

Designing a Research Project



Define the Problem



- **A creative process**

***Ex:** What is the effect of fertilizer on plant growth?*

- “Which **AMOUNT** of fertilizer causes the **greatest increase in plant growth?**” is a narrower focus.

Conduct Research

- Before generating a hypothesis:
 - **Conduct background research** to understand the scope of the study.
 - Use this research to **determine both the dependent and independent variables** of the study.



Create a Hypothesis

- **Must be testable**
 - Does it show Cause & Effect?
 - **If we do this...then this will happen...**
 - *Ex: If 10 ml fertilizer per L of water is added to the bean plants, then the bean plants should grow taller than any other bean plants*
 - It is objective?
 - Is it CLEAR?



Designing an Experiment

Think about **Cause & Effect**

- Name the **Independent Variable (IV)**
 - What is the variable that you will purposefully change during the experiment ?
 - **Ex:** Amount of Fertilizer
- Name the **Dependent Variable (DV)**
 - What variable will be measured, in response to changes in the IV?
 - **Ex:** Plant height, from base to highest leaf where it attaches to the stem.



Define the Groups

- Name the Control Group

- *What is the experimental group you use for comparison?*
- *Ex: Plants with no fertilizer added*



- Name the Controlled Variables

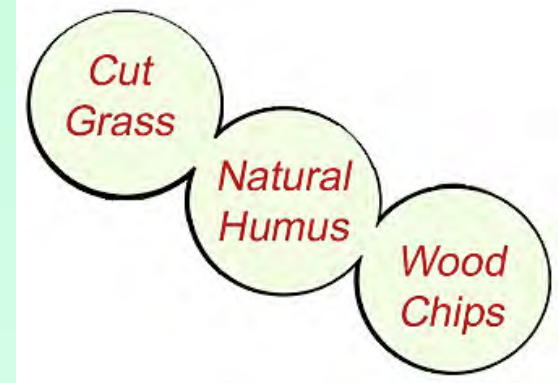
- *List everything that will be kept the same in the experiment*
- *Ex: Brand of fertilizer, level of light, species of plant, time & amount of watering, type of soil & container*



Design the Study

- USE A CONTROL GROUP

- or comparative sets of data
- For behavioral studies, compare with known behavior in the wild

