Authentic science investigation in the classroom: Tools for creating original testable questions and graphical hypotheses

Supplementary Materials

Question Strips:

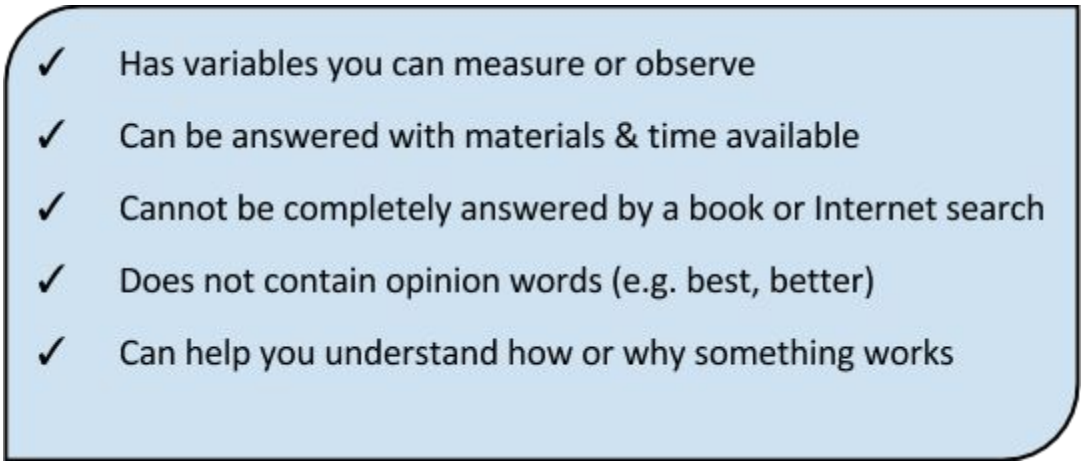
1. Why does a plant grow?	5. Will my plant grow?
2. What type of soil is best for plants?	6. Will the amount of water increase plant height?
3. Will the type of fertilizer affect the number of fruits produced by the plant?	7. Will a plant grow taller in California or Alaska?
4. Does the size of the pot affect the number of plant roots?	8. What kind of seeds do I need to grow a plant?

Category labels: Cut these out so students can arrange questions under each category

TESTABLE QUESTIONS
NON TESTABLE QUESTIONS

SORTING ACTIVITY WORKSHEET

Part 1: Use the checklist below to sort the questions in your envelope:



Part 2: Write down the questions you sorted under "NON TESTABLE QUESTIONS". Draw a line(s) to match each question up to the reason(s) why it is not testable.

NON TESTABLE QUESTIONS:

	Does NOT contain variables that can be measured or observed.
	Can NOT be answered with materials and time available.
	Can be answered using a book or Internet search.
	Contains opinion words (e.g. better, best).
	Does not help understand how or why something works (e.g. can be answered with a yes or no).

Rewrite one of these non-testable questions to make it testable:

Sorting Activity Key

TESTABLE QUESTIONS (we can investigate now)

Variables that are observable/measurable are underlined.

3. Will the type of fertilizer affect the number of fruits produced by the plant?
4. Does the size of the pot affect the number of plant roots?
6. Will the amount of water increase plant height?

TESTABLE QUESTION (we can't investigate right now)

7. Will a plant grow taller in California or Alaska?

This question is testable but it is not feasible for us to investigate right now because we are not able to go to these places to test plant growth. We could test plant growth at different temperatures (or some other variable that might be different between California and Alaska) instead of location to investigate this question.

NOT TESTABLE QUESTIONS

1. Why does a plant grow?

This is a how/why question rather than a testable question. It is also a question that could be answered using books or the internet rather than an investigation. How/why questions are often the questions that start us thinking about what we are interested in. Often doing research on these broad questions lead us to testable questions that can investigated.

2. What type of soil is best for plants?

This question is not specific enough. How will one measure what is the "best" ? Students should avoid using words like "better" or "best" and replace them with specific ways to measure "better" or "best" (EX: What type of soil will make plants grow tallest?).

