Fizzics Education

Science shows & workshops

Kitchen Chemistry

Experiments!

Teacher Edition

Contents

Welcome!

Hi there! We put this short kitchen chemistry book together to help you teach the science the way students love. It puts into the practice some of the things we've learned through delivering thousands of science programs each year to students across Australia since 2004.

- We'll give you a run down on the scientific method, and how to fairly test variables in a science experiment.

- You'll find a sample experiment page that your students can use. It is designed to get students to identify variables correctly and to reflect on their results, rather than copying in the method of each experiment.

- 30 science experiments!
  There are also links back to the Fizzics website so you can see videos of most of these experiments too.

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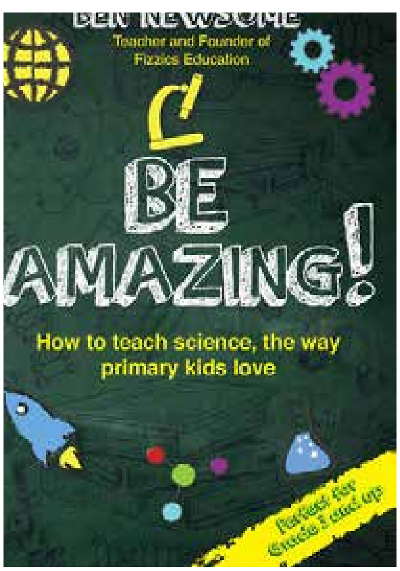

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Variables & fair testing; teaching the heart of science experiments

Whilst this is not the most 'fun' way to start this booklet, understanding the scientific method is important.

It doesn't matter who you're teaching – it is always important to make sure your students understand the importance of and the skills associated with the fair testing of variables as they start to explore the scientific world.

We've been teaching the scientific method in science incursions for several years in schools, and during these visits we've often found that people request a simple overview of how teachers can teach scientific methodology in their own classrooms regardless of what the scenario actually is.

The scientific method is essentially a researcher's ability to identify a question they want to ask, where they can use controls to investigate one element of a given situation so that they can take measurements and then analyse them so that a conclusion can be drawn.

The Scientific Method

1. Identify the conditions of a situation (temperature, humidity, light etc).
2. Can any of these conditions change? We call this "varying."
3. If one of the conditions can be varied (ie. Temperature), can you measure it?
4. Can the rest of the conditions be kept the same? If so, proceed with your experiment. If not, you need to decide if it will affect your results – will it look like your experiment look like it has been done poorly?
5. Can you create an experiment where you can vary one of the measurable conditions to see if it has an effect on another measurable condition in the experiment?
6. Make a prediction on how you think varying the condition will change the other condition.
7. Run the experiment, keeping one of the conditions exactly the same while varying the condition that you want to measure the effect of.
8. Repeat the experiment at least 3 times. You may wish to them all at the same time or in succession.
9. Record the results accurately each time you do the experiment.
10. Draw a conclusion based on your results.
11. Write up the experiment so that someone else can reproduce what you did using your instructions and see if they also produce the same result.

Now after explaining the above to your students and letting them get used to the idea, you can start to introduce scientific language. Change the word “condition” to “variable” for a start and highlight that the word variable comes from the word “vary” i.e. to change. This pretty much indicates what we’re trying to do in lots of ways! So, once the student come to grips that you have variables in an experiment it is time to introduce the types of variables without confusing them. We’ve found it easier to ask the following:

- what did we vary each time in the experiment?

- what did we measure in hope of seeing a different result after varying the experiment?

- what other things did we control in our experiment?

In the above example, the students will quickly identify that you were changing the temperature each time and that we were hoping to see a change in the plant height, with everything else remaining constant in the greenhouse. Now it’s time to put a list up on the board of the above questions except this time we give them their scientific names:

- The **independent variable** is the one we varied each time in the experiment.

- The **dependent variable** was the one which we measured in hope of seeing a result change in response to changing the independent variable.

- The **controlled variables** were the other variables we controlled during the experiment.

