The Scientific Method

of doing

a Science Project

Ethics

It is important to know at the outset what you are *not* allowed to do.

It all revolves around honesty and respect.

It is about right and wrong, good and bad, responsible and irresponsible.

It is unethical to:

Pretend that someone else's work is your work (plagiarism)

Do research that causes harm to humans, animals, insects or the environment

Do research on illegal substances

Ask personal questions in a survey

It is unethical to:

Do anything for your project that may endanger anyone (eg. firearms are banned)

Do research that involves collecting plants or animals that are protected by Nature Conservation Laws

Do research on humans or animals that involves eating or drinking any medicines or unusual amounts of anything

It is unethical to:

Involve a child under 18 in your research without the written permission of their parents or guardian.

Do research that deprives a human or animal or insect of sleep, solids or liquids.

Display in public a comparison of brand name items without giving the brand name owner the opportunity to defend their product.

If there is any doubt about your project, make sure that you have written statements from your teacher and/or parents and/or a medical doctor and/or a veterinerary surgeon and/or a scientist and place them in your project file.

The Scientific Method

1. Ask a question
2. Doing Background Research
3. Constructing a Hypothesis
4. Testing your Hypothesis
5. Analysing your Data and drawing a conclusion
6. Communicating your results

1. Ask a Question ? ? ?

To be, or not to be, that is the question—

William Shakespeare (Hamlet)

A scientific question usually starts with:

How,

What,

When,

Who,

Which,

Why,

or Where.

Can you design a fair test to answer your question?

A "fair test" requires that you change only one factor (variable) and keep all other conditions the same.

If you cannot design a fair test, then you should change your question.

Your Science Fair project question should involve factors or traits that you can easily measure.

For example, a factor using a number,
or a trait like a colour.

2. Doing Background Research

Some essentials

Timeline

How much time do I have to complete the project ?

Today's Date :

Step 1 completed by (Date) :

Step 2 completed by (Date) :

Completion Date :

Due Date :

2. Doing Background Research

Some essentials

Timeline

Journal

- Get a notebook
- Make rough notes of EVERYTHING you do

Journal

Get a notebook

Make rough notes of EVERYTHING you do

Record successes and failures

Record sources of information

Make rough diagrams, charts, etc

Hand it in with your project -

evidence of your work

2. Doing Background Research

Timeline

Journal

Identify the **keywords** in the question for your science fair project

Use a table with the "question words" (why, how, who, what, when, where) to generate research questions from your keywords

Research questions

	Why	How	Who	What	When	Where
Effect						
Music						
Growth						
Pot plant						

What effect is there on the foliage?

What effect is there on the roots?

What effect is there on the shape?

Research questions

	Why	How	Who	What	When	Where
Effect						
Music						
Growth						
Pot plant						

What effect does classical music have on the pot plant ?

What effect does jazz music have on the pot plant ?

What effect does loud music have on the pot plant ?

Research questions

	Why	How	Who	What	When	Where
Effect						
Music						
Growth						
Pot plant						

How is the rate of growth affected by music?

Research questions

	Why	How	Who	What	When	Where
Effect						
Music						
Growth						
Pot plant						

Where does a pot plant grow best?

When does a pot plant grow the most? Summer?

What kind of pot plant is most likely to be affected by external factors?

2. Doing Background Research

Timeline

Journal

Research questions

What mathematical equations and/or graphs will I need to analyse and explain my project?

Has any research been done on the effects of music on pot plants ?

Who can help me or advise me with this project?

Make a list to keep track of ALL the books, magazines, and websites you read as you follow your background research plan.

This list of sources will later become your **bibliography**.

Collect the following information for each source:

Author name:

Title of publication:

Date of publication:

Publisher (publishing company):

Volume number:

Page number:

The Scientific Method

1. Ask a question
2. Do background research
3. **Constructing a Hypothesis**

A hypothesis is an educated guess about how things work.

"If ……then …… will happen."

You must be able to measure both "what you do"

and "what will happen."

The Scientific Method

1. Ask a question
2. Doing background research
3. Constructing a Hypothesis
4. **Testing your Hypothesis**

   Experimental procedure

   Variables

   List of materials needed

4. Testing your Hypothesis

Experimental procedure

Write the **experimental procedure** like a step-by-step recipe for your science experiment

A good procedure is so detailed and complete that it lets someone else duplicate your experiment exactly!

