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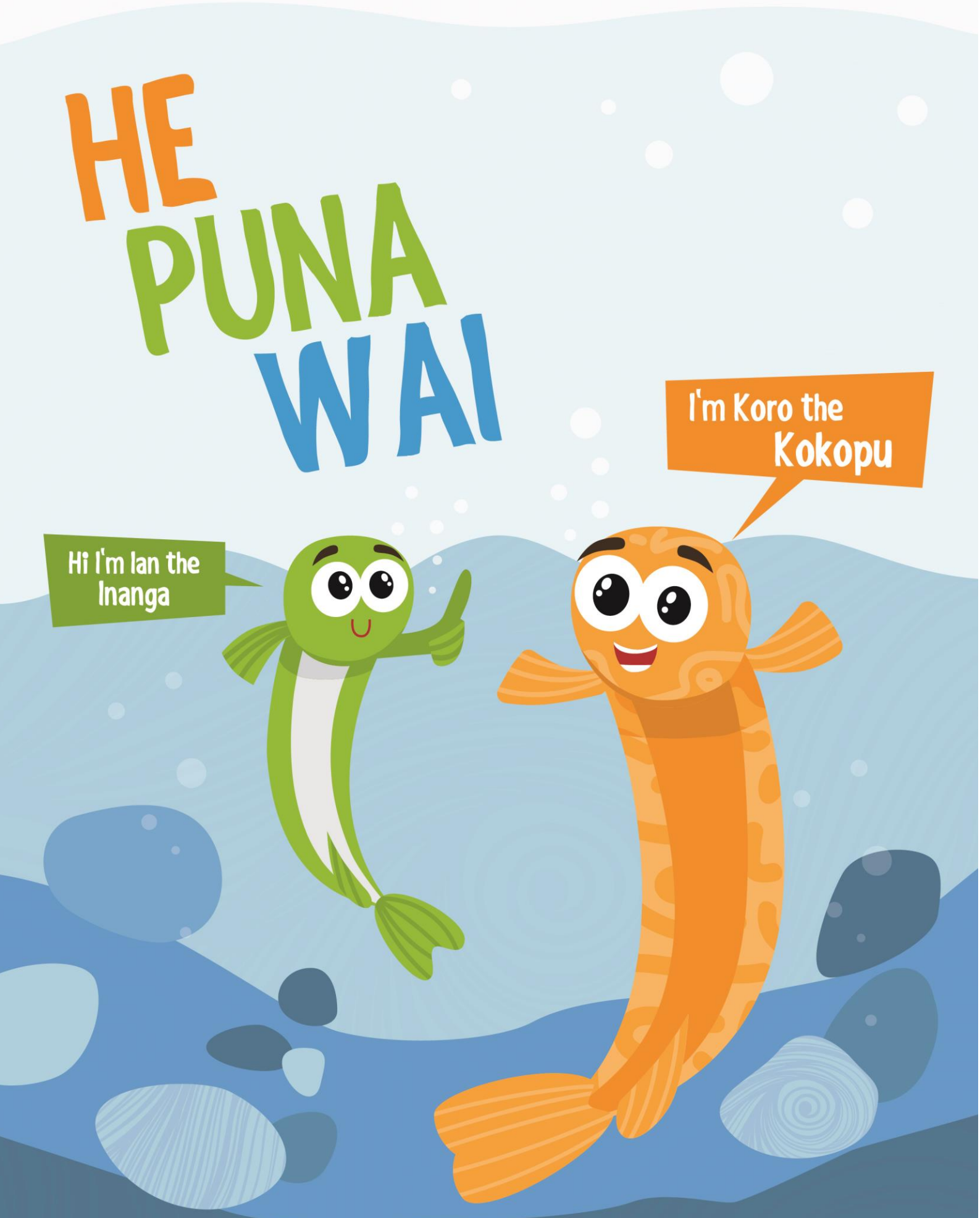

Experimenting with flocculation

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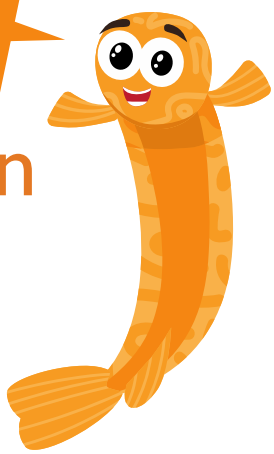


Experimenting with flocculation

Activity	Subject Areas	Inquiry Stage
4	Science	3. Pūhoru: Splash around

Overview

In this activity students explore treatment process and flocculation and how it works.

Key Concepts	• Properties and changes of matter. • Flocculation and clumping.

Curriculum links

New Zealand Curriculum

Learning Areas	Levels	Years
Science Science: Material World: Chemistry and society Nature of Science: Investigating in Science	3-4	5-8

Learning intentions

Students are learning to:

- Investigate the process of flocculation.

Success criteria

Students can:

- Observe and describe how the process of flocculation occurs and how it helps to clean water.

