Spark!

STUDENT RESEARCH FROM IDEA TO COMPETITION

STEM 4 Innovation Conference

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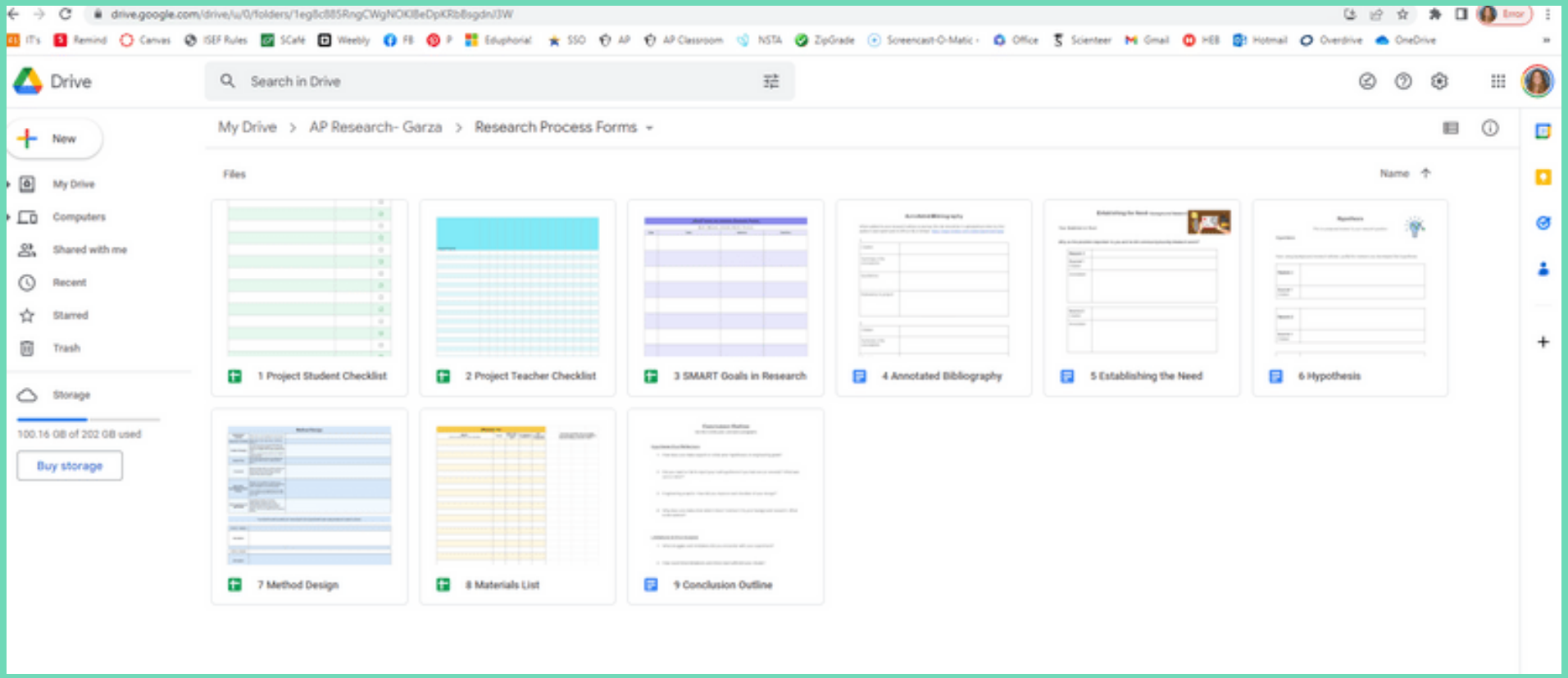
Recognitions:

- Truman T. Bell Excellence in Service Award
- CCISD- District Secondary Teacher of the Year
- Sigma Xi-Rice UTMC Outstanding Science Teacher
- Terri Berry SEFH Teacher of the Year-Sr. Div.
- Claude L Wilson Award for Teaching Excellence
- Coca-Cola Scholars- Educator of Distinction
- Regeneron STS Teacher of Merit
- U.S. Presidential Scholar's Most Influential Teacher