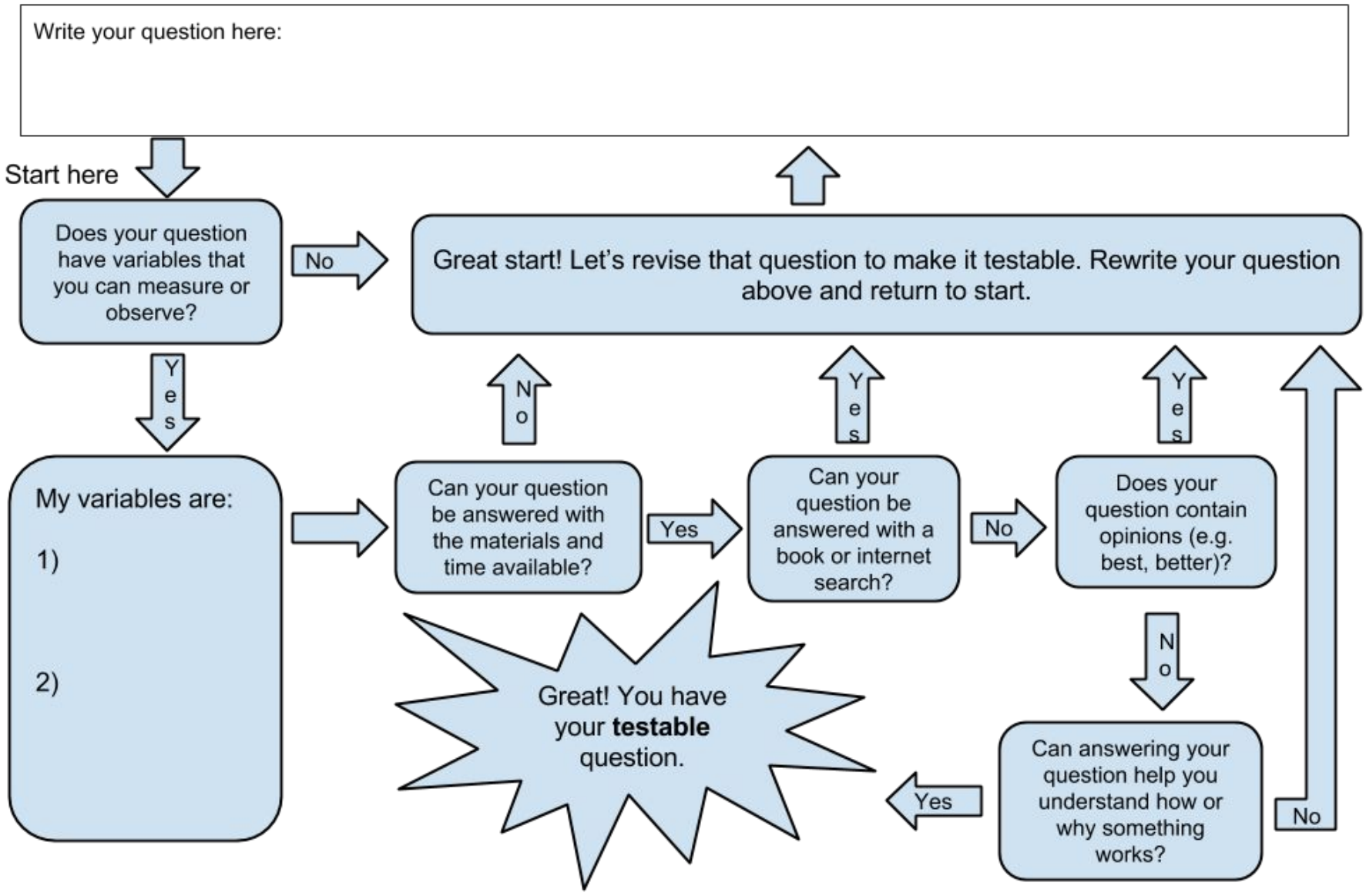
5. Will my plant grow?

This is a yes/no question rather than a testable question. Testable questions require more exploration than yes/no questions and generally result in learning something new about what we are investigating. For this to be a testable question, it should be reworded to include specific measurements. For example "Under what conditions will my plant grow?" or more specifically "Will my plant grow taller in Soil A or Soil B?"

8. What kind of seeds do I need to grow a plant?

This is a research question. It can be looked up online or in a book and does not require an investigation to answer.

