Scientific Method

Method used by scientists to do research

Observation

- Observation is a key to science fair projects.
- Observations are based on curiosity and a desire to explore the world around us.
- Observations could include all of the human senses.
- Observations could also be through technological devices, for example microscope, pH meter, manometer etc.
- Observations could be qualitative or quantitative, but scientists usually like quantitative measurements, as they are more precise.

Question / Problem

- Usually an observation leads to a research question or problem that requires further investigation.

Example:
Question: Is the black soil better for the growth of sunflower seeds?
Or
Problem Statement: Do sunflower seeds grow better in black soil?

Hypothesis

- You should write the hypothesis before performing experiment or study.
- Based on observation, you may formulate a hypothesis, or possible answer to the question or problem.

- Hypothesis is an educated guess or logical explanation that could be tested.
- Hypothesis is also a type of prediction that forecasts how one variable (independent or manipulated) can affect a second variable (dependent or responding).
- Record your hypothesis in your notebook before you start your project experimentation.
- State the fact that you have based your hypothesis on your past experience or observation.
- Do not change the hypothesis even if the project results do not support your hypothesis.

***Example**:*
*S*unflower seeds grow best in black soil.

Plan an experiment

- Do the background research and review the published materials related to your question or problem.
- Design a project-experimentation to test the hypothesis.
- Design an experiment that will permit an appropriate evaluation of a given hypothesis.
- It is important that only one variable (independent variable or manipulated variable) is changed, while keeping the other constant. This makes an experiment “controlled”.
- Include a precise way of measuring the results.
- Collect more than one set of data to verify your results.
- Write down the steps you will follow to do your experiment.

Conducting an experiment

- Follow the steps you wrote down in planning the experiment.
- Observe and measure the variables carefully with control.
- Keep all the data recorded in a notebook or project journal. It is important proof that you actually did the project. During the presentation and interview, the judges will want to see this work.
- Test your hypothesis through your procedure of experimentation (data collection) and analysis of your data.
- Always use metric measurements.
- Collect more than one set of data to verify your results.

Note: Items 2.3 and 2.4 are also called a procedure.

Results

- Results include data and analysis.
- Organize the data in the form of charts or tables or graphs so that it gives quick and easy interpretation.

Conclusion

- This is a brief summary of what you have discovered based on your experimental results.
- State your findings in relationships of one variable with the other.
- It indicates whether or not the data support your hypothesis. You will be accepting or rejecting your hypothesis based on the results of your investigation.

- Do not change the hypothesis, if your results are not what you expected.
- You may find the results of your project inconclusive. If this is the case, try to find why. Give reasons why you think the results did not support your hypothesis.

Research Paper:

Research paper should be available along with the project data book and an abstract at the time of project presentation and judging. A good paper includes following sections.

Project Title

- Select a title that summarizes your project.
- Keep it short and simple.
- It should be attention grabber and intriguing to the casual observer.
- It should stand out visually.

Table of Contents

- This allows the reader to quickly go through different parts of your project.
- Make sure to list the different sections of your paper by page numbers

Abstract

- Abstract is important, as it is a representation and brief overview of the project.
- It should be no longer than one page, containing a maximum of 250 words according to Intel International Science and Engineering Fair (ISEF).
- It should include the project title, your name, and school on top. Starting on the next line, purpose (hypothesis) of the project, method of research, pertinent data, conclusion, and application.
- Use short sentences and do not abbreviate. Use 'past tense' in your descriptions. Appropriate scientific terminologies should be used. Remember to correct your spelling, grammar, and punctuation.
- Discussion, acknowledgements, and unnecessary details should not be included in the abstract.
- Most science fairs will require a copy of your abstract to display at the exhibit and the other copies to handout to judges and visitors on the day of public-visitation.

Introduction

- This section will introduce the topic of the project.
- It should state what information or knowledge led you to your hypothesis.
- Include what prompted you to do this research and what you hoped to achieve.
- It is a statement of your purpose along with the background information that led you to do the study.
- If you are going to state references in your report, this is where more citations are likely to be given.
- The introduction is written before starting the project and collecting the data, therefore results should not be included under this heading

Materials and Method (or procedure)

- This part of the report contains information about the project experiment.
- It should include procedural steps with materials used, calculations, amounts, and measurements.
- Describe in detail the methodology you have used to collect the data.
- If you have designed an apparatus or equipment, then include a detailed design or diagram.
- It is important to follow the same procedure every time the experiment is repeated to get consistency in results.
- The purpose of writing a procedure is to provide detail method of your experiment, so that if someone else wants to follow your procedure, then that person should be able to achieve the same data.

Results

- Results include data and analysis.
- Present the data in the form of charts, tables, or graphs.

Discussion

- This is the heart or the essence of your paper.
- Discussion of your experimental results is a principal part of your project report. Therefore, begin by presenting all your observations and data.
- In this section, interpret and critically evaluate your results in light of what is already known, and explain your new understanding to the problem.
- Develop your argument for and against your hypothesis.
- Explain whether the data you have obtained support your hypothesis.
- Acknowledge any anomalous data or deviation from what you expected.

- Do not make generalized statements that are not based on your data, known facts, or reason.
- Be sure to relate your findings to earlier work in similar studies and cite those studies
- Derive conclusions based on your findings about the process you are studying
- Explore the theoretical and/or practical implications of study or findings

Conclusion

- Draw your conclusion based on the analysis of your data. You should conclude whether or not results support your hypothesis.
- This is the final outcome of your project or experiment.
- May prove or disprove your hypothesis

This is in addition to what has already been described in section **2.6

Acknowledgement

- Give credit to the institutions or people who have assisted you in your project

References or Bibliography

- These are the list of citations used in your research paper
- Your references should include any documentation that is not your own
- Please adopt standard citation format of references (CSE or MLA)

Example from a journal article:

Meise CJ, Johnson DL, Stehlik LL, Manderson J, Shaheen P. 2003. Growth rates of juvenile Winter Flounder under varying environmental conditions. Trans Am Fish Soc 132(2):225-345.