:Science Fair Website

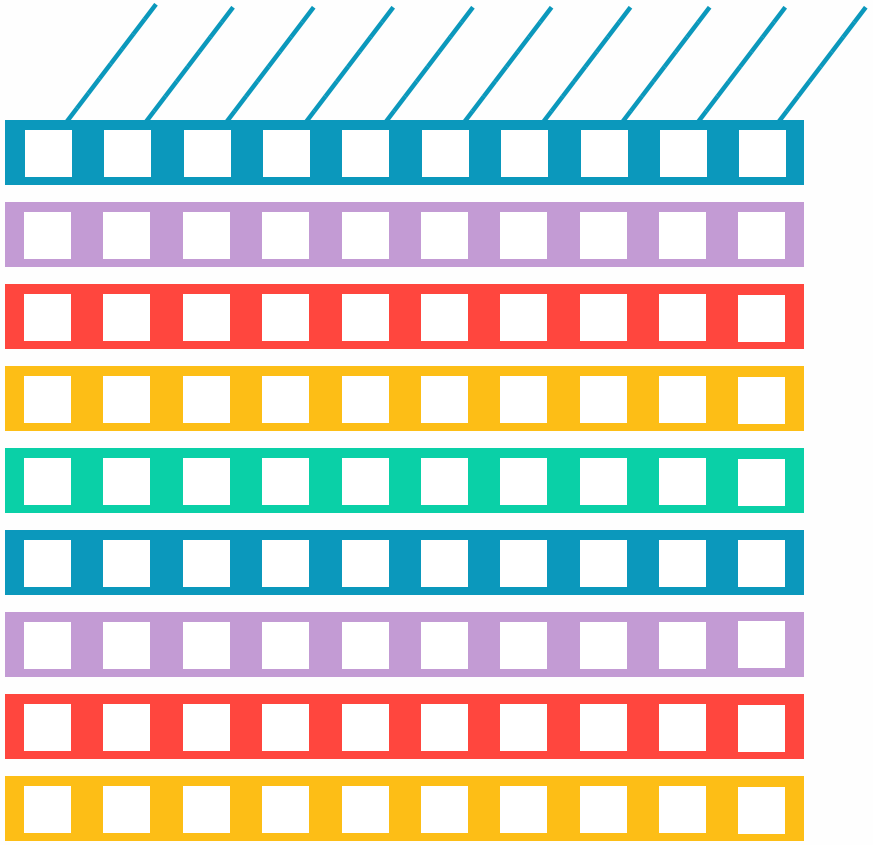
Google Drive- Research Process Forms



Keep yourself organized

PROJECT CHECKLIST

STUDENT NAME



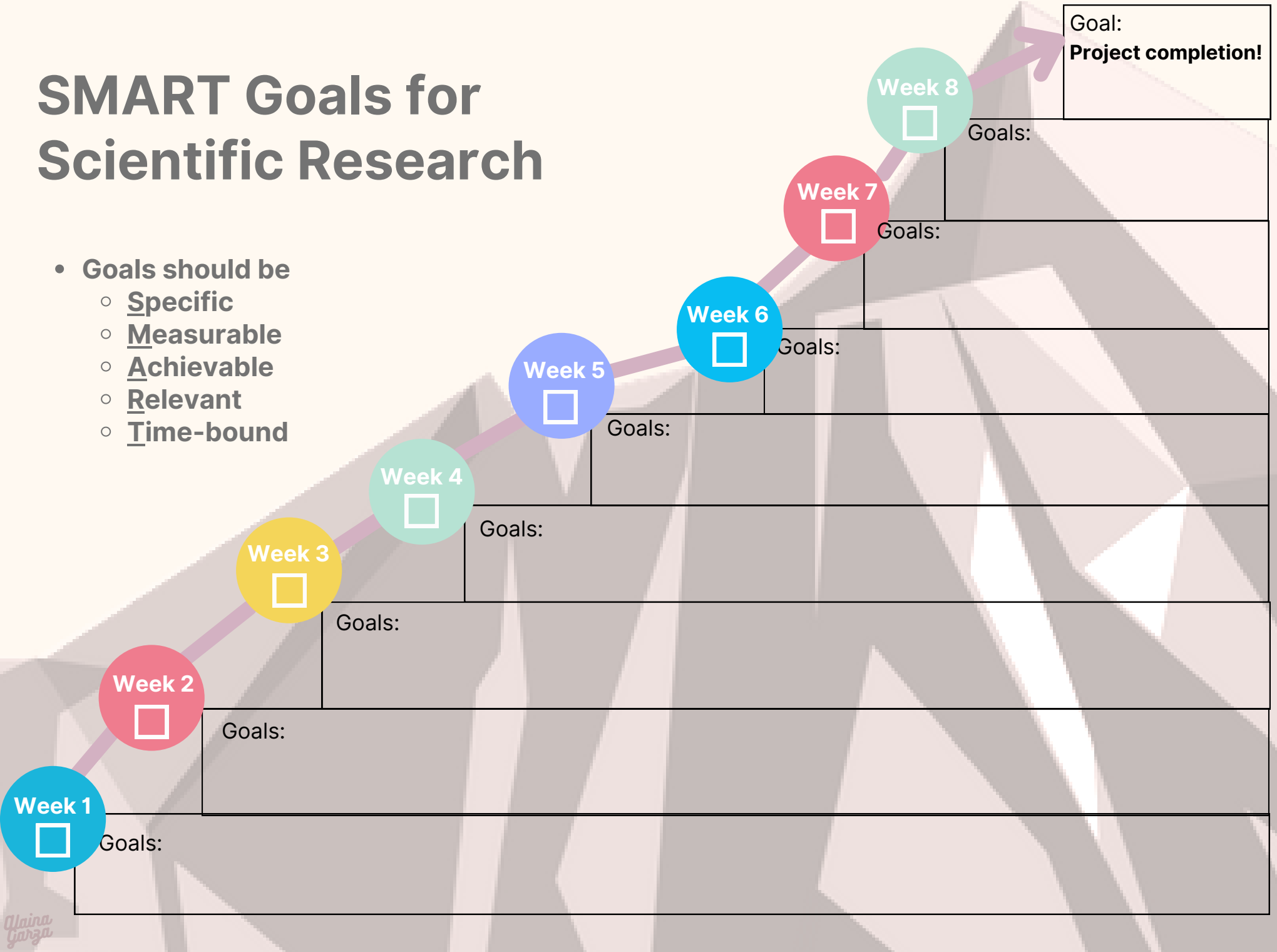
keep your students organized

Research Due Dates

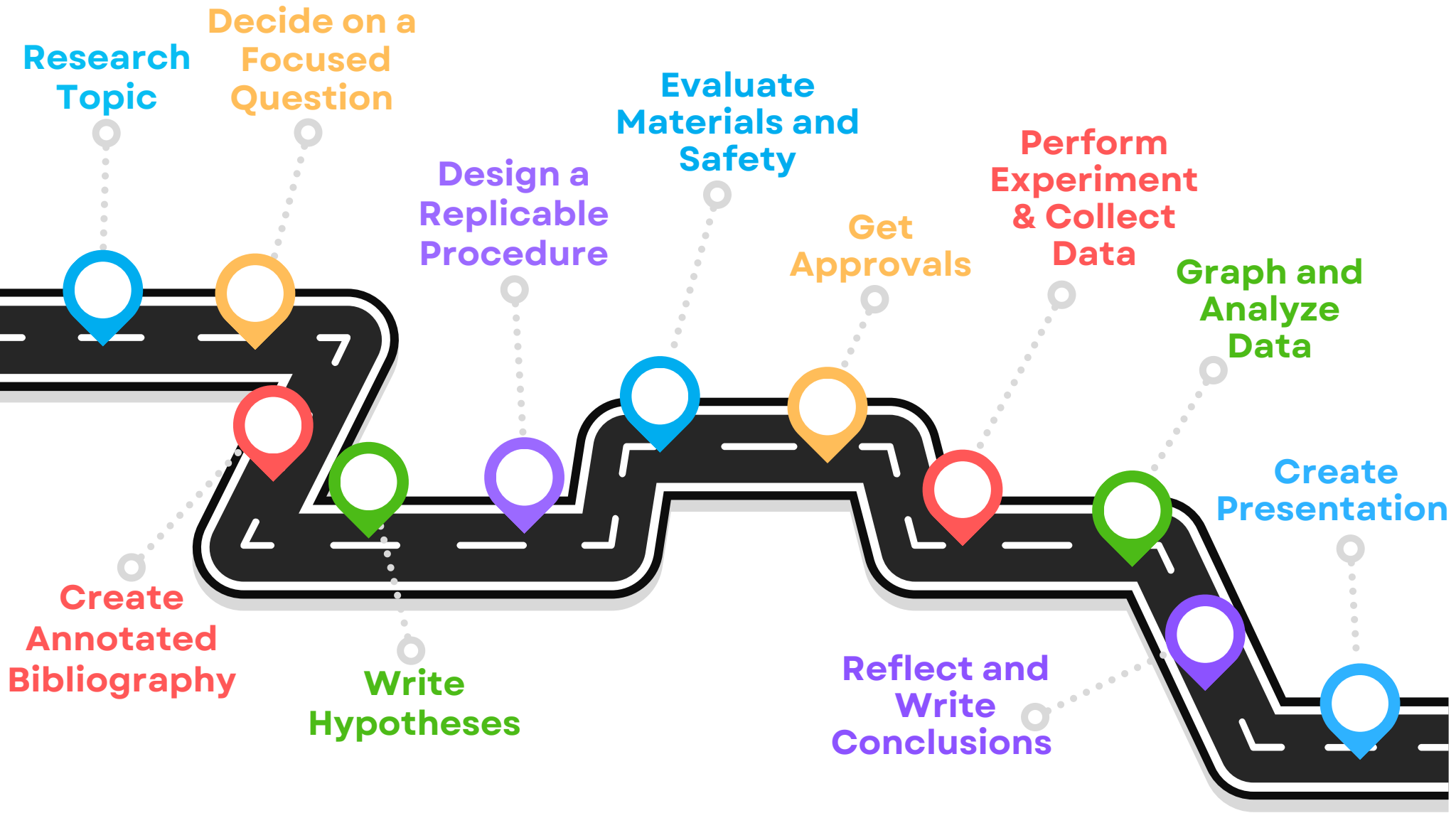
ITEM	DUE DATE	CHECK
Project Idea Form		☐
5 Annotated Sources with Background Form		☐
Hypothesis Form		☐
Alignment Form		☐
Method Design Form with 5 more Annotated Sources		☐
Materials Form		☐
Data Check		☐
Data Analysis Check		☐
Conclusions Form		☐
Notebook and Board Completed		☐

SMART Goals for Scientific Research

- Goals should be
  - Specific
  - Measurable
  - Achievable
  - Relevant
  - Time-bound