4. Testing your Hypothesis

Experimental procedure

Repeating a science experiment is an important step to verify that your results are consistent and not just an accident.

For a typical experiment, you should plan to repeat it at least three times

If you are doing something like growing plants, then you should do the experiment on at least three plants in separate pots

4. Testing your Hypothesis

Experimental procedure

Variables

Scientists use an experiment to search for **cause and effect** relationships in nature.

In other words, they design an experiment so that changes to one item cause something else to vary in a predictable way.

4. Testing your Hypothesis

Experimental procedure

Variables

Example:

cause

Place a metal bar in boiling water for 1 minute

and measure the expansion

effect

4. Testing your Hypothesis

Experimental procedure

Variables

These changing quantities are called **variables**.

A variable is any factor, trait, or condition that can exist in differing amounts or types.

An experiment usually has three kinds of variables: independent, dependent, and controlled

4. Testing your Hypothesis

Experimental procedure

Variables

The **independent variable** is the one that is changed by the scientist.

To ensure a fair test, a good experiment has only one independent variable.

As the scientist changes the independent variable, he or she **observes** what happens.

A "fair test" requires that you change only one factor (variable) and keep all other conditions the same.

4. Testing your Hypothesis

Experimental procedure

Variables

The scientist focuses his or her observations on dimensions the **dependent variable** to see how it responds heat to the change made to the independent variable

The new value of the dependent variable is caused by and depends on the value of the independent variable

4. Testing your Hypothesis

Experimental procedure

Variables

Controlled variables are quantities that a scientist wants to remain constant, and he must observe them as carefully as the dependent variables

Some people refer to controlled variables as "constant variables"

4. Testing your Hypothesis

Experimental procedure

Variables

For example, if we want to measure how much dependent variable water flow increases when we open a tap, it is independent variable important to make sure that the water pressure controlled variable is held constant.

Most experiments have more than one controlled variable

4. Testing your Hypothesis

Experimental procedure

Variables

In a good experiment, the scientist must be able to **measure** the values for each variable.

Weight or mass is an example of a variable that is very easy to measure.

Emotions like love and hate are not easily measurable in a scientific sense; therefore they would be poor variables to use in an experiment.

4. Testing your Hypothesis

Experimental procedure

Control group

Always try to have a control group.

A control group is identical to the experimental group except for the variable being tested.

The ONLY difference between the control group and the experimental group is the variable being tested.

4. Testing your Hypothesis

Experimental procedure

Control group

For example, if we are trying to discover the effect of classical music on plant growth, we will have a control group of plants that have exactly the same light, food, water, environment, etc, but the control group will NOT be exposed to classical music.

4. Testing your Hypothesis

Experimental procedure

Write the experimental procedure, step-by-step.

In each step, remember to mention each variable, and the control group.

Keep your experimental procedure as simple as possible.

The Scientific Method

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5. Analysing your Data and drawing a conclusion

