Eight steps to a successful science project

This is meant for older students (5th grade to middle school). For younger students, parents can use this s a behind-the-scenes guide to help students enjoy their project.

STEP 1: Choose a topic
What interests you? Choose a topic that you want to learn more about for the science fair. Anything can be a science topic – rocks, stars, fish, your friends, noodles, feathers, bread, plants, leaves, your dog, exercise, the beach …. Now, learn about it – go to the library, check the computer, read a book, ask an expert, play with it, explore it, visit it. Write down what you learn about your topic and start thinking about what you'd like to test or find out.

STEP 2: Ask a testable question???
Now that you know what other people know about your topic, what question do you want to ask? What did you read about that you want to try? What kind of a problem do you need to solve? The easiest way to create a testable research question is to figure out what you want to measure and then to compare that measurement between two things. There are a lot of things to measure: height, length, growth rate, number, time, distance … There are two basic ways to set up your comparison. In an experiment, you compare your treatment (what you manipulate) to the control (what you don't change). For example, heights of plants that get fertilizer as compared to the heights of plants that don't get fertilizer. You could also compare observations between two things that are already different, like density of rocks of one type versus density of rocks of another or favorite sports of people who are wearing boots versus sneakers. Simple is fine. All of science, everything we know, is built from small experiments comparing one thing to another.

Write your research question. A good format for a question is:
Does _____ (what you manipulate) have an impact on _____(what you think will respond)?

Or

Is there a difference in _____ (what responds) between _____ and _____ (what is manipulated or compared)?

Then you can write a hypothesis:
There is a difference between _____ and _____ because _____.

For example:
Research question: Does light quality have an effect on plant growth?
Hypothesis: There is a difference between the height of grass grown under light bulbs versus sunshine because the sunshine is composed of more types of light.

STEP 3: Design your methods
How are you really going to do it? This takes planning. Write out your proposed methods. Methods are like a recipe for your project. They explain exactly what equipment you will need and exactly what steps you will take. Writing it all down before you start is a really good idea.

It will help you think through all the details of your project (and it'll be all ready for your poster later).

Four good words to consider now are, REPLICATION, REPEATABLE, RANDOM and BIAS:

- Every time you do a project you are likely to get slightly different results so REPLICATION is a great idea. REPLICATION involves doing the same thing a couple of times or observing several different samples. Comparing boys' favorite food to girls' favorite foods, for example, you would ask more than one boy and one girl. Comparing wind speeds on hills versus valleys, you might need to visit a couple different hills and a couple different valleys.
- A big part of science is making projects REPEATABLE so that someone else can try it or modify it to try a new idea. Being very careful about your methods and writing down every detail will make your project REPEATABLE.
- What are you going to study? Leaves grown in the sun versus the shade? What if you pick all the sick-looking leaves and cover them with shade and then compare them to some healthy leaves exposed to the sun? This would be an example of bad planning or BIAS. A better idea would be to pick leaves that get shaded at RANDOM (label all the leaves and pull names out of a hat or flip a coin for each leaf). Selecting your sample at RANDOM will help you to avoid BIAS, influencing the outcome of your project.
- Other examples of BIAS include suggesting questionnaire responses, helping out one treatment and not the other (for example watering the plant with fertilizer A but not the plant with fertilizer B). Try to keep everything the same in your comparison except for the one thing you are comparing.

STEP 4: Do it!!!

Collect your data. Make a data table to organize your results before you begin. If you have to modify your methods, write down what changes you have to make. Remember to record each observation separately (and not just the average) and to record any zeros (they're data too). Take careful notes in addition to recording your data. Take pictures for your poster.