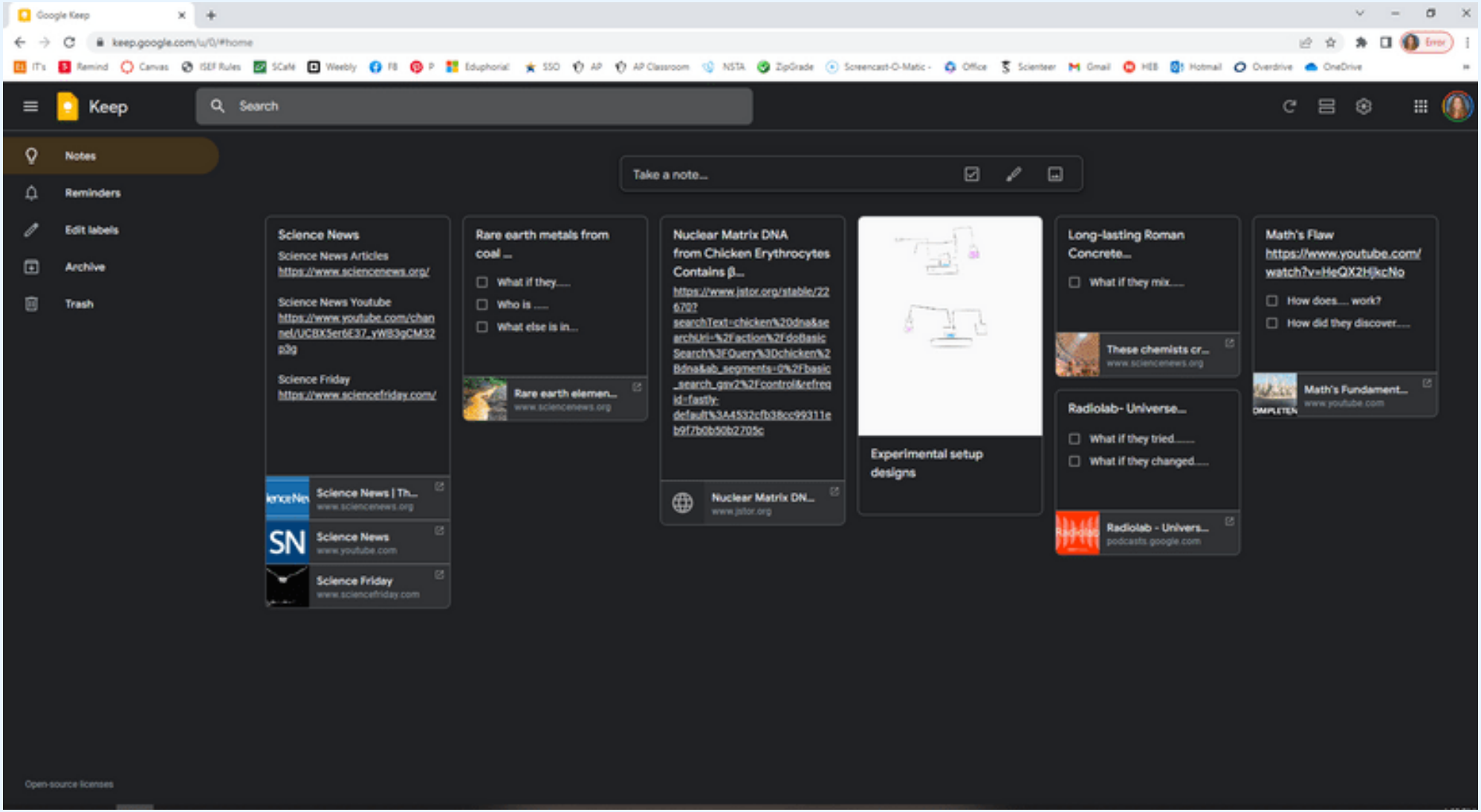
Project Roadmap



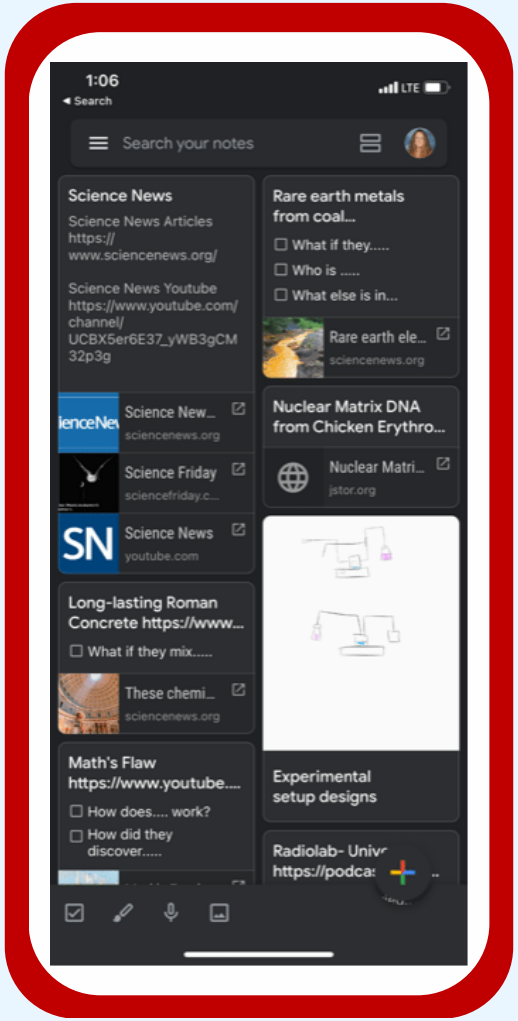
FINDING AN IDEA

Organize Thoughts and Ideas

Use something like Google Keep to make it easy to store your ideas and questions all year!



We don't always have our computers or lab journals with us,
but you know what we do have.....



MY INTERESTS

LOOKING FORWARD

Name something that you are excited about for this year.

Name something that you are nervous about for this year.

A CHALLENGE

What is one challenge that you have faced during your time at this school?

How has it shaped who you are now?

AN OPPORTUNITY

What is one opportunity that you have been given while at this school?

How has it shaped who you are now?

A TICKET

You've been given a ticket to go anywhere, anytime...

Where will you go?

What will you do?

What will happen when you get there?

UPSETTING FINDINGS

Name two research findings that you trust, but wish were not true.

A TALENT

What is a talent that you have that defines you in an essential way?

How does it define you?

AN INTEREST

What is an interest that you have that defines you in an essential way?

How does it define you?

More Prompts

- Write about an item you have that isn't expensive but means a lot to you
- Recall an important memory from your childhood and tell it from the perspective of someone else who was present.
- What is the most adventurous thing you've eaten?
- If you could live inside one of your favorite stories, what would you change about it?
- What was the last piece of media you read, heard, or saw that inspired you?
- Write about what you think the world will look like in 10 years.
- Recall an object you found on the sidewalk/side of the road. Why did someone give it away? Why did they have it to begin with?

I Wonder.....

5 QUESTIONS A DAY

Day 1					
Day 2					
Day 3					
Day 4					
Day 5					
Day 6					
Day 7					

adapted from Caitlin Sullivan, Society for Science

FINDING YOUR PROJECT

WHAT IS YOUR INTEREST?

HAVE YOU NOTICED A PROBLEM OR A TOPIC THAT YOU WANT TO EXPLORE MORE?

DISCOVER WHAT IS KNOWN

LISTEN TO PODCASTS, WATCH SCIENCE VIDEOS, READ ONLINE POSTS ABOUT YOUR TOPIC.

GO TO THE SOURCE

READ PEER-REVIEWED JOURNAL ARTICLES. WHAT HAVE OTHERS FOUND IN THIS TOPIC?

Science builds upon other scientist's work.