Example from a book chapter:

McDaniel TK, Valdivia RH. 2005. New tools for virulence gene discovery. In: Cossart P, Boquet P, Normark S, Rappuoli R, editors. Cellular microbiology. 2nd ed. Washington (DC): ASM Press. p. 473-488.

Example from an electronic article:

Hong P, Wong W. 2005. GeneNotes: a novel information management software for biologists. BMC Bioinformatics [Internet]. [cited 2007 July 24]; 6:20. Available from: http://www.biomedcentral.com/1471-2105/6/20

Project Display Board

Displaying your project in science fair is the most important tool for the presentation of your research. Therefore, it should be clearly visible, neat, and should have all the information required at the time of judging.

Title

Your title should be the *largest text* on the display board. It should be readable from minimum of six feet or from across the room.

Display Board

Standard display boards are tabletop and of three-panel (tri-fold) type, but a freestanding type and commercially available role-able laminated poster boards are also acceptable. According to the rules of International Science and Engineering Fair (ISEF), your project display should fit into the following configurations.

Dimensions: 122 cm (48”) in width or side to side, and 76 cm (30”) in depth or front to back. The permitted height from floor to the top should not be more than 274 cm (108”).

Science Fair Board Layout: This is not the same as your written report. The objective of a display board is to present your research in a way that others can easily understand.

- Title should go on the central panel.
- People have a tendency to read the project board like reading a book, from top to bottom and left to right. Therefore, when setting up the board, start putting the earlier work of your research on the left panel and the right panel should be used for the work done at the end of the project.
- Presentation on the left panel should display the research question or problem, hypothesis, introduction, materials and method or procedure.

- The right panel should display your results, conclusion, acknowledgements, and at the end your name and school.

- Intel ISEF also requires an abstract that should be displayed at the bottom of this panel.

- The central panel is the most significant part of the entire board as this panel should stand out to draw attention to your display. It should display data, graphs and pictures as these illustrations will make the project easy to comprehend.

- However, do not clutter the central panel with unnecessary pictures and graphs as this will confuse and distract the viewers from the main research of your project. A similar effect is produced by too much texting on the display board.

- Graphs, tables and pictures should be neatly labeled and numbered for citation in the text. As far as pictures are concerned please follow the rules and regulations of ISEF.

Writing Format:

- All text material should be typed or printed in black using white paper.

- Letters for the title should be 3 to 4 inch high.

- Subtitles (e.g. Hypothesis, Introduction, Material and Method etc.) should be in font size 36.

- Use number 16 or 18 font for the text.

- Use 1” margins.

- Use only 8 1/2 x 11 paper.

- Put a blank line between paragraphs.

- Titles and subtitles should have dark colors so that they standout.

- Use the computer to generate labels in appealing colors.

- You must not use more than three contrasting colors.

- Never use neon colors as they do not look professional and would distract the onlooker.

- All the graphs, figures and diagrams should be appropriately numbered and labeled.

Display Materials or Demonstration Equipment: Apart from displaying the scientific report, logbook and abstract, the following items should be considered to be displayed:

- Mock-ups of three-dimensional design used in the research.
- Laptop illustrations of the procedure.
- PowerPoint and videos would be excellent complements to the text and graphics on the board.
- Display your demonstration equipment in engineering projects.
- Items that are not allowed to display are living organisms, chemicals, drugs, human or animal parts, food, body fluids, preserved vertebrates or invertebrates.
- For further rules and regulations, please browse through the Intel ISEF website.

Oral Presentation

The Oral Presentation is your time to be judged and your opportunity to impress the judges with your project, knowledge, and enthusiasm. The Oral Presentation is an important part of the science fair project. Remember that you are in competition, and better the judges understand and appreciate your work, the higher the scores you will get. People are affected not only by your knowledge but by the way you look, the way you talk, and the way you act.

- Dress professionally and appropriately with decent clothes.
- Be polite, pleasant and cheerful.
- Speak loud and clearly (not too loud or not too soft).
- Avoid verbal clutter (Um, Ah, like, you know, etc.).
- Do not chew gum or candy.
- Stand to the side of your display board and face the crowd.

- Introduce yourself including your grade and your school.
- During your presentation, maintain eye contact with the judges.
- Open your presentation with an interesting statement or question about your project.
- Explain a little bit how the idea of your project originated.
- Thoroughly research your subject for background information.
- Organize your presentation and follow the steps of scientific method.
- Try not to read from the script or the board.
- Particularly emphasize the area of the project where you were creative and innovative.
- Briefly mention any problems you had during the experimentation and how you rectified them.
- Involve the judges during your presentation by showing and handing them your designs, research equipment, or gadgets.
- Use your charts and graphs to present the data along with illustrations and pictures.
- At times, a memorized speech becomes problematic as it can become emotionless, flat, and boring. Therefore, try to avoid memorization. To help you remember, you can make some index cards with hints and points to refer to while speaking.
- Time yourself to be sure that you finish in the allotted time. Remember to allow time for questions and answers.
- Try to think of questions that the judges may ask and be sure that you can answer them completely and concisely. If you do not know answer, then be honest. Judges like honesty. Do not fake the answer.
- If you disagree, explain your opinion, but do not argue with the judges.
- Finally, what is the significance of your research and its application? Inform the judges if any new ideas or any questions were developed by doing this project, for one project often leads to another project.
- Close your presentation by thanking the judges.