Science Project Handbook

BENCHMARKS LEARNED THROUGH SCIENCE PROJECTS:

SC.8.N.1.1 Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions. **HIGH**

SC.7.N.1.2 Differentiate replication (by others) from repetition (multiple trials). **MODERATE**

SC.7.N.1.5 Describe the methods used in the pursuit of a scientific explanation as seen in different fields of science such as biology, geology, and physics. **HIGH**

SC.6.N.2.2 Explain that scientific knowledge is durable because it is open to change as new evidence or interpretations are encountered. **MODERATE**

Let's begin.

PROJECT DATA LOG

Your Science Project Composition Book is an important piece of evidence that helps you track data and the progress of your project. Keep a record of everything you do in it from the moment you start looking for a scientific problem to the very end. Take notes as you work on your project. Date each time you work on your project. Take time to organize your thoughts so that every entry is as neat as possible. This will show how much effort and time you spent on your project. You may even want to make sketches or take pictures as you go too and paste them in your composition book. This record is the most important part of your project and you will want to display it with your completed project.

To set up your DATA LOG you will need a new composition book. Number every page. Use ink for everything in your book. Reserve the first page for a title page. Pages 2,3, and 4 should be for your table of contents. Each time that you make an entry you should enter the information into the TABLE OF CONTENTS. Everything that you do, think, discuss, research, notes you make, and references you find should be in your DATA LOG in INK.

.

In your Project Data Log begin to brainstorm by listing 5 things you like to do. List a few questions about what you can learn about these topics. Then …

IDENTIFY THE TESTABLE QUESTION OR PROBLEM:

a) *Begin by observing* your surroundings, making inferences and *asking testable questions*.
b) Look for *problems* in your life or surroundings that you could solve...then ask a question about it.
c) Use the internet to search for information on an *interesting topic*. Read about the topic and see if you can come up with a testable question in your search.
d) As a last resort look at the internet for previously completed science projects and pick one that is rarely done or put a new spin on an old topic.
e) Choose something that interests you and change the experiment up so that it becomes your experiment.

f) Make it a challenging project that is middle school appropriate.
g) If your first idea is not approved *don't give up… keep searching* and checking with your teacher.
h) Record everything you do and all the sources you use in your Project Composition Book

TESTABLE QUESTIONS

1. Written as a question. (?)
2. Something that requires experimentation (not to be started without teacher approval).
3. Something that can be done within the time constraints you have (usually one to two months).
4. Something that provides USEFUL information.
5. Something that is testable.
6. Something that will provide enough data to make a reasonable conclusion.
7. Something that will have results that you can **measure (quantitative data). (MEASURED BY NUMBERS)**
8. Something appropriate for your grade **(not too elementary).**
9. Something that YOU are interested in.

VARIABLES & YOUR HYPOTHESIS:

The hypothesis is a statement that tells what you think the answer to that question will be. Your answer is based on what you know, which is based on your research and observations you made BEFORE you came up with your hypothesis. (IT IS OK IF YOUR HYPOTHESIS IS NOT SUPPORTED BY YOUR DATA. MORE KNOWLEDGE IS GAINED FROM FAILURES THAN FROM SUCCESSES!)

Your hypothesis statement will include three parts:

1. What YOU will change (test) between the groups. **The Tested (Independent) Variable**
2. What DATA you are measuring as a result. **The Outcome (Dependent) Variable**
3. WHY these results are expected. **What have you observed that makes you think this?**

EXAMPLE:

Problem Question: What effect does TEMERATURE have on the ELASTICITY of rubber bands?
Hypothesis: IF I change the TEMPERATURE (Ind. Var.) of rubber bands, THEN I predict that the bands that are heated to 90°F will have the greatest ELASTICITY (Dep. Var.) because most solids expand when heated and contract when cooled.

One entry that follows your testable question, identification of your variables, and research notes will be your procedures.

PROCEDURES

Clear procedures are important.
-They should be SPECIFIC, nothing should be confusing if anyone tried to replicate your experiment.
-They are listed in a "step 1", "step 2" format.
-They are thorough enough so that anyone could replicate the experiment and get similar results.
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!
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 five times (more is better).

The PROCEDURE I will follow to test my variable is:

Step 1:_____
Step 2:_____
Step 3:_____
Step 4:_____
Step 5:_____
Step 6:_____
Step 7:_____
Step 8:_____
Step 9:_____
Step 10:_____

(Attach an additional page of procedures if more than 10 steps)

Don't forget to put in your materials.