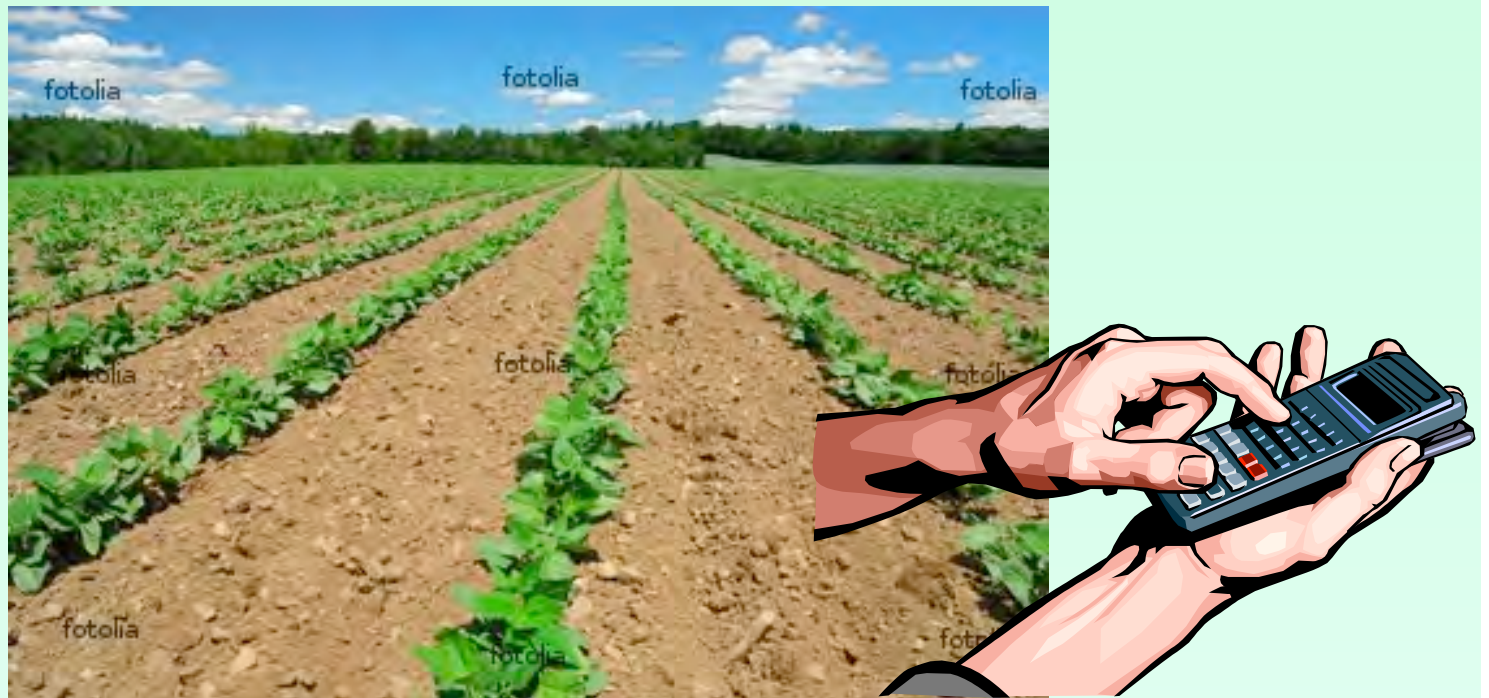


- ***For Engineering projects, explain the benefits of your design***



Design the Study

- Determine the number of trials or groups needed for validity
 - **Ex:** 5 bean plants for each concentration, 5 bean plants for the control



Design the Study

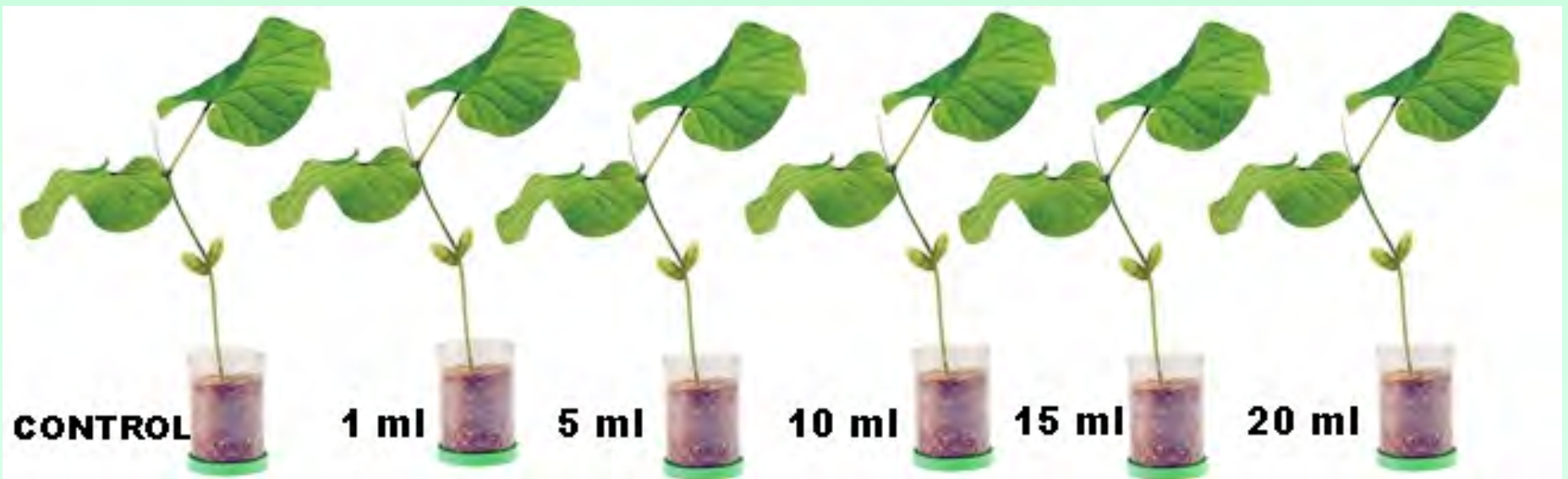
- **Write the Materials & Methods (*Procedure*)**
 - Don't number steps; use paragraph form
 - *Make them everything clear & repeatable*
- **Use diagrams or a flow chart if needed**