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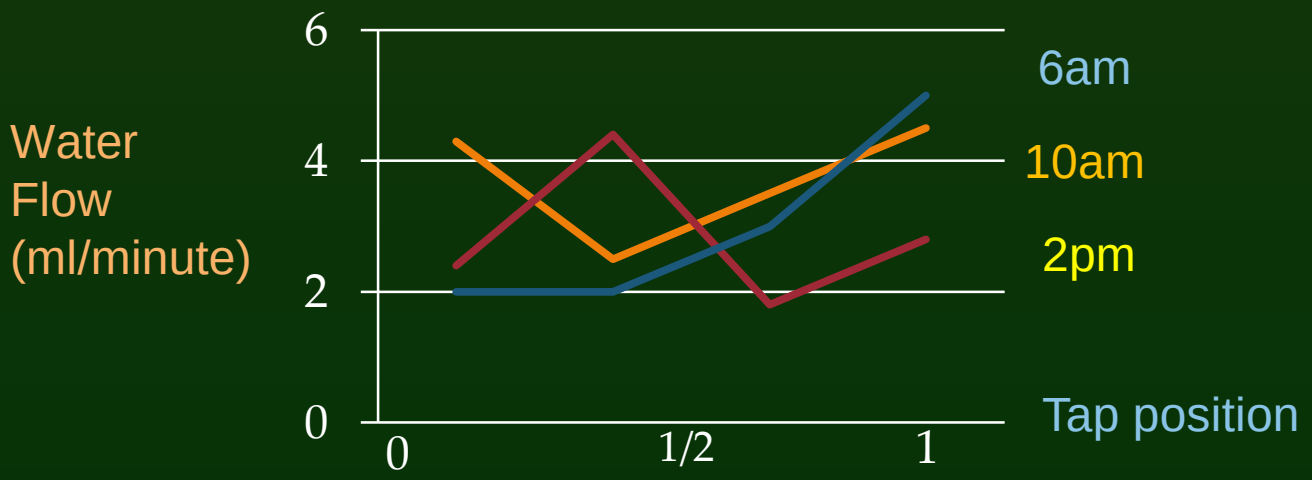
- **Review** your data.
- Try to look at the results of your experiment with a critical eye.
- Ask yourself these questions:
  - Is it complete, or did you forget something?
  - Do you need to collect more data?
  - Did you make any mistakes?

5. Analysing your Data and drawing a conclusion

Make sure to clearly label all tables and graphs.

Include the **units of measurement** (volts, mm, grams etc.)

Place your **independent variable** **on the x-axis** of your graph and the **dependent variable** **on the y-axis**.



5. Analysing your Data and drawing a conclusion

Summarize your science fair project results in a few sentences which explain how they support or contradict your original hypothesis

Include key facts from your background research to help explain your results as needed.

If appropriate, state the relationship between the independent and dependent variable.

5. Analysing your Data and drawing a conclusion

Summarize and evaluate your experimental procedure, making comments about its success and effectiveness.

Suggest changes in the experimental procedure and/or possibilities for further study.

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6. Communicating your results

6. Communicating your results

Your science fair project final report will entail pulling together the information you have already collected into one large document.

Your final report might be several pages long, but don't be overwhelmed!

Most of the sections are made up of information that you have already written.

6. Communicating your results

Project Report

6. Communicating your results

Problem Statement

State the question you asked, or the problem you investigated, or the aim of your project

Hypothesis

State your Hypothesis

6. Communicating your results

Introduction

Explain how you began your project.

Use your "Background Research"

Give keywords and relevant research questions

Explain where and how you gathered information

6. Communicating your results

Procedure (or Method)

1. Write in "the third person"
2. Give variables
3. Explain materials and/or special location and/or special equipment required
4. Use numbering
5. Be logical and concise
6. Give each step and important detail
7. Give relevant diagrams and/or photographs

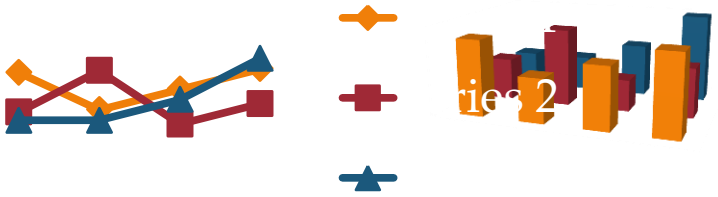
6. Communicating your results

Results

1. Observations
2. Data and Results in tables

Cats	Dogs	Rain
1	2	7
9	8	00

3. Graphs, pie-charts, bar-charts, etc



6. Communicating your results

Analysis of Results

1. Discuss and interprete your results
2. Be honest
3. Explain errors and/or deviations

Conclusions

1. State what you have learned.
2. Give ideas for future research

6. Communicating your results

Bibliography

1. List all of your sources of information and references that you consulted

Acknowledgements

1. Thank the people and/or organisations that helped you

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Create an Abstract

The abstract is a useful summary of the project.

It provides justification for the research.

The abstract allows the reader to decide whether your project write-up (the main file) is worth reading.

The Plagiarism Statement and the Abstract are found on the first two pages of the main file.

What do you need for the Science Fair?

1. Journal
2. Project File
3. An attractive summary of your project on A4 Sheets of paper to stick on a poster board
4. Abstract
5. Plagiarism Statement

Poster Board