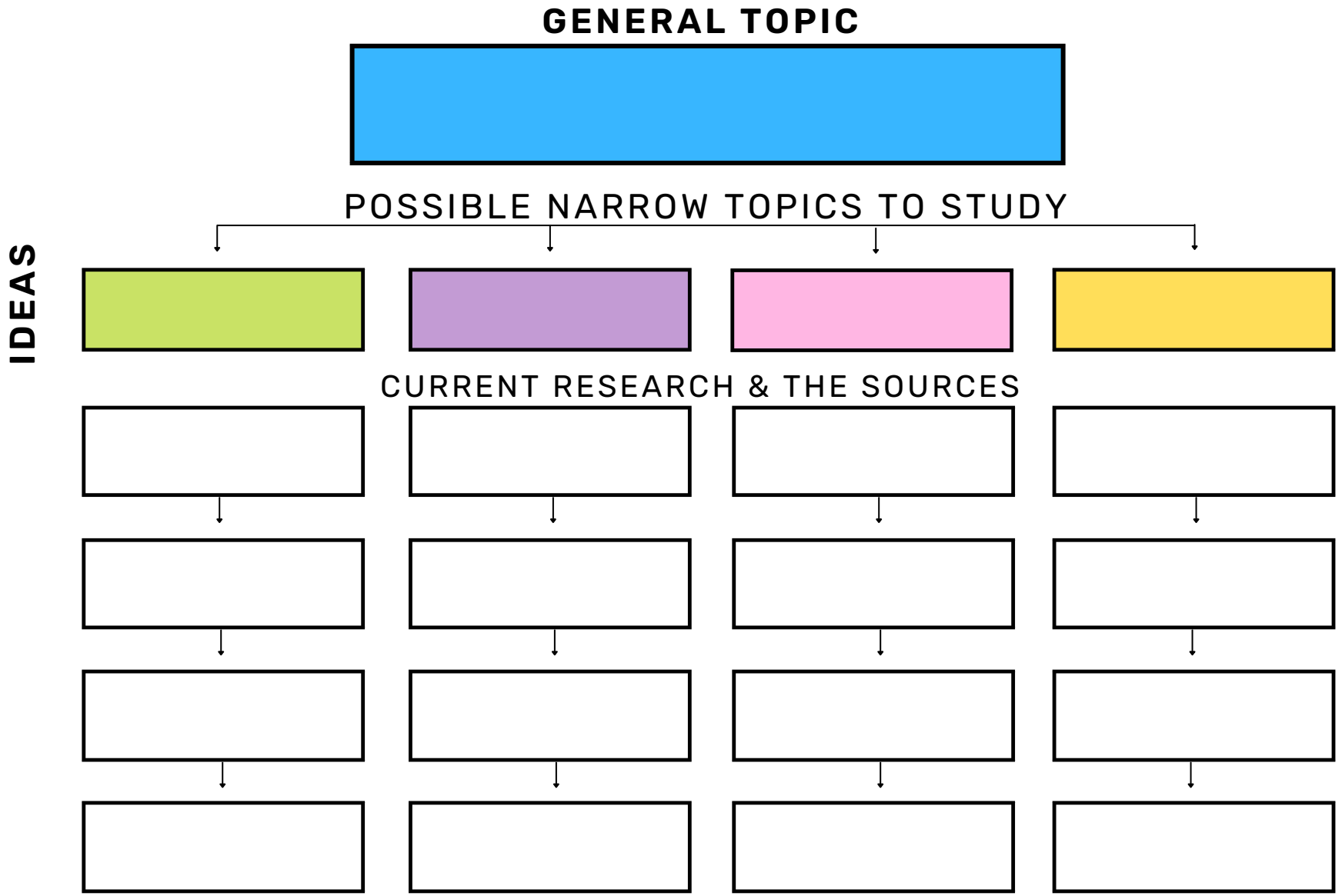
DEVELOP YOUR QUESTION

USING THE ARTICLES, JUSTIFY THAT THERE IS A PROBLEM AND YOUR REASONING BEHIND THE GOAL/HYPOTHESIS.

IDENTIFY SOLUTIONS

WHAT METHODS COULD YOU USE FOR EXPERIMENTATION? JUSTIFY WHICH WOULD BE BEST, AGAIN USE THE ARTICLES. KEEP IN MIND WHAT IS FEASIBLE FOR YOU.

GOING TO THE SOURCE



Scholarly Research Resources

Check with the school library!

1. Science Direct
2. National Library of Medicine
3. National Academies
4. PubMed
   PubMed Central
5. DOAJ- Directory of Open Access Journals
6. Scopus, Jstor, IEEE Xplore or Ebsco if your school has access.

Establishing the Need

Background Research

QUESTION/GOAL:

Rationale: Why is this problem important to you and the community/society/research world?
-Justify the significance of your project using published articles.

Reason 1

Reason 2

Sources

Context: Establish a setting of who, what, where and possibly when for this research.
-Justify the using published articles.

Who is affected by this problem?

Where is this issue occuring?

How often and for how long has it been happening?

Sources

Annotated Bibliography

APA Citation

Summary of its conclusions

Quotations

How is it relevant to your project?

Method Research

ARTICLE 1

Scientific question:

Method description:

How I might use this:

ARTICLE 2

Scientific question:

Method description:

How I might use this:

ARTICLE 3

Scientific question:

Method description:

How I might use this:

ARTICLE 4

Scientific question:

Method description:

How I might use this:

ISEF Rules and Guidelines for Research

- Rules for ALL projects
- Roles and Responsibilities of Students and Adults
- Human Participants
- Hazardous chemicals, Activities and Devices
- Vertebrate Animals
- Engineering and Invention Project Guide
- Potentially Hazardous Biological Agents
- Display and Safety Rules

Project Support

Find supplies and mentors

SEND LOTS OF E-MAILS!

Many people are interested in helping the next generation scientists but don't have a way to do so. Your emails will give them that chance! Even if you get a series of Nos, all you need is one Yes! Send as many as you can, just be clear in what you are asking of them and why you have chosen to email them specifically.

1

LAB KITS

Many science and CTE teachers have lab kits that can be modified to test different variables. For example: Aquatic science: water quality test kits, AP Biology: DNA Analysis and PCR kits, Physics: PASCO or Vernier test probes, etc.

2

FAMILY FRIENDS AND CONTACTS

Your family may know someone that works at a hospital, pharmacy, university, environmental organization, engineering firm, etc. They would be great resources to mentor or brainstorm with. They may even have access to supplies to use!

3

PREVIOUS PROJECTS FROM OTHERS

Students can expand on projects that other students have done in previous years.

- Hold a meeting at the end of competition season for students to talk about future studies that may spark ideas for others.