Fig. 2 Data from Sage seedlings grown with varying amounts of Fertilizer/day, over 40 days

	Amount of Fertilizer (ml)				
	50	100	150	200	250
# of plants reaching 30+ cm	0	0	4	2	0
# of plants reaching 20+ cm	0	2	4	6	1
# of plants reaching 10+ cm	2	8	2	2	7
# of dead plants	8	0	0	0	3

Draw Your Set-up

- Design and sketch the experimental set-up, *with labels*



- *Set-up at beginning of experiment (each concentration group = 5 plants)*

Experimental Design: Pre-Lab

Complete this ExD planning form BEFORE beginning a lab

Title: *The Effect of ... (IV) on ... (DV). (write last)*

Independent Variable: *Name the variable that you will purposefully change during the experiment; include units. Indicate the levels of IV in the columns below. (# of minutes, different temperatures, levels of fertilizer, types of soil...etc)*

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Dependent Variable: *Name the variable will be measured, that responds to changes in the IV. (Population growth; Dissolved oxygen level, plant height, habitat preference, etc...)*

HYPOTHESIS: *What you think will occur to the Dependent Variable (DV) as you change the Independent Variable (IV) – the cause & effect relationship. Use an "if...then..." format. Your educated guess MUST be testable.*

Control: *What is the experimental group you will use for comparison?*

Repeated Trials: *How many numbers per group; how many times will the experiment be performed?*

Controlled Variables (Constants): *List everything that will be kept the same in the experiment - (light, temperature, wind level, noise level, amount of water, etc...)*

SKETCH OF EXPERIMENTAL SETUP, with labels: *(put on back)*

Complete
your
design
template,
get
approval

Select a Method of Data Collection

- Take samples **randomly**
- Make sure there is a way to **show patterns/trends** in the data



Write a Proposal

- State **the problem**
- Include a rationale and **justification**
- **List references** you have found
- If using **vertebrates**, justify their use and explain the humane manner in which they will be treated.



Write a Proposal

- State **general materials & methods**
- Include the **length of time** study will run
- Estimate **costs**
- Explain any **safety procedures** you need to follow



Write a Proposal

- Indicate **where** the study will take place
 - Will any **special facilities** will be necessary?
 - Have you received **permission**?
 - State any supervision requirements
 - How are you **getting there**?
- State any expected **results**



Collect Data in a Log Book

- USE a bound notebook ONLY
- A **diary**, detailing all activities
 - Kept **in ink**, with no erasures or other obliterations
 - **Cross out** errors with a single line

SWELL SHARK LOG.

ASK ALEX IF HE FEEDS THEM AHEAD OF TIME; IF HE HASN'T PLEASE FEED ONLY TWICE PER WEEK. FEED ^{SQUID} ON TUESDAYS AND SHRIMP ON FRIDAYS. FEED ONLY ONE PIECE EACH DAY. 1 PIECE = 2 1/2 to 3 cm³

* PLEASE KEEP TRACK OF FEEDING IN THIS LOG.

→ SHARK 1 = smaller head, younger than rest; front fins darker stripe.

SHARK 2 = longer snout, pointy. Light stripe of tan at point.

