

Planning an Investigation

Scientists plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables. Variables are parts of the experiment that are changed by the experimenter (independent variables) and the types of data being measured (dependent variables).

You will be acting as a scientist in the kitchen as you seek to understand or improve a recipe of your choosing.

What is your testable question?

how does marinating affect the color and taste of meat

What type of question are you asking?

1-Curiosity Driven, 2-Understanding Relationships or 3-Explanation Seeking?

1 and 2

This activity is designed to help you think about how you will plan and conduct your investigation. Go to the pages that correspond to the type of question you are asking and only complete the questions on those pages.

Question Type 1- pages 1, 2 & 7

Question Type 2- pages 1, 3-4 & 7

Question Type 3- pages 1, 5-6 & 7

***Pages 8 & 9 are optional extension questions for students who want to think more deeply about experimental design**

Type 1 Questions-Curiosity Driven

Sometimes we investigate questions that we cannot predict outcomes for or create directional hypotheses for. However, we should still approach these questions in systematic ways with a clear idea of what we are manipulating in the investigation and what we are looking for in our results.

- **Example of a Type 1 question:** Why do some baking recipes get modified for altitude?
- **Possible investigation:**
 - *Make the unmodified recipe, make the modified recipe and make something halfway in between the two.*
 - *Carefully observe all relevant characteristics including: amount of rise, density of bread, flavor, cook time, appearance on the outside of the bread and the appearance on the inside of the bread.*

What do you plan to alter in your investigation? This is your **independent variable**. In what ways will you alter it? How many experimental groups will you test and what will be the specific value of the independent variable in each?

the time of marination (no marination, 10min,30min,1hour)

What aspects of your investigation will remain the same for all trials?

the pork, the heat, the oil

What outcomes/characteristics of your food will you measure or observe to help you answer your testable question? The information you are gathering is/are your observations and measurements of your **dependent variable(s)**. *It is ok to have just one or to have several.*

the moisture/ amount of liquid in the meat. Taste and color

What safety concerns need to be considered with your experiment?

when frying the pork, be careful of the oil and water when frying

Type 2 Questions-Understanding Relationships

Sometimes we directly investigate the relationship between two quantities or the effect that changing one quantity directly has on another.

- A **directional hypothesis** specifies what happens to a **dependent variable** when an **independent variable** is manipulated. In particular it states whether an increase(or decrease) in the independent variable will increase or decrease the value of the dependent variable.
- **Example of a non-directional hypothesis:** *If the amount of baking soda in my cookies is changed the fluffiness will change.*
- **Example of a directional hypothesis:** *If the amount of baking soda in cookies is increased, the fluffiness will increase.*

What is your hypothesis?

I think that the more time you marinate with soy sauce, the more moisture there is going to be in the meat

Is your hypothesis directional? If not, how can you change to make it directional?

no, When marinating with soy sauce, the meat will spread out more to let the soy sauce in.

How many different experimental groups for the independent variable will you investigate? How much will you change the independent variable between each trial? *These changes could be amounts of an ingredient, time for a cooking step, temperature of heating etc.*

I think around 3-4 groups, one for no marination and 2-3 at different times of marination. (10min,30 min and 1 hour)

What aspects of your investigation will remain the same for all trials?

the pork, heat/temperature and oil

What outcomes/characteristics of your food will you measure or observe to help you answer your testable question? The information you are gathering is/are your observations and measurements of your **dependent variable(s)**. *It is ok to have just one or to have several if you think a change in the IV will affect multiple aspects of the final product.*

the moisture/ amount of liquid in the meat. Taste and color

What safety concerns need to be considered with your experiment?

when frying the pork, be careful of the oil and water when frying

Type 3 Questions-Explanation Seeking

Sometimes we investigate something because we have been told it is the best way to do something, but we don't know if that's true or why it's true. These investigations seek to confirm or disprove what we've been told in the past, seek to understand why something works the way it does or to identify relationships that can be explored further.

- **Example of a Type 3 question:** Why do some recipes recommend blanching vegetables?
- **Possible investigation:**
 - *Cook three types of vegetables. For each vegetable blanch one portion using ice water, blanch a second portion in room temperature water and don't blanch the third portion.*
 - *Carefully observe all relevant characteristics of the vegetables including: color, texture, flavor and crispness at three different times: immediately after treatment, five minutes after treatment and ten minutes after treatment.*

What do you plan to alter in your investigation? This is your **independent variable**. In what ways will you alter it? How many experimental groups will investigate and what will be the specific value of the independent variable in each?

What aspects of your investigation will remain the same for all trials?