4

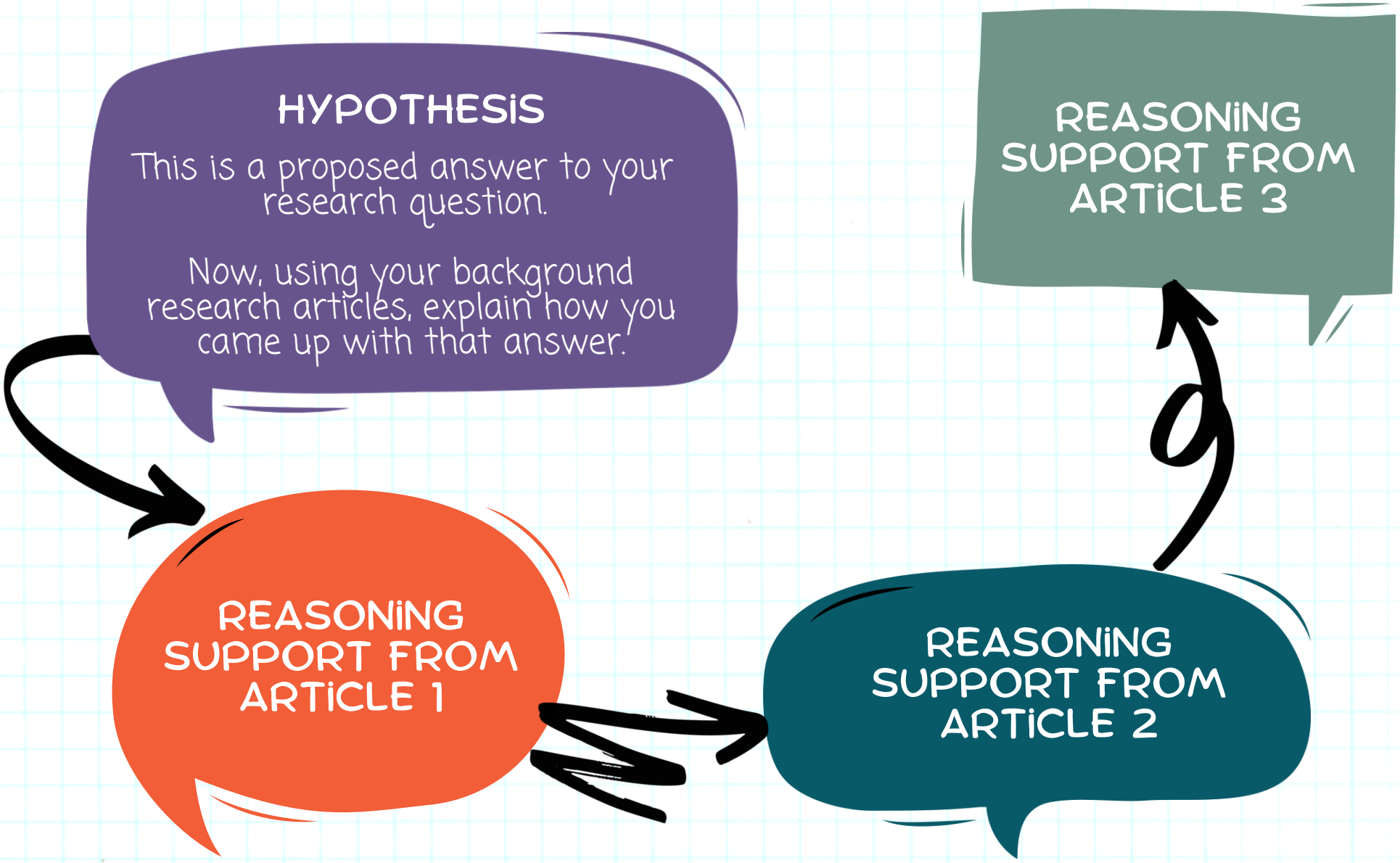
LOCAL COMMUNITY GROUPS

Find mentors or assistance for data collection by contacting educational outreach programs from local organizations. Parks, zoos,

METHOD DESIGN

INDEPENDENT VARIABLE	*What will you be changing for each group?*	
DEPENDENT VARIABLE	*What will you be measuring or collecting data on?*	
CONTROL GROUP	*How will you set up a group that does not have the variable applied to it? This will be what you compare your experimental group(s) to.* *Can you include both positive and negative control groups?*	
SAMPLE SIZE	*How many groups will you be testing and how many times will you collect data on them?*	
CONSTANTS	*What are things that you need to make sure stay the same for all groups? -things that could have an effect on the results if they were changed.*	
ALTERNATIVE HYPOTHESIS/ PROJECT GOAL	*Based on your research, what are your predicted results for the experimental group when compared to the control group?* *If your project is an engineering one, what is your goal and how will you know if it has been met?*	
NULL HYPOTHESIS	If hypothesis testing is involved: *What results would you see if the independent variable does not end up having an effect on the experimental group?* *This can be rejected with statistical analysis.	

SUPPORTING YOUR HYPOTHESIS



PROJECT ALIGNMENT

Problem or Question

Hypothesis or Engineering Goal

Procedure Overview and Data Collection

Does your hypothesis or engineering goal propose an answer to your problem or question?

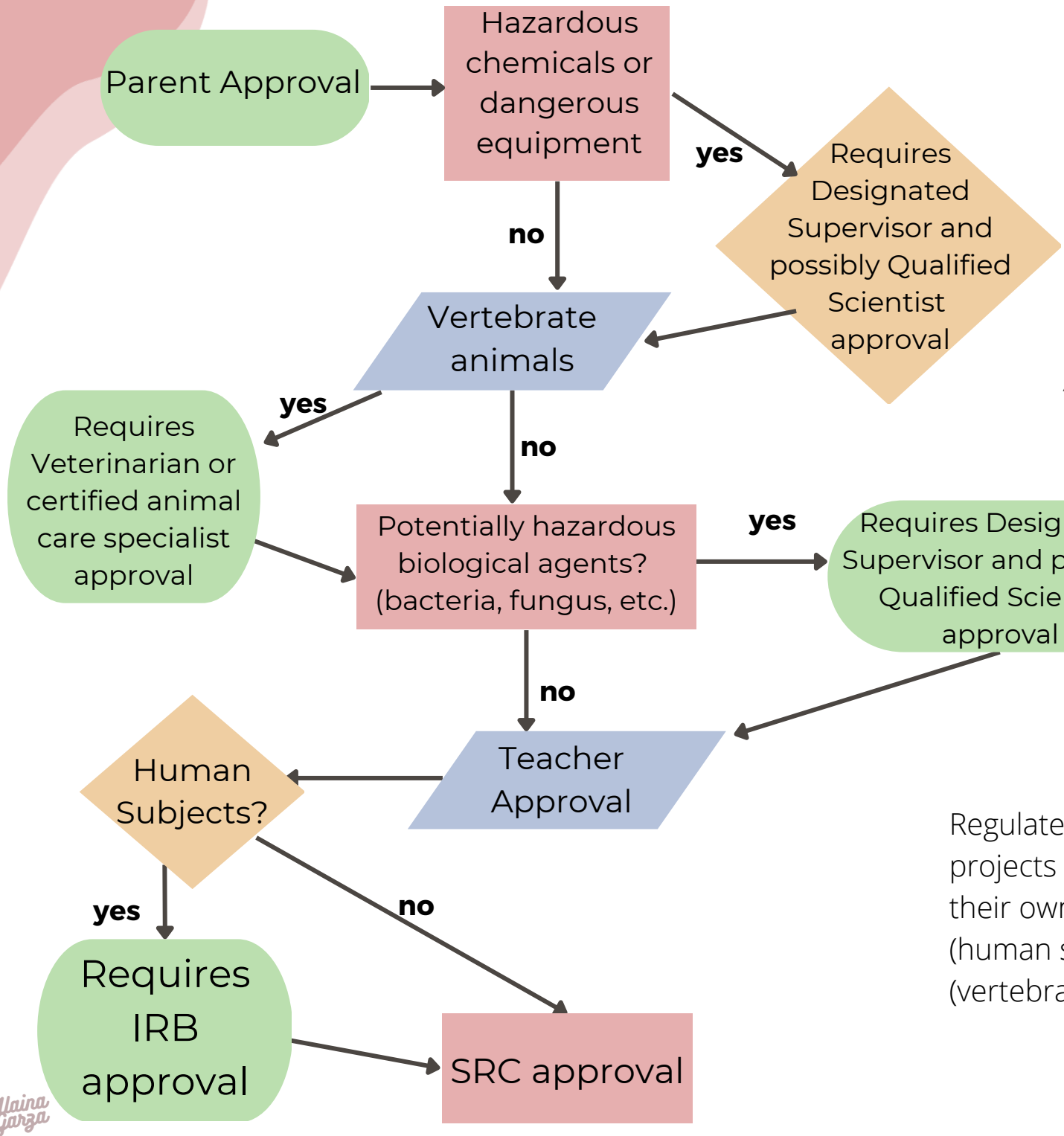
Will the procedure that you have designed lead to an answer to the the problem or question?