SHARK 3 = wider head, moves slower, wider body, rounded snout.

DATE	WHO FEED	SHARK 1	SHARK 2	SHARK 3	COMMENT
3/26	CF	0	0	0	
3/27	AS	0	1	0	Shrimp.
3/29	AS	0	0	0	"
4/3	HR	6 = 1/2 pc	2 = 1/2 pc	1 pc	squid
4/8	AS	1	1	1	Shrimp
4/12	AS	1	1	1	Squid
4/15	AS	1	1	1	Shrimp

Collect Data in a Log Book

- **First page:** your name, address, phone number, and the name of your advisor
 - **Problem statement and a brief summary**
- All other entries start with the date, location, time, special conditions of the activity. You should **record all of the following activities:**
 - *Conference with advisor*
 - *Telephone calls*
 - *Research*
 - *Thoughts about your project*
 - *Descriptions of any setup and changes in design*
 - *Data taken while performing the study*
 - *Label all drawings/diagrams*



Conduct the Experiment

- **Receive approval, conduct the experiment**
 - *Collect data in a table, with units.*
- **Data Analysis**
 - *Show any calculations*
 - *Make a labeled, graph trends*



Collect & Measure Samples

- Collect living specimens safely and with care
- **Measure consistently**
 - Use ONLY SI or metric measurements!
- Don't **contaminate** samples
- Record **errors**



Objectively Analyze Data

- **Common Statistics**

- Mean (Average)

Jr. Div.

- % Error

Jr. Div.

- Standard Deviation

Jr. Div.

- Chi Square

Sr. Div.

- T-tests

Sr. Div.

- Diversity Indices

Sr. Div.

- Any statistical tests appropriate to your grade level



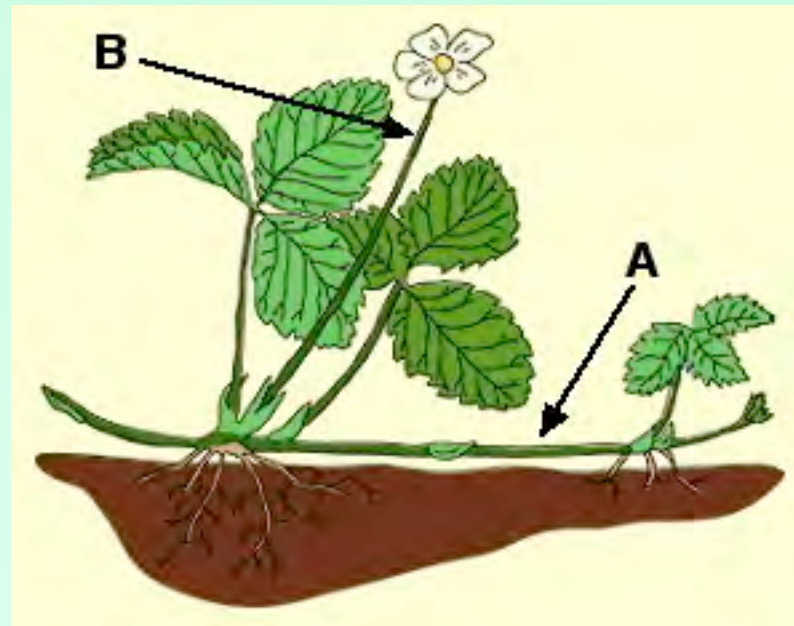
Come to a Conclusion

- **Summarize results** and answer how the IV affected the DV.
 - Include an **Error Analysis**: what happened and how it may have affected your results
- **Conclusion**
 - Brief summary of your findings
 - *Was your hypothesis validated by the data?*
 - *Why or why not?*



Refine and Retest

- If there is time, *improve on the design*
- *Re-test!*



Report the Findings

- Team members should work **closely**
- Use **proper format**
- Include **graphics**
- Make **deadlines**



Designed & Photographed by

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