Scientific Method Overview

The scientific method is a way of telling the truth from lies or delusions.

The scientific method is an organized way to figure something out.

The scientific method is a way to ask and answer questions by making observations and doing experiments.

The scientific method is a technique for investigating and getting new knowledge, or correcting and integrating previous knowledge.

The four parts of the scientific method are:

1. Framing the Investigation
    A. Make an observation
    B. Ask a question
    C. Research the subject
    D. Form a hypothesis
2. Designing the Experiment
    A. To test the hypothesis
    B. Must be safe
    C. Must be testable
    D. Correctly use equipment
3. Collecting and Presenting Data
    A. Notes (field notes)
    B. Data Table
    C. Units
    D. Graph (visual representation)
4. Analyzing and Interpreting Results (The Conclusion)
    A. Check and USE data
    B. Check problem statement and hypothesis
    C. Include observations
    D. Synthesize data
    E. Answer the prediction, question or hypothesis

Framing the Investigation:

Step #1: Make An Observation

1. Observations: use our senses to gather information about the problem, and record FACTS! Only the FACTS!
2. Inferences: logical interpretations based on observations.
3. Predictions: what we think will happen in the FUTURE based on our observations and inferences.

Step #2: Ask a Question (Problem Statement)

1. Think – what must be fixed or solved?
2. Be concise, specific and clear. Who? Which? What? When? Where? Why? How?
3. The question must be phrased in a way that is answerable and measurable.
4. There can be only 1 major idea presented in the question.

Step #3. Background Information: Research and Observations

1. Take time to gather information about the situation or problem
2. Sources: textbooks, references, experts, reliable Internet sources, creditable universities, professional journals, etc…
3. Carefully read and collect information, document your sources

Step #4. Hypothesis

A hypothesis is a possible solution to a problem that is testable.

Components:

"IF. . ." this is the condition or the situation; what you are going to do.

"Then. . ." the expected results; what happens in response to the "IF"

"Because . . ." this is the scientific reason why the "If" caused the "Then"

Designing the Investigation

Purpose: to test the hypothesis and solve the problem or answer the question.

Variables

1. Manipulated/Independent Variable (MV or IV): the variable that is purposely changed to test the hypothesis. (Input or cause)
2. Responding/Dependent Variable (RV or DV): The factor that may change in response to the manipulated variable. (Output or effect)\
3. Constant/Control Variable: What is constant or unchanged in an experiment, allows you to tell if the MV caused the change.

Lab Write-Up

1. List equipment and materials needed for the investigation.
2. Identify safety needs and safety equipment in the lab. Also mention safety needs of equipment.
3. Diagram of lab set-up that is labeled.
4. Procedure is written in a step format 1, 2, 3… a sequence that is understandable and can be replicated.

Collecting and Presenting Data

Purpose: To record data in a way that can be easily understood and show patterns and relationships.

Criteria

1. Collect data that is consistent with the lab design.
2. Record relevant and accurate data in an organized way.
3. Display data to support analysis.

Ways to Display Data

1. Field Notes/Observations: Detailed, explicit, neat; words and drawings as are appropriate. (Journaling)
2. Data Table: Collect and display data (Example)

Manipulated Variable	Trial 1	Trial 2	Trial 3	Average

3. Graphs: Show Patterns and Trends (data in a picture format)

   A: Bar Graph: Compare things between different groups.

   B: Pie Chart: Compare parts to a whole.

   C: Shows changes over time.

Types of Data

Qualitative Data	Quantitative Data
• Deals with descriptions • Observed but not measured with traditional lab equipment • Examples: textures, smells, appearances, feelings, color. . . • Qualitative → Quality	• Deals with numbers • Data that can be measured • Examples: mass, volume, temperature, height, time • Quantitative → Quantity

Analyzing and Interpreting Results: The Conclusion

Purposes: A conclusion paragraph contains a description of the purpose of the experiment, a discussion of your major findings, an explanation of your findings, and recommendations for further studies.

Criteria: Present and relate the investigation results to the hypothesis.

Six Steps of writing a Conclusion (write in paragraph form)

1. Yes/No – answer if the hypothesis was supported or not.
2. Summarize the hypothesis, don't just restate it!
3. Use data to support your conclusion, if the hypothesis was correct or not. Interpret, and synthesized the data.
4. Identify possible errors that influenced the experiment and how they affected the lab data.
5. Identify ways to eliminate these errors.
6. Suggest ways to improve upon the experiment, or to further test it.

Writing a conclusion – Sentence frames

Step	Possible sentence frames (sentence starters)
1	"The hypothesis <u>was/was</u> not supported."
2	"The purpose of the experiment was to investigate the effect of the (IV) on the (DV)"
3	"The hypothesis that (insert hypothesis) was (supported/partially supported / not supported) by the data . . . (use/explain data)."
4	"Errors in this experiment include . . . these effected the lab by…
5	"To eliminate these errors . . . "
6	"Future experiments should . . . because / this would show . . ." "The experiment could be improved by . . ."