Just a slight repetition and now the students can see where you’re coming from. You’re almost there! Ask the students to find out if they are happy with how the experiment went. They’ll of course say yes/no/maybe/not sure but you can re-phrase by asking directly “Was the experiment fair or not?”. Kids have an inherent idea of what is fair or not, you just have to watch them argue in the playground over taking turns! All you have to do is have them evaluate the experiment and work out whether the way you ran the experiment allowed you to fairly test the question you raised, i.e. ‘Does temperature affect plant growth?’. In this you can ask them a variety of questions:

- Did we accurately measure the temperature? Was there anything that could lead to an error here?

- Did we accurately measure the plant height? Was there anything that could lead to an error here too?

- Did we accurately control the other variables? Was there anything that could lead to an error here?

- Was there anything else in the experiment replications that gave a result that could be considered unfair?

This is a good time now to discuss why you had the students run the experiment several times. Why? To get an average reading across the experiments to reduce experimental error. At this point, you’ve more or less nailed it!

By having students follow the sequence of identifying and controlling variables and accurately measuring the result, all whilst posing questions as to whether the experiment is fair or not you'll go a long way to setting up the mindset needed to run any experiment in any discipline. What you're actually teaching is experimental design, a critical thinking process that should never be skipped prior to running an experiment in the real world. A great scenario to pose to students about the values of good experimental design is this: imagine if you spent 3 years and thousands of dollars on a particular study only to find out at the end that your experiment was flawed from the beginning. You'd be more than upset!

Finally, you need to mention that the point of writing up the experiment is so that someone else can repeat the way you ran it and check if they get the same results. In scientific speak, you're creating a falsifiable and repeatable experiment. In other words, are you just making stuff up or can someone test the validity of your claims? This reminds me of a very famous quote!

"No amount of experimentation can ever prove me right; a single experiment can prove me wrong."
Albert Einstein

Of course, now is the time to reinforce the concept by posing an entirely new experiment and guiding them through identifying the variable types, fair testing and finally evaluating what they did. If you repeat this exercise enough times, the thought processes of a researcher will be ingrained in your students and the whole process of how scientists work will be less of a mystery. They'll then be able to identify variables quickly in any given experiment and pose a testable question that produces a valid result that can be repeated by someone else. It's definitely worth chatting with students about how they could apply the scientific process to their own lives;

- What is the best ratio of ingredients to use in a chocolate cake?

- Which shampoo gives my hair most strength?

- Which lawn fertilizer is the best to use?

- Which octane level produces the best fuel economy in a car?

For the vast majority of situations you're looking at, there's often a way of scientifically checking what is actually going on. Essentially, the scientific method is saying ' if I have situation of X, Y, Z... what would happen to Z if I vary X and control Y...and how can I fairly test this to record a valid answer that is reproducible and testable by someone else?'

If you follow all of this and begin to apply it in your classroom, the kids minds can only grow as result. It was the very advent of the scientific method that really accelerated civilization to produce our current way of life. Understanding how scientists work is a very important task for all teachers to instil in our students regardless if they're academically gifted or not. Unfortunately, not doing so risks creating a generation with a lack of understanding of scientific processes that can quickly bring about public mistrust and even animosity against the very people using working hard to use verifiable evidence to improve our lives. Besides which, wouldn't be just great to have the skills to work out why things happen all the time? Sounds like a plan to us!

Experiment Title: ______________________________

Picture of your experiment

Aim:

____

____

Materials

____

____

____

Variables

- Independent variable (the one we varied) ______________________________
- Dependent variable (what we measured to see an affect)______________________________
- Controlled variables (everything that stayed the same)______________________________

____

Prediction

What did you think would happen if you changed the independent variable?

____

Results summary (attach your raw data to this sheet)

____

____

Experiment Reflections

a) Which happened?______________________________

b) Did this match your prediction?______________________________

c) Explain why you observed this. ______________________________

DISH SOAP SLIME

You will need:

- Detergent. Either dishwashing liquid, hand soap or shampoo
- Food colouring/glitter (optional)
- Table salt
- A container
- One Spoon

Instruction

1

Squeeze some detergent into the container.

2

Add the food dye, or glitter.

3

Sprinkle some salt into the mixture and stir well with a spoon.

Repeat step three until a 'slime' consistency is reached. Each addition of salt could take a minute or so to mix in, so be patient.

Why Does This Happen?