Will the procedure that you have designed provide data to support or refute your hypothesis or engineering goal?

Materials List

MATERIAL (INCLUDE CONCENTRATIONS OF CHEMICALS IF APPLICABLE)	QUANTITY	WHERE IT WILL BE OBTAINED FROM	HAZARDOUS OR DANGEROUS?	PURCHASE COST IF APPLICABLE

Approvals



Regulated Research Institution projects are required to have their own approvals for IRB (human subjects) or IACUC (vertebrate animals).

PROJECT NOTEBOOK TITLE

Your project title should be informative, it does not need to be cute.

- No spiral notebooks.
- Dates are important!
- Use PEN! Science should be messy, there should be things that are crossed out. No white out!
- Never tear out pages! Just fold a page over if you don't want it.

PROJECT NOTEBOOK SECTIONS

01 Table of Contents

Add page numbers to the table of contents

02 Problem or Engineering Goal

What are you attempting to accomplish with this project?

03 Introduction/Rationale

Why did you choose this project?
Who will this project help?
Elaborate and "hook" your reader!

04 Research Notes

Annotated Bibliography.
You need at least 10 sources.

05 Hypotheses

Why do you think this? You need supporting paragraphs with in-text citations from your research articles.

06 Experimental Design

What are your variables?
What are your experimental groups and control groups? Why?
What are the limitations of the procedure?

07 Materials List

Make a bulleted list.
Make sure you list amounts, concentrations, etc.

08 Procedure with Safety

Be very detailed! It should be replicable.
Include all safety precautions that will be taken.

09 Daily Log

Handwritten with dates.
Include pictures and activities.
*Photos cannot include other people's faces or any brand names.

10 Raw Data

Data charts go here, handwritten or printed from the computer. Include all samples.

11 Data Analysis

Place graphs here and describe any trends that you see.
Add your statistical analyses and explain what they mean.

12 Conclusions

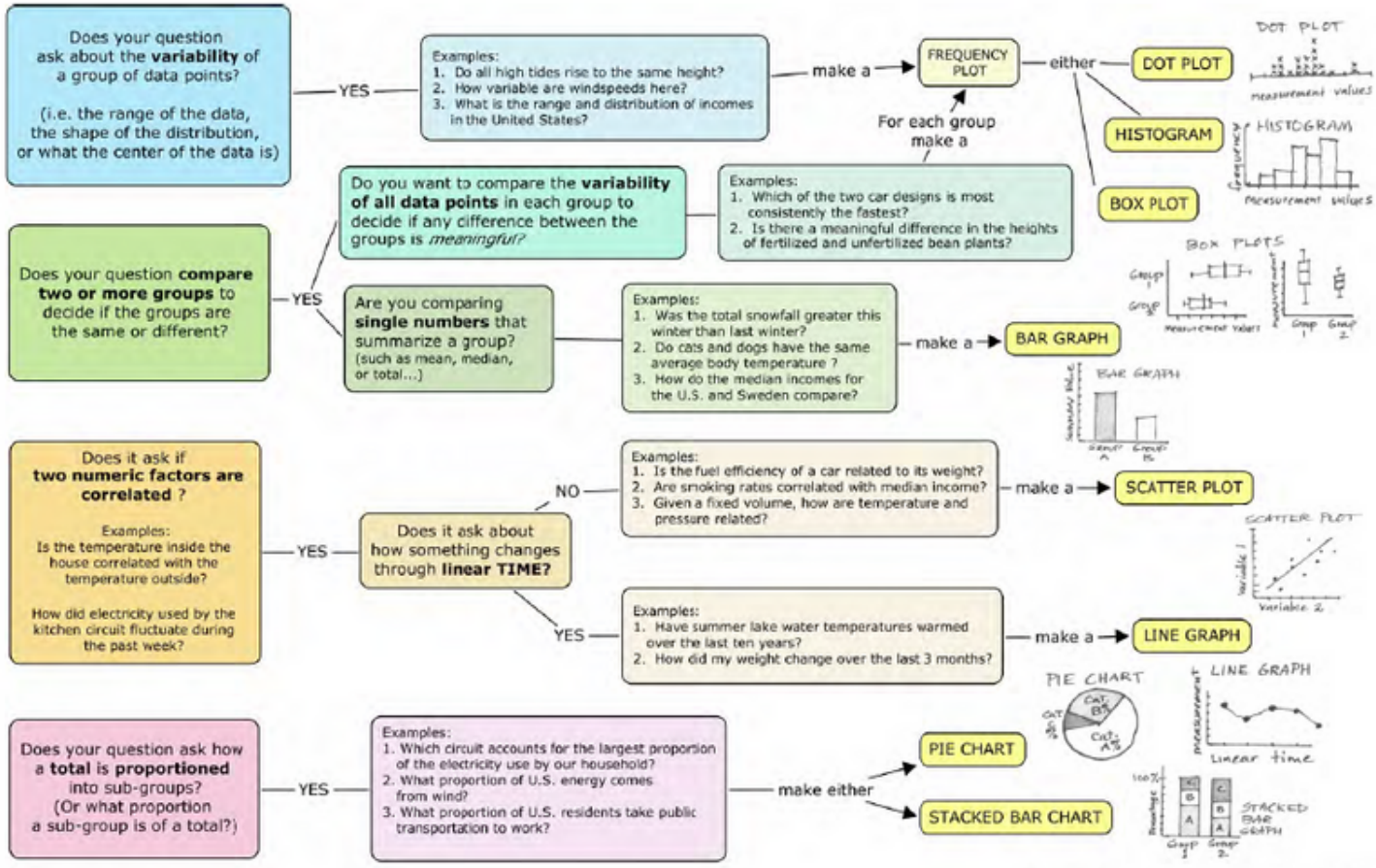
What parts of your data supported or did not support the hypothesis?
Why did the data show what it did? What is the science behind it?
What are the implications of your results?
What would you have done differently?
How can this study be furthered in the future?

Daily Log- Handwritten

DATE	NAME	LOCATION	ACTIVITIES	INITIALS

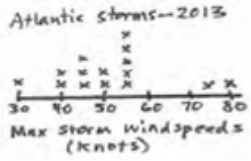
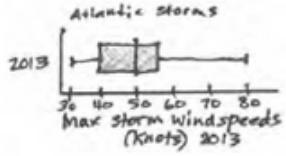
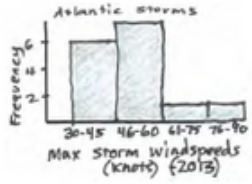
Graph Choice Chart

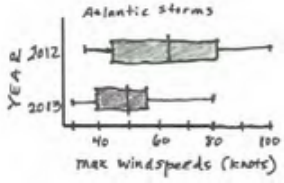
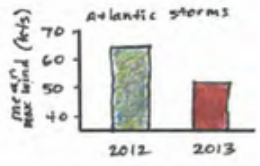
What question would you like to explore? Write your question as a complete sentence.