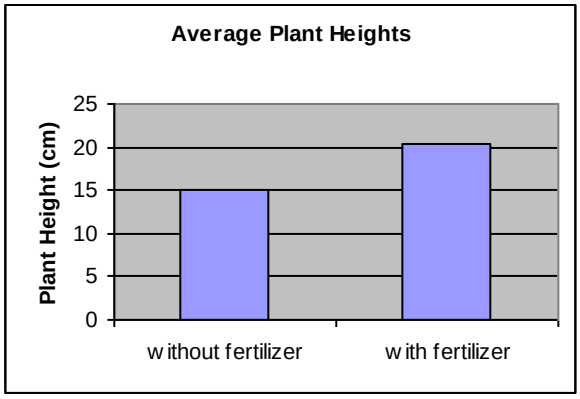
STEP 5: Deal with your data

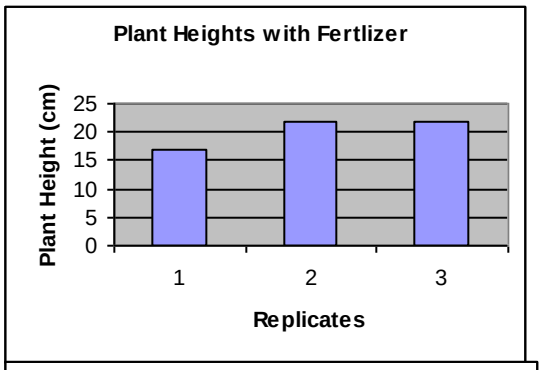
This can be the most fun and most creative part of your whole project. Make an organized table of your data with columns for each thing that you compared and rows for each time you collected data. If you compared things over time, the rows might also be measurements over time. If you compared a lot of things, you might need more columns.

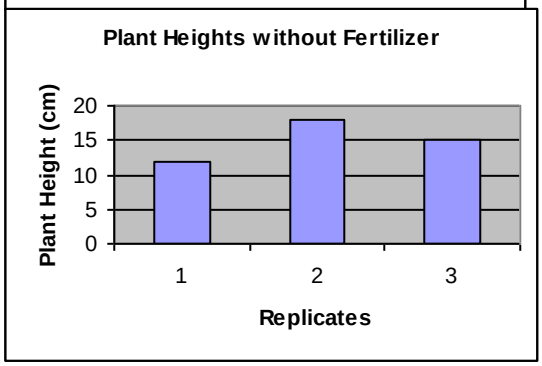
Replicates	**Plant height without fertilizer**	*Plant height with fertilizer*
1	In this box you would record the height of the first plant that you grew without fertilizer 12 cm	In this box you would record the height of the first plant that you grew with fertilizer 17 cm
2	In this box you would record the height of the second plant that you grew without fertilizer 18 cm	In this box you would record the height of the second plant that you grew with fertilizer 22 cm
3	In this box you would record the height of the third plant that you grew without fertilizer 15 cm	In this box you would record the height of the third plant that you grew with fertilizer 22cm

Look at your data; think about your data; try to understand your data. Does anything surprise you or did things turn out as you expected? Does any one observation stick out? Is there anything in your notes to help explain the patterns that you see?

Choose a graph type for your data. Only use a pie chart if you want to show pieces of a whole (things that add up to 100% for example). Use a line graph for things that are connected, like measurements over time or distance. Bar charts are simple but are often best. Explore ways to show both the average of several observations and the range of those observations. You might need a couple of graphs to show the whole story (see below). Be creative in how you draw the bars. This example would be more fun if the bars looked like plants. Label your axes!!







The table, the graphs, averages, and any information about unusual observations goes into the results section of your poster.

STEP 6: Make your conclusions

Look at your graphs and your data and think about what it tells you. What is the answer to your question? Did things turn out as you expected? Why or why not? What do you wish you had done differently? What other questions would you like to ask? If you had a million dollars, what further experiments would you do on this subject? These are questions you are likely to be asked by the science fair judges and the answers to all these questions go into your conclusion paragraph for your poster. You might even want to go to the library or check the Internet to help you understand your data or to help you think of future research project ideas.

STEP 7: Create your poster. You have everything ready: background information and a research question (your introduction), a careful description of what you did (your methods), graphs and data tables (your results), and some ideas about what it all means and what new questions you have (your conclusion). These go on your poster along with any photographs of

you doing the research, photographs of your study subject or of your experiment, samples, sketches, maps, examples, or diagrams. Lay it all out before you glue anything down! It can help avoid trouble if you write only on paper and glue the paper to the board (versus trying to write a title directly on the board). It helps to put each white piece of paper on a slightly larger colored piece of paper to make a frame or you can print on colored paper or draw a frame around each section. It is also a good idea to add references for any information that you learned from someone else (for example something you learned from a book or from the Internet). Add a border, make a really fun title, ask some questions or add some fun facts. Have fun with this part and be creative.

STEP 8: Bring your poster and your new knowledge to the science fair. Come ready to tell the judges why you were interested in the topic, what you learned, and what you wish you had done differently. Other common questions include: "What was the coolest part?", "Did it come out as you expected?". Some folks may look carefully at your project and your graphs and ask more detailed questions about why you chose to do your project one way or another or they might ask related questions about your subject. Prepare any interactive displays. Be proud of the new knowledge you have created with science.