Dish detergent, shampoo, hand soap, and anything else you might use to wash things contain surfactants. A surfactant is usually a molecule with a hydrophilic "head" and a hydrophobic "tail". This means that it is able to bridge between water soluble and oil-soluble interfaces. An anionic surfactant is one with an anionic functional group at the "head" position. They are the most common surfactants used in industry, typical examples are lauryl sulfates, laureth sulfates, sulfonates and phosphate esters. If your soapy liquid of choice has one of these chemicals in its long list of ingredients, it should make a slime when you add just the right amount of salt to it.

When surfactants are in solution they can sometimes arrange themselves into these aggregate units called micelles, where all the surfactant molecules have their "tails" pointing inwards and "heads" pointing outwards, or vice versa. In the detergents that we used to make the slime, the micelles formed have anionic "head" groups sticking out into the solution, with their hydrophobic "tails" in the centre. This gives the micelles a certain charge density on its outer surface, which can be affected by the addition of salt. The ions from the dissolved salt, at the right concentration, can cause bigger micelles to form and pack closer together, resulting in a thicker mixture or gelling effect. But if salt concentrations are pushed beyond that optimal level, the micelle structures can breakdown and the mixture viscosity will decrease.

For more slime recipes and experiments, check out our comprehensive guide to SLIME!

Variables to consider

- Different amounts of salt
- Different types of detergent
- Does sugar affect the experiment?
- Temperature of materials

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ERUPT A VOLCANO

You will need:

100mL Vinegar

4 tablespoons of bicarbonate soda mixed in 150mL water

150mL Detergent

A few drops of Orange or Red Food Clouring

A 500mL container

And for a more realistic looking volcano brown coloured play dough

Instruction

Mix the detergent, food colouring and vinegar in the 500 mL container.

Put the mixture outside, or at least in a place where you are allowed to get messy.

If you want, you can make a mode of a volcano out of the play dough. However this is not necessary.

Mix the bicarbonate soda and water into a glass and stir.

Pour the Bicarbonate soda and water mixture into the 500mL container; the container with your detergent, food colouring and vinegar mixture.

And Stand back.

Why Does This Happen?

Reacting vinegar and bicarbonate soda together produces carbon dioxide and water.

The reaction is as follows

Vinegar + Bicarbonate Soda —> Carbonic Acid + Sodium Acetate

The carbonic acid is unstable though, so it breaks down into liquid water and carbon dioxide as a gas, causing the massive 'build up' of pressure you saw in the experiment.
The water is left in the vinegar solution whilst the carbon dioxide rises and fills the balloon on the bottle.

The Continental Drift theory put forward by Alfred Wegener in 1912 describes the Earths outer layer, the crust, as being made up of giant 'plates' that drift apart and together over millions of years. These plates, now known as tectonic plates, sit on the outer mantle of the Earth known as the asthenosphere. The asthenosphere contains solid rock that moves like a very slow fluid over geological time because of enormous pressures within the the Earth. The movement of the asthenosphere carries the tectonic plates together and apart.

It is along these divergent and convergent plate boundaries where earthquakes and volcanic eruptions mainly occur, as well as mountain and ocean trench creation. Other areas for volcanic activity are 'hotspots' far from the plate boundaries. These are areas where the hot magma from the outer mantle has melted the crust, forming a vent for a volcano to form. Once magma is erupted from the a volcano it is called lava, which can be between 700°C and 1200°C.

Variables to consider

- Temperature
- Different dilutions of vinegar

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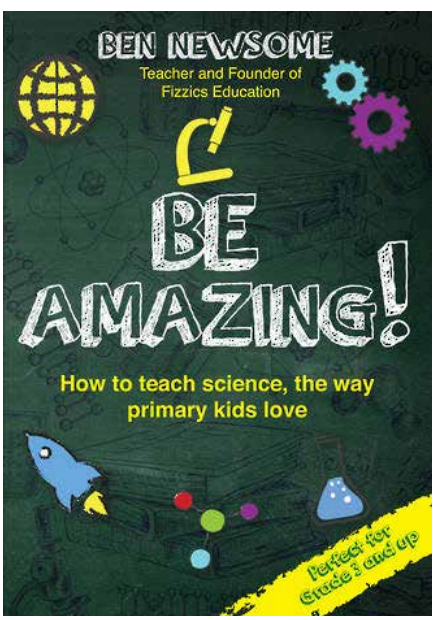

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