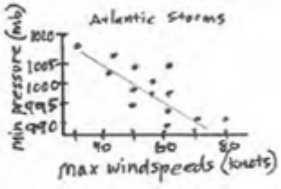
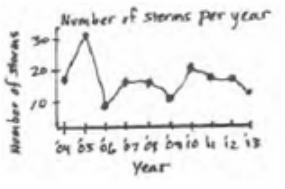


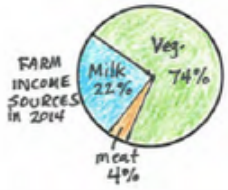
The Maine Data Literacy Project -- Graph Choice Chart

Graphing tips

Variability questions: **Frequency plot** (3 kinds)	**Dot plot**	**Box & whisker plot**	**Histogram**
Kind of data: **One categorical group** and **One numeric variable** (one axis) *Frequency plots show how variable the group is. Describe variability by range, measure of center (mean, median, or mode), and the shape of the distribution.*			

Comparing groups questions:	**Frequency plots** OR	**Bar graph**
Kind of data: **Two or more categorical** groups & **One numeric** variable ***Frequency plots*** *allow you to compare how variable the groups are.* ***Bar graphs*** *only show a single number (ie. sum, average, percent or count) for each group.*	 (To compare two groups of values)	 (To compare two summary values)

Correlation questions:	**Scatter plot** OR	**Line graph** (for time series)
Kind of data: **Two numeric variables** *Both variables must be continuously numeric. Connect dots only if one variable is linear time (i.e. days, years...) Put time on the X-axis.* *Show correlation with a 'line of best fit'.*		

Proportion (percentage) questions:	**Pie chart** OR	**Stacked bar graph**
Kind of data: Size of a subgroup as a **percentage** of the whole group (Total of sub-groups must = 100%) *In pie charts and stacked bar graphs, all sub-group percentages must total 100%.*		

Criteria for an informative graph:

___ Graph type fits the question
___ Axes are drawn & scaled correctly
___ Axes are labeled clearly, correctly
___ Units are given
___ Data are plotted accurately
___ Legend is present, if needed
___ Graph is overall neat & legible
___ Title and/or caption present
___ Trend line shown (scatter plot or line graph only)

___ Graph helps answer the question

(There are other kinds of questions and other kinds of graphs, and often more than one graph type is useful for a given question. Learn to graph data for these basic kinds of questions first.)

STATISTICAL TESTS

Is my data categorical, discrete or continuous?
Click Here

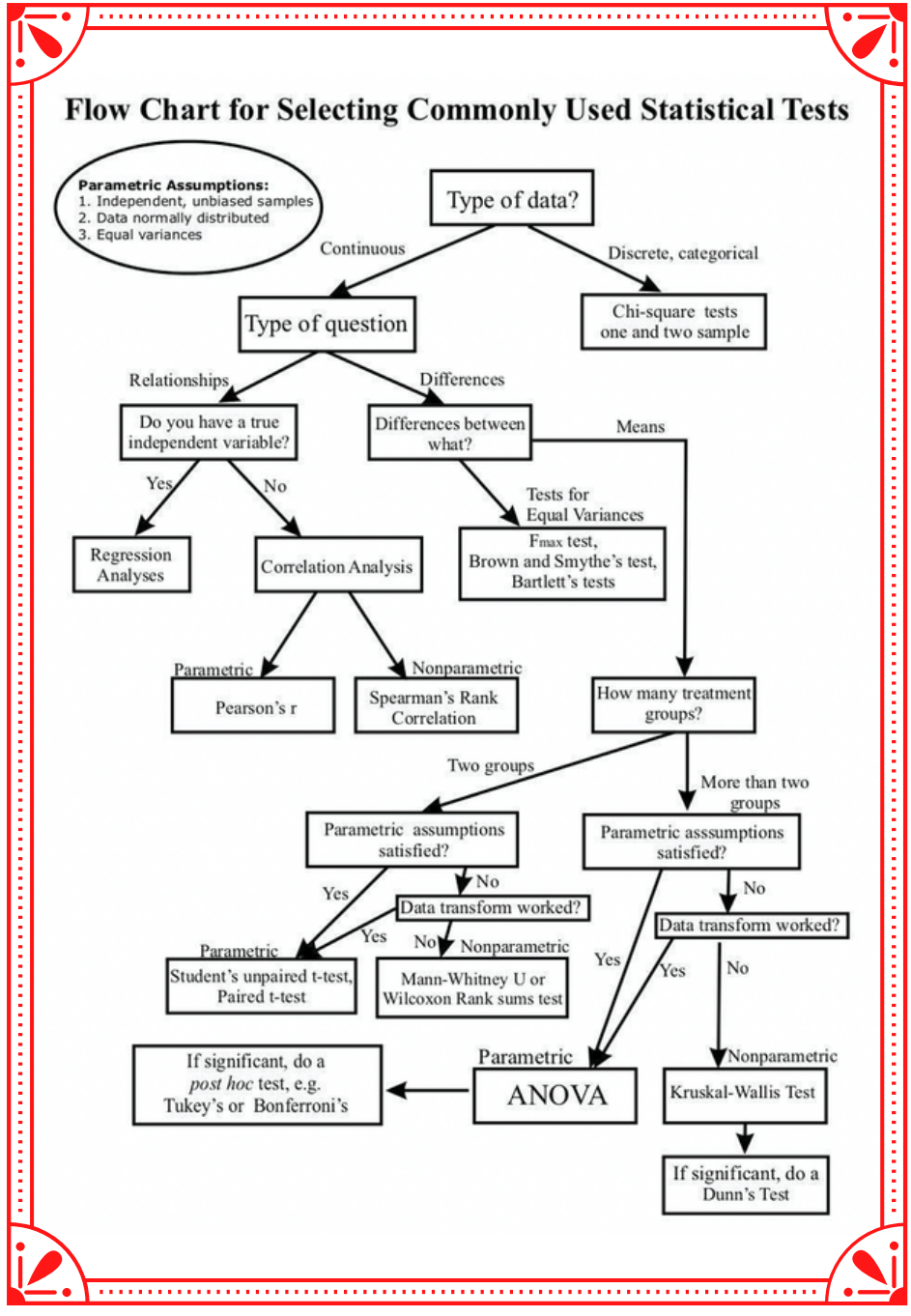
Is my data normally distributed?
Click Here

Statistical Tests

The following statistical tests are used to determine whether observed differences are statistically significant

1. Parametric tests are used when data follow a particular distribution (e.g., a normal distribution—a bell-shaped distribution where the median, mean, and mode are all equal). These tests are generally more powerful.
2. Nonparametric tests are used when a particular distribution cannot be assumed; they rank data rather than taking absolute differences into account.
3. Unpaired tests compare values from independent samples.
4. Paired tests are performed on paired data. For example, where the same parameter is measured on each patient before and after an intervention.
5. Two-tailed tests should be used when an intervention could potentially lead to either an increase or decrease of the outcome.
6. One-tailed tests should be used when an intervention can have only one plausible effect on the outcome.

Science Direct Article link with more information



Writing the Conclusions

STEP 1 Hypotheses/Goal Reflections

- How does your data support or refute your hypotheses or engineering goals?
- Did you reject or fail to reject your null hypotheses if you had them? What was your p-value?
- Why does your data show what it does? Connect it to your background research. What is the science?

STEP 2 Limitations & Error Analysis

- What struggles did you encounter with your experiment?
- How could these limitations and errors have affected your results?
- How did you attempt to minimize the effects of the limitations and errors?
- What would you do differently next time to improve your experiment?