Testable Question Flow Chart



Step 1 - BRAINSTORM

Things I could change or vary

Place yellow post-it note here	**Place yellow post-it note here**	**Place yellow post-it note here**
Place yellow post-it note here	**Place yellow post-it note here**	**Place yellow post-it note here**

Things I could measure or observe

Place blue post-it note here	**Place blue post-it note here**	**Place blue post-it note here**
Place blue post-it note here	**Place blue post-it note here**	**Place blue post-it note here**

Step 2 - CHOOSE VARIABLES

I will change or vary (manipulated/independent variable)

Place yellow post-it note here

I will measure (responding/dependent variable)

Place blue post-it note here

I will keep these constant (control variables)

Place yellow post-it note here	Place yellow post-it note here	Place yellow post-it note here
Place yellow post-it note here	Place yellow post-it note here	Place yellow post-it note here

Step 3 - ASK A QUESTION

When I change or vary (manipulated/independent variable)

Place yellow post-it note here

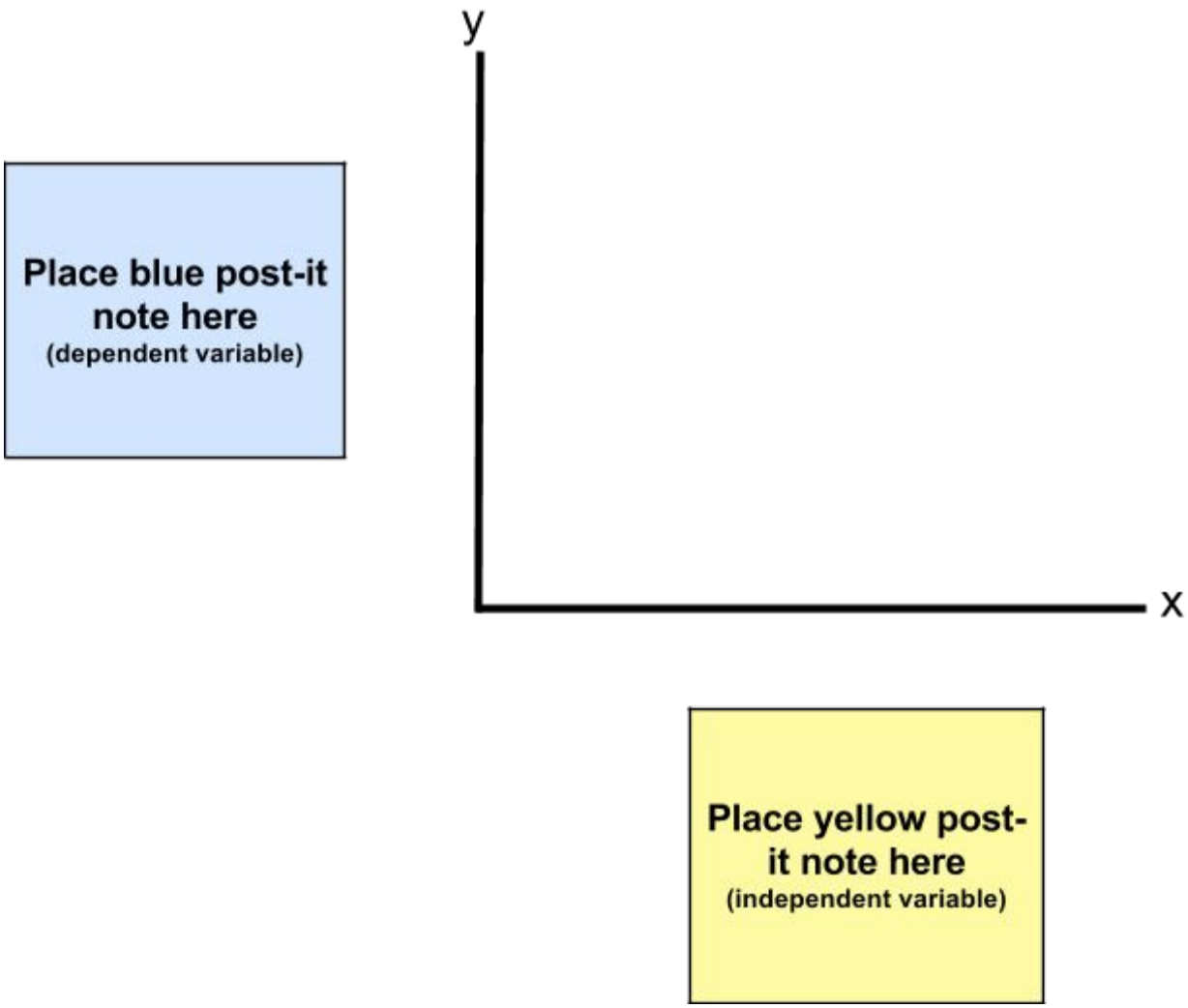
what happens to (responding/dependent variable)?