MATERIALS LIST

Quantity and Units	Description
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____
• _____	_____

In your DATA LOG you will need to prepare a proposal draft. You may copy the following, fill it out, print it and tape it into your log. YOU MAY NOT BEGIN EXPERIMENTATION BEFORE THIS DRAFT IS APPROVED BY YOUR TEACHER AND A FORMAL PROPOSAL HAS BEEN TYPED AND SUBMITTED ALONG WITH FORMS 1, 1a, AND 1b TO YOUR TEACHER**.**

SCIENCE PROJECT PROPOSAL/DRAFT

_____Please revise and resubmit.

_____ Make the following corrections or adjustments.

_____ This project will require IRB/SRC review. You will need to do the following before you can submit it for further review.

_____You may proceed to your formal proposal. You may not begin experimentation before you have received final approval.

_____This project is not acceptable for the following reason(s)

1. **Project Title (in the form of a question you want to answer.)**

"_____
_____"

2. **Purpose of experiment (Why do you want to do this experiment? What do you hope to find out?)**

_____
_____
_____
_____

3. **How will you experiment meet your goals and objectives? (What is the relationship between your project and your goals & objectives?)**

_____
_____
_____
_____

Identify the following:

4. **TEST/INDEPENDENT Variable:_____**

5. **OUTCOME/DEPENDENT Variable:_____**

6. **EXPERIMENTAL Group:_____**

7. **CONTROL Group:_____**

8. **What are your CONTROLS (things you keep the same)?**

_____

_____

9. **How will you measure your DEPENDENT variable(s)? (Quantitative [NUMBERS] Measurement):**

_____

_____

10. **How many times will I REPEAT my experiment? Or what will be your sample size?**

_____

_____

11. **The MATERIALS and amounts of each I will need to complete my experiment are:**

HOW MANY?	TOOL/MATERIAL/INSTRUMENT

12. **The PROCEDURE I will follow to test my variable is:**

Step 1:_____
Step 2:_____
Step 3:_____
Step 4:_____
Step 5:_____
Step 6:_____
Step 7:_____
Step 8:_____
Step 9:_____
Step 10:_____

Add additional lines if needed

13. **I will count:**_____
14. **I will measure:**_____
15. **I will observe the following:**

_____

_____

16. **You need to have a table and graph. Your independent variable goes on the X-AXIS and your dependent variable goes on your Y-AXIS.**
    a. **The x-axis will show:**_____
    b. **The y-axis will show:**_____

17. **These are the 5 (minimum) websites, books and periodicals where I found information about my project:**
    _____
    _____
    _____

I have discussed the proposal draft with my child and I support his/her pursuing the project. I realize that the teacher will make the final decision about the project unless this project must be referred to the school IRB or the Regional SRC.

Parent signature _____
Date _____

After you get approval to complete the formal Research Proposal you will need to complete Forms 1, 1A. 1B, and Form 3 Risk Assessment. You will also have to prepare a complete RESEARCH PLAN. You will not receive permission to conduct research (do your experiment) until the forma proposal is accepted. If you require SRC or IRB approval, your teacher will help you understand what needs to be finished.

RESEARCH PLAN

Required For all Projects

Provide a typed research plan and attach to Student Checklist (1A). Please include your name on each page.
The research plan for ALL projects is to include the following:
A. Question or Problem being addressed
B. Goals/Expected Outcomes/Hypotheses
C. Description in detail of method or procedures (The following are important and key items that should be included when formulating ANY AND ALL research plans.)
- **Procedures: Detail all procedures and experimental design to be used for data collection**
- **Risk and Safety: Identify any potential risks and safety precautions to be taken.**
- **Data Analysis: Describe the procedures you will use to analyze the data/results that answer research questions or hypotheses**

D. Bibliography: List at least five (5) major references (e.g. science journal articles, books, internet sites) from your literature review. If you plan to use vertebrate animals, one of these references must be an animal care reference.
- **o Choose one style and use it consistently to reference the literature used in the research plan**
- **o Guidelines can be found in the Student Handbook**

Items 1–4 below are subject-specific guidelines for additional items to be included in your research plan as applicable:

1. Human participants research:
   - Participants. Describe who will participate in your study (age range, gender, racial/ethnic composition). Identify any vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).
   - Recruitment. Where will you find your participants? How will they be invited to participate?
   - Methods. What will participants be asked to do? Will you use any surveys, questionnaires or tests? What is the frequency and length of time involved for each subject?
   - Risk Assessment
     - o Risks. What are the risks or potential discomforts (physical, psychological, time involved, social, legal, etc.) to participants? How will you minimize the risks?
     - o Benefits. List any benefits to society or each participant.
   - Protection of Privacy. Will any identifiable information (e.g., names, telephone numbers, birth dates, email addresses) be collected? Will data be confidential or anonymous? If anonymous, describe how the data will be collected anonymously. If not anonymous, what procedures are in place for safeguarding confidentiality? Where will the data be stored? Who will have access to the data? What will you do with the data at the end of the study?
   - Informed Consent Process. Describe how you will inform participants about the purpose of the study, what they will be asked to do, that their participation is voluntary and they have the right to stop at any time.
2. Vertebrate animal research:
   - Briefly discuss potential ALTERNATIVES to vertebrate animal use and present a detailed justification for use of vertebrate animals
   - Explain potential impact or contribution this research may have

- Detail all procedures to be used
  - Include methods used to minimize potential discomfort, distress, pain and injury to the animals during the course of experimentation
  - Detailed chemical concentrations and drug dosages
- Detail animal numbers, species, strain, sex, age, source, etc.
  - Include justification of the numbers planned for the research
- Describe housing and oversight of daily care
- Discuss disposition of the animals at the termination of the study

3. Potentially Hazardous Biological Agents:
   - Describe Biosafety Level Assessment process and resultant BSL determination
   - Give source of agent, source of specific cell line, etc.
   - Detail safety precautions
   - Discuss methods of disposal
4. Hazardous Chemicals, Activities & Devices:
   - Describe Risk Assessment process and results
   - Detail chemical concentrations and drug dosages
   - Describe safety precautions and procedures to minimize risk
   - Discuss methods of disposal

Your Experiment should be conducted in an ethical manner.

Collecting data and recording it in your log is imperative. After you conclude the experiment you will do the following.

DATA TABLES

Data tables should include:

-AT LEAST 5-10 trials are included. REMEMBER, the more trials- the more reliable your experiment will be.

-The metric units of what is measured (degrees Celsius, cm.)

-What was tested (TEST/Independent Variable).

-What was measured (OUTCOME/Dependent Variable).

-Find the mean of each group. Use only significant digits.

- -If applicable, the time when the measurements were taken.

Sample Data Chart

Elmer's White School Glue

sample	Flow Distance, cm				Average Distance, cm
	test 1	test 2	test 3	test 4	
#1					
#2					
#3					
#4					

GRAPHS

Graphs should include:

- Title- IMPORTANT!
- Units on both the X and Y axes.
- A legend off to the side that tells me what each color represents. (if applicable).
- **The independent variable on the x-axis** of your graph and the **dependent variable on the y-axis**.
- The **units of measurement** (volts, inches, grams, etc.).

You can do a line, bar, or even pie graph to represent your data (pick which one shows your data the best.

DATA ANALYSIS

Ever watch a football game? They always have a commentator that gives you information about the game. Now, you can clearly see that this one player just fumbled the ball. But, the commentators explain WHY they fumbled the ball (#42 has had slippery fingers all season…this is his fourth fumble), and what does

this fumble means for the rest of the game (they have little chance of intercepting the ball before the end of the fourth quarter. This will be their 10th straight loss of this season).

- The point of this analogy is that YOU need to be the commentator for your project. You did it! You are the expert! Give me a play-by-play.
- Do the appropriate statistical analyses. The basics are mean, median, mode, and range
- What happened?
- What is affecting your data? What is your table or graph showing you?
- Why did you get those results?

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?

CONCLUSION

Your **conclusions** summarize how your results support or contradict your original hypothesis.

- Summarize your science project results in a few sentences and use this summary to support your conclusion. Include key facts from your background research to help explain your results as needed.
- State whether your results support or contradict your hypothesis. (Engineering & programming projects should state whether they met their design criteria.)
  If appropriate, state the relationship between the independent and dependent variable.
- Summarize and evaluate your experimental procedure, making comments about its success and effectiveness.
- Suggest changes in the experimental procedure (or design) and/or possibilities for further study.

