fair at the Randall Museum, but the Bay Area Science Fair accepts only projects done by one student.

3) The student's name and any identifying information (school, teacher's name, etc.) may appear only on the back of the project and/or in a corner of the display small enough to be covered by a 3" by 5" card. Names will not be visible during judging. Awards or ribbons from your school science fair must be removed before setting up a display.

4) When set up for display, the project must be no larger than 44 inches wide by 30 inches deep and must be able to stand on a table by itself for at least a week. It should be labeled similarly to the diagram on page 6 in this booklet. Museum staff will not repair a poorly constructed display or in any other way attend to the equipment. Oversize projects may be disqualified.

5) All electrical apparatus must be built according to standard electrical safety laws. Projects that use 110 or more volts may not use push-button switches (doorbell type) or open-knife switches. All projects using 110 or more volts must have a main disconnect switch of a type approved by the National Board of Underwriters. All wires must be of the size and insulation appropriate for the current and voltage used. All electrical apparatus of 110 or more volts must be enclosed by barriers that positively prevent observers from receiving an electrical shock.

6) In keeping with BASF guidelines, electricity will no longer be provided by the San Francisco Science Fair. Working electrical apparatus placed on display can be powered only by batteries.

7) Dangerous chemicals or drugs, open flames, and explosives must not be exhibited.

8) No hypodermic needles or syringes or other sharp objects are allowed with projects.

9) No live or dead animals, plants, or cultures (bacteria, fungi, molds, etc.), food, or liquids may be exhibited; use photographs or drawings instead.

10) **Projects that involve animals, humans, pathogens, or controlled substances must meet the requirements of the Bay Area Science Fair**. For more information, see the BASF website, http://home.pacbell.net/sfbasf/.

11) ALL entrants are responsible for the installation, maintenance, and removal of their projects. **All projects must be removed from the Randall Museum by the Saturday following the Science Fair Ceremony.** Leftover projects will be discarded after this date. Museum staff will not be responsible for the security of items exhibited.