Place blue post-it note here

"When I change or vary _____, what happens to_____?"

Step 4 - GRAPHICAL HYPOTHESIS

This is how I expect the independent variable to change the response of the dependent variable



Explain what your graph predicts:

Why do you expect to see this pattern?:

Step 5 - DATA TABLE

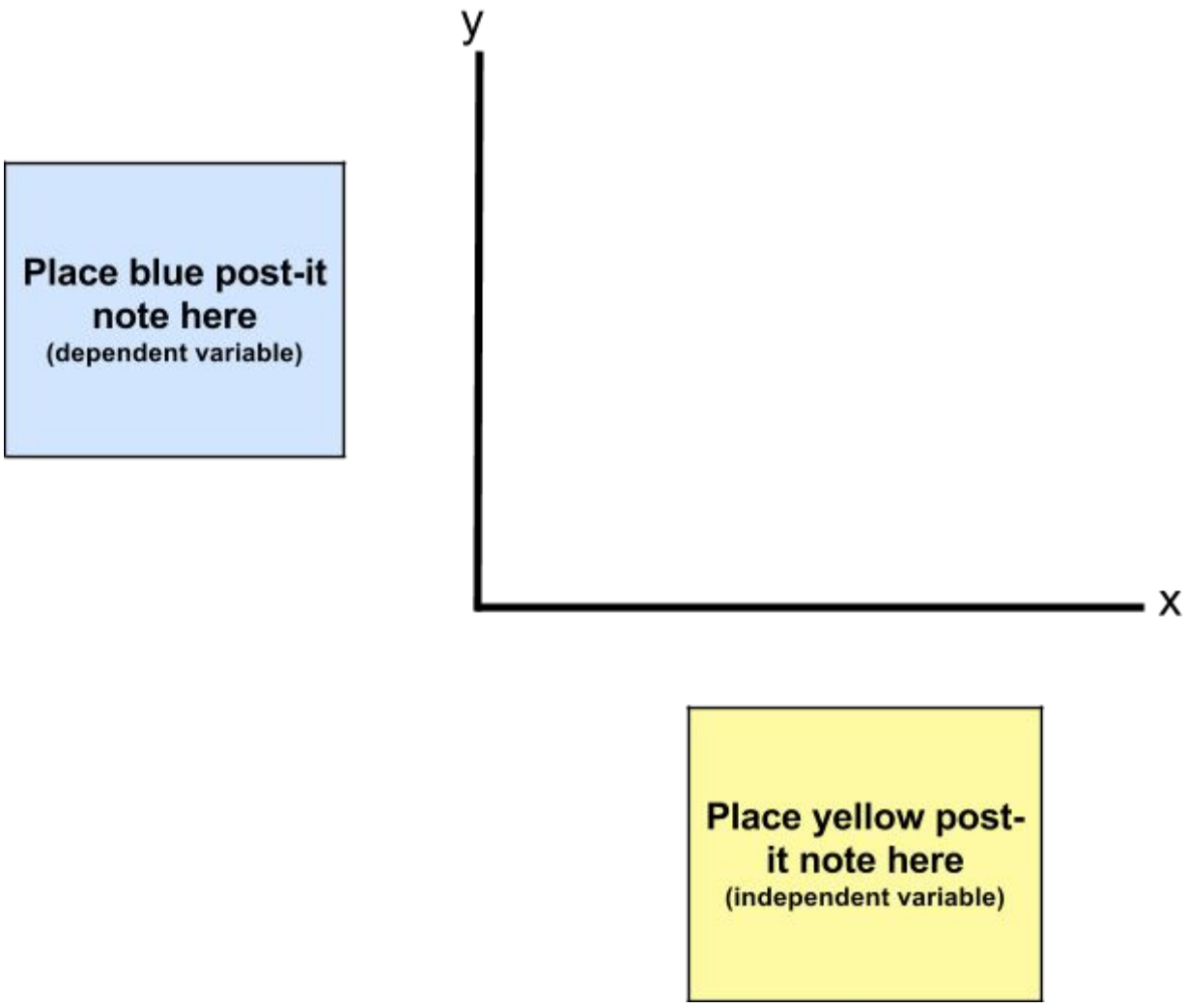
This is what I measured

Date	Trials			Average

Calculating the average $\text{Average} = \dfrac{\text{sum of measurements}}{\text{number of measurements}}$

Step 6 - RESULTS GRAPH

This is how the independent variable affected the dependent variable



This graph shows...