STEP 3 Implications of findings

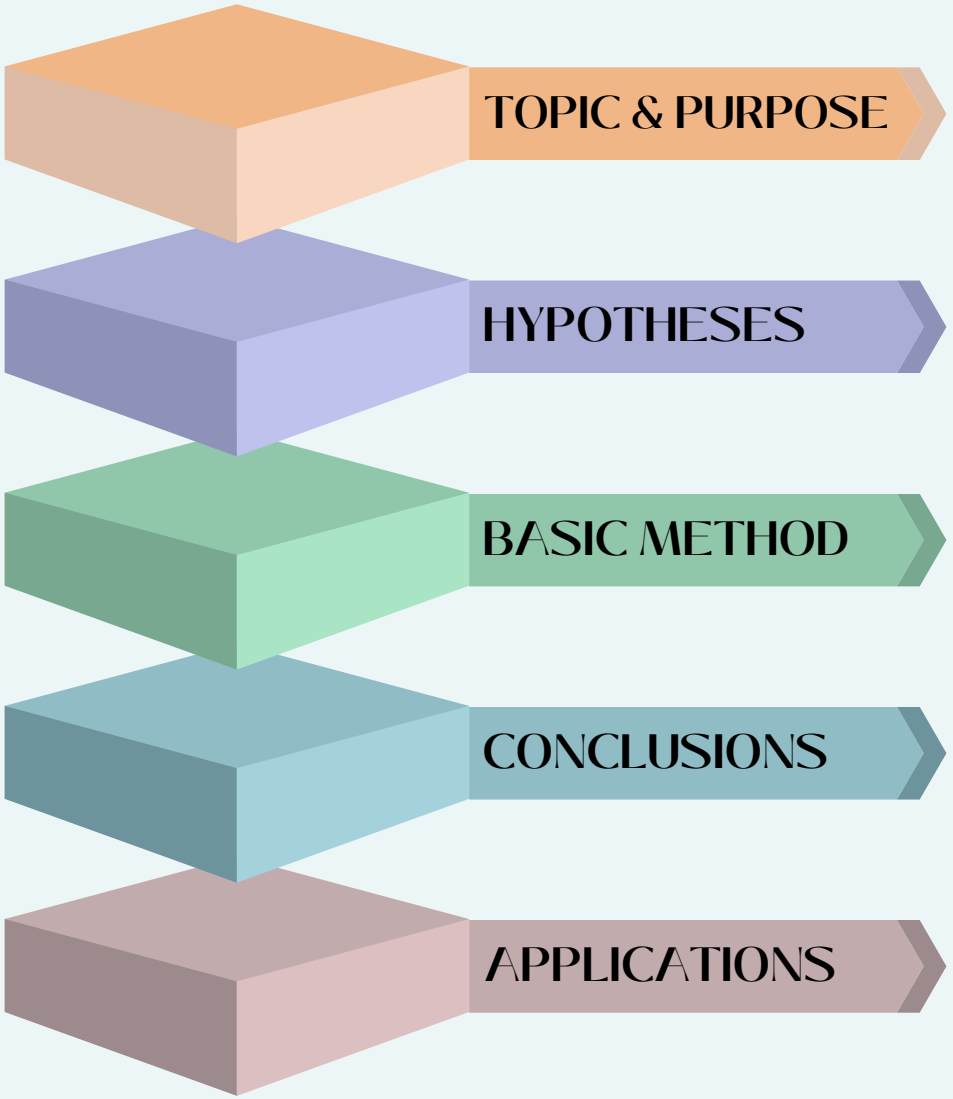
- How do your results impact the research that has already been done by others?
- Could your results have an impact on any other group or environment? How?

STEP 4 Future studies

- How can your research be furthered?
- What questions has this research made you wonder about?

Writing the Abstract

Under 250 Words



What was your topic and why did you study this?

What were your hypotheses and why did you think these would happen?

Briefly, how did you carry out your experiment (just the highlights)?

What results were found and how did they support or refute the hypotheses?

What implications and applications could your results have?

HOW TO BE
A GREAT PRESENTER

Create a 2-3 minute elevator speech that walks your audience through your board.

01

Create simple visuals

02

Know your topic and your audiences

03

Focus on your key ideas

04

Practice makes perfect

05

Don't read your presentation

06

Eliminate filler words

07

Make an eye contact and body language

*When answering questions, don't be afraid to say that you don't know.

A Possible Board Layout

TITLE

Introduction

Include your purpose and rationale. May include problem statement.

Review of Literature

Background research should include in-text citations.

Hypotheses or Solutions and Reasoning

Include in-text cited background research on why/how you came to these hypotheses.

Works Cited

APA format is preferred. MLA is fine too.

Materials

Procedure

Results

Data tables, graphs and pictures

*all graphs, charts and images need to have a citation or "made by student researcher"
*no faces or brand names in images

Data Analysis

Conclusions

Future Studies

Ideas for furthering this research

Display & Safety Rules

JUDGING

Suggested Questions

- What was your favorite part of your project?
- Was there anything that was surprising to you?
- If you were going to do this project again, what might you do differently?
- Where did you get this idea?
- How did you come up with your hypotheses?
- What was your control?
- How did you choose your independent and dependent values?
- Will you explain this graph?
- Who might want to know about your results?
- How did you calculate that result?
- How many times did you repeat your experiment?
- Who helped you with your experiment?
- How are your findings important?
- What questions are you left wondering?
- Did you have fun doing your project?
- What did you learn from your project?
- How does your project relate to other research?
- Why did you chose to do a science fair project?
- Did you run into any problems?
- Walk me through your lab notebook.
- Does your project have practical applications?
- Could you have come up with another conclusion?
- How much time did you spend on your experiments?
- How did you come to your conclusions?
- What was the most challenging part of your project?
- How did you address the limitations of your method?

Judging Form & Comment Card

Project Title:

I. Research Question (10 pts)	
Science	low < 1 2 3 4 5 6 7 8 9 10 > high
• clear and focused purpose	
• identifies contribution to field of study	Comments:
• testable using scientific methods	
Engineering	
• description of a practical need or problem to be solved	
• definition of criteria for proposed solution	
• explanation of constraints	
II. Design and Methodology (15 pts)	
All projects	low < 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 > high
• well designed plan and data collection methods	
• variables and controls defined, appropriate and complete	Comments:
Engineering	
• exploration of alternatives to answer need or problem	
• identification of a solution	
• development of a prototype/model	
III. Execution: Construction and Testing (20 pts)	
All projects	low <1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20> high
• systematic data collection and analysis	
• reproducibility of results	Comments:
• appropriate application of mathematical and statistical methods	
• sufficient data collected to support interpretation and conclusions	
Engineering	
• prototype demonstrates intended design	
• prototype has been tested in multiple conditions/trials	
• prototype demonstrates engineering skill and completeness	
IV. Creativity (20 pts)	low <1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20> high
• project demonstrates significant creativity in one or more of the above criteria	Comments:
V. Presentation (35 pts)	low < 1 2 3 4 5 6 7 8 9 10 > high Comments:
a) Poster/Powerpoint (10 pts)	
• logical organization of material	
• clarity of graphics and legends	
• supporting documentation displayed	
b) Interview/Video (25 pts)	low <1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25> high Comments:
• clear, concise, thoughtful responses to questions	
• understanding of basic science relevant to project	
• understanding of interpretation and limitations of results and conclusions	
• degree of independence in conduction project	
• recognition of potential impact in science, society and/or economics	
• quality of ideas for further research	
• for team projects: contributions to and understanding of project by all members	

Adapted from ISEF's Judging Form

QUESTIONS

IDEAS