What outcomes/characteristics of your food will you measure or observe to help you answer your testable question? The information you are gathering is/are your observations and measurements of your **dependent variable(s)**. *It is ok to have just one or to have several.*

What safety concerns need to be considered with your experiment?

Types 1, 2 & 3 Questions

How will you collect data, measurements or observations, on your dependent variable(s)?

Describe your plan for each of the dependent variables you intend to measure or observe

Dependent variable Is it quantitative or qualitative?	Measurements or observations needed	How to measure?	What tools will you need?	How many measurements per trial? (replicates)	How accurate and precise will this be?	Other considerations
<i>Density; this is quantitative but it could also be qualitative if asked as a taste test question or not measured</i>	<i>Mass and volume; taste test survey results</i>	<i>Cut a piece of cookie that is exactly 2 cm x 2 cm and then measure the height. Multiply the height by length and width to get volume in cm^3. Measure the mass of piece of cookie on scale and then divide the mass by the volume to get the density in g/cm^3; do as a blind taste test</i>	<i>Ruler marked to the nearest millimeter, electronic balance, knife,; computer, Google form, napkins, serving fork</i>	<i>3 for each different type of cookie(each version of independent variable), at least 10 survey participants trying all types</i>	<i>The scale measures to the nearest hundredth of a gram so my mass will be x.xx g and the ruler measures to a tenth of a cm so my length will be x.x cm meaning my density will have an accuracy of 2 decimal points.</i>	<i>This will take about 2 minutes per measurement and will leave plenty of other cookies for taste tests. There will likely be some irregularities with cookies when cut with a knife so perhaps I should use a pre-set cookie cutter.; Surveys will take about 5 minutes, I should bring enough food for 15 people to try small bites</i>
<i>moisture:quantitative, you can measure how much liquid is in the meat</i>	<i>mass and volume of water. in ml</i>	<i>squeeze the meat and measure . measure the difference</i>	<i>something to collect the liquid</i>	<i>3</i>	<i>this can be accurate depending on how well you squeeze the liquid out of the meat</i>	<i>I should find another way to test the moisture</i>
<i>color :qualitative</i>	<i>visible: how dark the meat is</i>	<i>we would need people to look at the meat and tell us if the color is dark or not</i>	<i>eyes</i>	<i>3</i>	<i>not precise because</i>	<i>try to find a trend of what people think</i>
<i>taste : qualitative</i>	<i>taste test</i>	<i>we would need people to taste it, to determine the</i>	<i>mouth</i>	<i>3</i>	<i>depend on each individual taste bud</i>	<i>try to find a trend of what people think</i>

		<i>taste</i>				

Advanced Planning Considerations-OPTIONAL

- *Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of supporting explanations for phenomena, or testing solutions to problems. Consider possible **confounding variables** or effects and evaluate the investigation's design to ensure variables are controlled.*

Controlling variables in experiment design

Sometimes in an experiment we are attempting to measure the effect of one change and we end up inadvertently and simultaneously changing something else as well that has a more significant impact on the outcome. When possible, make the appropriate adjustment to counteract the change like shown in the situation below.

Ex. If you are changing the amount of lemon juice in lemon bars to change the acidity, you are also changing the amount of water in the recipe. This change can be addressed by proportionally decreasing the amount of water you add.

However, there are some situations where the change might be too complex to counteract. In these cases, you need to recognize the additional changes you are making and consider how they might affect your measurements (dependent variables).

Ex. If you are changing the amount of butter in a recipe to change the amount of fat, you are also changing the amount of water, protein and potentially salt in the recipe or if you are changing the type of flour to eliminate gluten you are also changing starch types and ratios, sugar content, other proteins etc.

What is your independent variable and what is the change you are hoping to affect?

Ex. Amount of lemon juice and amount of acid

- *How can I ensure that the results that I am measuring are directly affected by the manipulation of the variable in my experiment? What else might be changing with the IV beyond your intended change?*
Ex. By adding more lemon juice I'm also increasing the amount of water

Can you counteract the unintended changes? How?

Ex. *Reduce the amount of water being added to offset the additional water in the lemon juice*

- *In what ways might my experimental procedure provide sources of error or provide potentially misleading data?*

If you cannot counteract the unintended changes, what possible effects could they have on your measured data?

Ex. *When I change to almond flour to eliminate gluten, I am also getting a lot more easily digested starches which could lead to a sweeter tasting banana bread and a 'thicker' banana bread because the starches might form a gel with the water in the recipe*

To read more on confounding variables please check out this entertaining [link](#).