Science Project Fundamentals

Part 1: The Science Investigation

First, there is a difference between a science ***demonstration*** and a science ***investigation***. A demonstration shows how something works. You already know what will happen at the end. For example, it's fun to show that mixing vinegar and baking soda (or Coke and Mentos) causes a reaction. You see the reaction, but that's all it is--a demonstration. No new information is discovered. You already know what the outcome is going to be.

A science ***investigation*** is a hands-on experiment where you learn something by observing what happens and gathering data as you go along. You may guess at the end result beforehand, but you won't know with certainty what will happen until you finish the experiment.

(Note: building a model is a science demonstration which may be acceptable at some science fairs. For example, showing how hydrogen powers engines is a science demonstration. Check with your teacher about the rules.)

The idea behind a science project is to see "*what happens if...*" you change one variable in your experiment while keeping all other conditions the same. In doing your science project, you will learn the Scientific Method.

The Scientific Method

Question

What do you want to figure out? What problem are you trying to solve? You should be able to write the question in a simple sentence. The more specific the question, the easier it is to keep "all conditions" the same and change only one thing. Your question has to be **testable** with the materials you have. (Do not design an experiment that needs expensive lab equipment or takes more time than you are assigned.)

Prediction

The prediction is your guess about what will happen. Suppose your question is, "Which temperature – hotter or colder – causes seeds to germinate faster?" Your prediction might be "I predict that seeds kept at a higher temperature will sprout faster."

It is important to word your prediction correctly. Do not say, "Higher temperatures are better for seeds." "Better" is not a specific measurement. “Faster” or “at a faster rate” is something you can measure. Write a prediction that can be proven in a measurable way.

It is perfectly fine for your prediction to be incorrect. That’s part of the scientific process. Set up your experiment, observe what happens, and collect your data. The data is the evidence that proves whether or not your prediction is correct.

Variables

List your controlled, manipulated, and responding variables.

Controlled variables: what factors will you keep the same?

- Same type of seeds
- Same pot type/size
- Same potting soil
- Same location (not one plant outside, one plant inside)
- Type of plant food, amount of plant food, and feeding times at the same interval (1 tbsp of water every 3 days)

Manipulated variable: what one factor will you change?

- Seeds are kept at different temperatures before planting

Responding variable: what are you measuring? What unit of measure will you use?

- Rate at which the seeds sprout into plants (measured in days)

NOTE: Set up a **fair test** -- **only change one variable** in your experiment. If you change more than one variable, the experiment becomes flawed. You won’t know with certainty which factor affected the outcome of your experiment.

For example, with the seed-sprouting experiment, you are testing seeds stored at 90°F and 50°F. **Vary the temperature**, but make sure the seeds are stored at specific temperatures for **the same length of time**. Do a “control group” of seeds at room temperature. All sets of seeds are stored at their temperatures for exactly 60 minutes before planting each group. Then make sure all of the seeds get the same amount of light and water after you plant them.

Procedure

How are you going to conduct your experiment? Describe step-by-step how you are setting things up. Document what you plan to do. This way, you or anyone can follow the same procedure in order to repeat the experiment. (Scientists do this so anyone can reproduce the experiment to see if he/she gets similar results. Scientists reproduce experiments hundreds, even thousands of times.)

Sample size is important. How many seeds will you test at each temperature? Allow a big enough sample so you can have a few "duds" in each group. If you only test one seed per temperature, how will you know there wasn't already something wrong with the seed to begin with? Put 3-5 seeds in each test group. Take the average of each set as your data.

If you have enough time, do **multiple trials**. Multiple trials ensure the results are consistent.

Keep a **science journal**. Write down every part of your experiment. Take measurements at frequent, regular intervals and record your data in your science journal.

Results

What happened? Describe what you see at the end of your experiment. Most importantly, show your data. Your data are the measurements you took during your experiment. Quantifiable data is empirical evidence. Be specific. For example, you observed that plants from your 90°F group were the first to sprout. They sprouted an average of 1 centimeter on the third day. Don't say, "I saw growth a couple of days after planting the seeds."

At the end of your experiment, plug your measurements into an excel spreadsheet to generate a graph or chart. Graphs or charts help visually show **trends or patterns in your data**.

Conclusion

It can be hard to understand the difference between results and conclusion, but the two are very different. The results are **what happened** in your experiment. The conclusion is **why you think it happened**.

Start your conclusion by stating whether or not the data supported your prediction. If it did not, that is also a valid conclusion. It does not mean your experiment failed.

"Here's what I thought was going to happen. Here's what actually happened." Do research on the internet to explain why you think things happened the way they did.

What did you learn? Can you make a recommendation from what you learned? Can you tie what you learned to the bigger picture?

Part 2: Display (see Diagram.pdf)

Your display must be easy to read and logically laid out. Judges read a display board from top to bottom, left to right. Arrange the display so that the parts of the scientific method are represented and in logical order. Do not make a judge hunt for information. Charts and graphs are a good way to show patterns or trends in your data. Pictures of your experiment can help tell the story, but don't overdo it with too many. This is not an art project.

Part 3: Presenting to a Judge

At this point, you are the expert on your topic. Be confident, make eye contact, and speak clearly (do not mumble). Talk about your experiment in logical order (for example, do not start with the data, start with the question). If you get stuck, take a breath and go to your display board for prompts.

If there are two of you, be sure to take turns presenting.

Judges like to hear what you learned from your experiment. They also like to hear you tie what you learned to the bigger picture.

Practice presenting to your parents and classmates. Good luck!