Developing an Experimental Project:
The Need to Knead - Part 1

by Wendy Topic

A successful experiment starts with a question or observation about the world around you. Once you have a question, you can design an experiment that will allow you to find an answer. Deciding on the variables that you will test and control is the key to a successful design.

Join Milo as he designs an experiment to test the need to knead.

1) Be curious and question your observations:

A discovery is often made when someone thinks “that’s odd...”

One weekend, Milo watched his mom making bread. She folded the dough over and over again. She said that you “knead” dough so that it rises and makes a nice light loaf. Milo wondered, “How long does the dough need to be kneaded?” His mom said that she really didn’t know, but Milo could do an experiment to find out!

2) A bit of research:

You need to know at least the basics before you can design a good experiment. All scientists build on the knowledge of other scientists, and they give credit to their sources.

Milo already knew that bread rises because of yeast, but that didn’t explain why bread is kneaded. A quick internet search showed that kneading causes gluten to form and allows pockets of air to be trapped in the bread. An article on wisegeeks.com (“Why Do You Need to Knead Bread?” by Malcolm Tatum, September 17, 2011) said that generally bread has to be kneaded for 8 to 10 minutes.

Milo’s quick search raised more questions:

- Can I trust this website? Where can I find a reliable source to back this up?
- What is gluten? How does it act as a binding agent in bread?
- What happens when you knead the bread for less time or more time?

Milo wrote these questions down so that he could research them later. He had already decided what he could answer with his experiment!

3) Ask a focused question:

He decided that he would do an experiment to try and answer “what kneading time gives the lightest loaf?” (He later changed the question slightly)

4) Decide which variable you can test:

To answer his question, Milo decided he would test:

	Dependent Variable	Independent Variable
Variable	kneading time	~~lightness of the loaf~~ density of the loaf
How I will test it	I will knead dough for 4, 6, 8, 10, 12, 14 and 16 minutes. I will bake the loaves and test the finished loaves.	Density is the mass divided by the volume. I will weigh each baked loaf and measure its volume.
Notes		I will measure the volume by wrapping each loaf in cling film, pushing it into water, and measuring the volume of water it displaces.

Generally, strong independent and dependent variable pairs can be plotted as an x-y (scatter) graph. This will allow you to discuss trends in your results. Weaker pairs can only be plotted as bar graphs or discussed qualitatively.

5) Control other variables that could influence your measurements and results:

Milo asked a baker what determines how much bread rises. Based on this research he decided he needed to control the following factors:

Variable/Factor	How it could change my results	How I will control it
Ingredients in the bread	Different amounts of yeast and sugar will change how quickly the bread rises. Different types of flour need different amounts of kneading.	Use only one recipe. For each trial, all the loaves will come from a single batch. There will be 7 mini-loaves per trial. Even if there are small differences in my ingredients, the mini-loaves in a single trial can be compared.

	Other ingredients can also act as binding agents (like egg).	
How the bread is kneaded	The technique used to knead the bread will influence how quickly gluten is formed (and how much the bread rises).	~~Could buy a machine to knead the bread (like a KitchenAide with a hook). Too expensive.~~ Have mom (an expert) knead the dough. Use a metronome to pace the kneading. After 4 minutes, cut a 100 g portion of the dough and set to rise. After 2 more minutes, cut another 100 g portion and set to rise. Continue until all 7 mini-loaves are complete at the end of 16 minutes of kneading.
Temperature	Yeast reproduces more quickly (and bread rises more quickly) when the temperature is higher.	Use a single batch of dough for each trial. Have all the bread rise in a single location (one cookie tray on counter). Results of different trials may not be completely comparable (as room temperatures will be slightly different), but the trends can be compared.
Baking conditions	Differences in the baking conditions could impact the density of the loaf.	Bake a single trial at the same time on a single sheet. I will do 7 trials, placing the loaves on the sheet in different positions to make sure that each "knead time" has a chance to have the "best" oven conditions.
Rising time	The more time the bread has to rise, the more it will rise.	I may not be able to control this completely! The low knead time mini-loaves will rise for a little longer. Since the total rise time will be 1.5 hours, the 12 minute difference between the first and last loaves is only 13% difference (relatively small).
How the volume is determined	If the loaves are not totally submerged, the measured volumes will be randomly different from the actual volumes.	Use a large (250 mL) graduated cylinder filled with approximately 100 mL of water. Record the initial water volume exactly. Make a tool push the cling film wrapped mini-loaves into the water. Mark on the tool the height of the water when the final water volume is measured. Use the same equipment and technique for all mini-loaf volume measurements. All measured volumes will be larger than the actual value, but they will all be larger by the same amount (the volume of the tool used to push the loaf under).

Milo has thought carefully about his experiment. He is now ready to test his experimental technique to see if it works. He may need to make changes to his procedure if it doesn't allow him to control his variables or if he isn't

able to collect reliable data. This is all part of designing (and revising) a good experimental project. Remember, if you already had all the answers, you wouldn't need to do the experiment!

To complete his project, Milo will need to do several things:

- Complete his background research to find trustworthy sources of information on gluten, bread and bread making (he should track his sources as he goes)
- Collect his measurements (volume and mass of the mini-loaves)
- Determine the density of the mini-loaves
- Analyze his data (using an x-y or scatter graph) of the density of the mini-loaves versus knead time
- Draw a conclusion that answers his research question "How long do you need to knead for the least dense loaf?"
- Decide how dependable his results are and evaluate the strengths and weaknesses of the procedure he designed.

See how Milo started to plan his project in the First Installment!
See how Milo collected and analyzes his data Collecting and Analyzing Data
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Wendy Topic is a science teacher at Glenlyon Norfolk School.
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