An 8th Grade benchmark states that you should say,

"The data supports my hypothesis… (NOT "I was right!")"

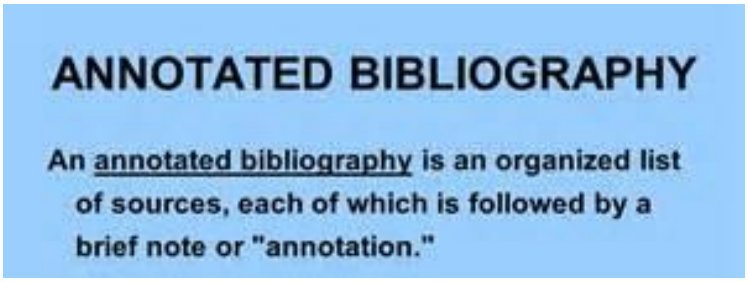
OR

"The data did not support my hypothesis… (NOT "I was wrong!")"

It is perfectly fine if your data did not support your hypothesis…the point of a science project it to LEARN something. End by explaining what you found out during your investigation. End with revisions you might make if you did this project again.

RESEARCH BIBLIOGRAPHY

List all references (e.g. science journal articles, books, internet sites) from your research plan and others you have found through further searching. . Write a paragraph summary of what you learned from each website, article, or book.



RESEARCH PLAN

Required For all Projects

Provide a typed research plan and attach to Student Checklist (1A). Please include your name on each page.
The research plan for ALL projects is to include the following:
A. Question or Problem being addressed
B. Goals/Expected Outcomes/Hypotheses
C. Description in detail of method or procedures (The following are important and key items that should be included when formulating ANY AND ALL research plans.)
- **Procedures: Detail all procedures and experimental design to be used for data collection**
- **Risk and Safety: Identify any potential risks and safety precautions to be taken.**
- **Data Analysis: Describe the procedures you will use to analyze the data/results that answer research questions or hypotheses**

D. Bibliography: List at least five (5) major references (e.g. science journal articles, books, internet sites) from your literature review. If you plan to use vertebrate animals, one of these references must be an animal care reference.
- **o Choose one style and use it consistently to reference the literature used in the research plan**
- **o Guidelines can be found in the Student Handbook**

Items 1–4 below are subject-specific guidelines for additional items to be included in your research plan as applicable:

1. Human participants research:
   - Participants. Describe who will participate in your study (age range, gender, racial/ethnic composition). Identify any vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).
   - Recruitment. Where will you find your participants? How will they be invited to participate?
   - Methods. What will participants be asked to do? Will you use any surveys, questionnaires or tests? What is the frequency and length of time involved for each subject?
   - Risk Assessment
     - o Risks. What are the risks or potential discomforts (physical, psychological, time involved, social, legal, etc.) to participants? How will you minimize the risks?
     - o Benefits. List any benefits to society or each participant.

- Protection of Privacy. Will any identifiable information (e.g., names, telephone numbers, birth dates, email addresses) be collected? Will data be confidential or anonymous? If anonymous, describe how the data will be collected anonymously. If not anonymous, what procedures are in place for safeguarding confidentiality? Where will the data be stored? Who will have access to the data? What will you do with the data at the end of the study?
- Informed Consent Process. Describe how you will inform participants about the purpose of the study, what they will be asked to do, that their participation is voluntary and they have the right to stop at any time.

2. Vertebrate animal research:
   - Briefly discuss potential ALTERNATIVES to vertebrate animal use and present a detailed justification for use of vertebrate animals
   - Explain potential impact or contribution this research may have
   - Detail all procedures to be used
     - o Include methods used to minimize potential discomfort, distress, pain and injury to the animals during the course of experimentation
     - o Detailed chemical concentrations and drug dosages
   - Detail animal numbers, species, strain, sex, age, source, etc.
     - o Include justification of the numbers planned for the research
   - Describe housing and oversight of daily care
   - Discuss disposition of the animals at the termination of the study
3. Potentially Hazardous Biological Agents:
   - Describe Biosafety Level Assessment process and resultant BSL determination
   - Give source of agent, source of specific cell line, etc.
   - Detail safety precautions
   - Discuss methods of disposal
4. Hazardous Chemicals, Activities & Devices:
   - Describe Risk Assessment process and results
   - Detail chemical concentrations and drug dosages
   - Describe safety precautions and procedures to minimize risk
   - Discuss methods of disposal