Background information: Experimenting with flocculation

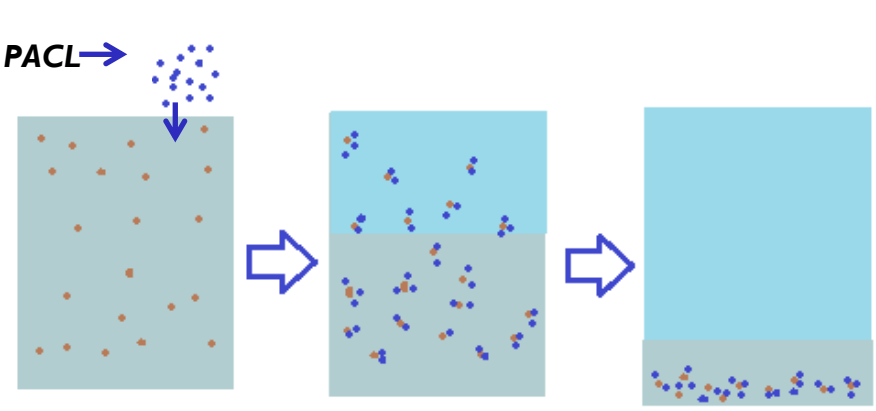
What are chemical and physical changes?

A chemical change is when one substance reacts with another, forming a new substance, such as burning wood or mixing baking soda and vinegar. A physical change is when something changes over time but does not change structure or composition, such as melting ice, boiling water or shredding paper.

Clumping or flocculation

In this activity students learn about flocculation and how common kitchen ingredients can be used in the flocculation process.
If you zoomed in on liquid water, as if you were using a powerful microscope, you would see water molecules and other tiny bits and pieces (particles) suspended or floating in the water. Flocculation is when sediment groups together, becomes heavy and then settles to the bottom.

We need the particles to settle out so we can separate clean water from these particles – the clear water is on top and the dirt settles on the bottom. To get this process started, we add something that will create a positive charge in the particles.
At the New Plymouth Water Treatment Plant, a chemical called PACL (Polyaluminium chloride) is added to encourage clumping of the dirt particles. The charged particles now attract each other and form larger clumps which settle, leaving the clear water on top. This clear water will then go to the next stage of the process.

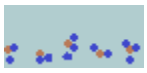


Dirt particles in the water float. Once a chemical is added to make the particles stick together they become heavy and sink. The clear water on the top can then be used.

Key

Brown dots are dirt particles, background is water.

Blue dots are a chemical called PACL (Polyaluminium chloride).



Brown and blue dots together are clumped particles or sludge.

What properties of salt and lemon juice help to clump dirt and remove it from water?

Lemon juice is acidic with a pH of around 2. The hydrogen ions in the lemon juice attract the dirt and other particles. Clay particles (bentonite) in soil have an electrostatic charge. This charge makes them attract to salt molecules as salt has charged ions. When clay is mixed with other particles they stick together, forming clumps.

Learning experience: Experimenting with flocculation

Resources

Poster:	Water treatment process
Student Activity Sheet 4:	Observing Flocculation Page 6

Water treatment review

Revisit the drinking water treatment process using Activity 3: Water to drink
or
Show students the Poster: Water treatment process

Experimenting with flocculation

- This experiment investigates the process of clumping, also known as flocculation. Flocculation is an important part of the water treatment process.
- Discuss what is meant by flocculation. *Flocculation can be thought of like a flock of sheep: in a paddock a dog can round up all the sheep into a flock. Similarly, in water we want the bits of dirt to come together.*
- Try the experiment: How can we separate dirt from water? on pages 3-6

Is this water safe to drink?

Even though water from your experiment may appear clear, do not drink it! The treatment process must include more than just the flocculation stage to make safe drinking water.
See this activity from Khan Academy to learn more about water-borne diseases:
https://www.khanacademy.org/partner-content/mit-k12/mit-k12-materials/v/flocculation

Other resources

Find out about Wellington's drinking water treatment, which is similar to New Plymouth's treatment process:
https://vimeo.com/218612085

Experiment

How can we separate dirt from water?

A chemical change is when one substance reacts with another, forming a new substance, such as burning wood or mixing baking soda and vinegar. A physical change is when something changes over time but does not change structure or composition, such as melting ice, boiling water or shredding paper.

Learning objectives

After this activity, students should be able to:

- Describe how flocculants work to help purify water.

Things you need for each group

2-3 clear plastic bottles.

1-2 litres of dirty water (add dirt to water).

4 teaspoons of salt.

1 teaspoon of lemon juice (optional).

Prediction/ hypothesis

Ask students to make a prediction about what they think will happen when salt and lemon juice are added to the bottles of dirty water.

Method

Prior to your experiment

Collect the dirty water from a stream or nearby lake. Make sure to collect some sand or dirt when collecting the water so you can see the flocculation process. It is valuable to do this with the students. Alternatively, you can make dirty water by putting two tablespoons of dirt into a bottle half-filled with water and shake. Ensure the dirty water is the same for all bottles so that you can compare results between them.

During your experiment

Add the following:

Bottle 1: only dirty water. This is a control; set this aside (we don't add anything other than the dirty water to this bottle).
Bottle 2: add two teaspoons of salt to the dirty water.
Bottle 3: add two teaspoons of salt and one teaspoon of lemon juice to the dirty water.
Label each bottle 1,2 and 3.

Leave the three plastic bottles to settle and observe. Take notes and record observations after 15 minutes, one hour and then the next day. Compare the treated water with the control bottle. Which bottle has the clearest water?

Discussion

- Which bottle's dirt settled the fastest? Which bottle was the slowest to settle? Why do you think this was?
- What did the water look like the next day? What did the control bottle look like?
- We used salt to mimic the chemicals used in the water treatment plant. Are there any other ingredients that might make the dirt settle faster?
- How do we get the clean water off the top without mixing the bottle?
- Even through the water and its suspended particles have been separated, this water would not be safe to drink. This water would still require further treatment to be sure it would not make you unwell.

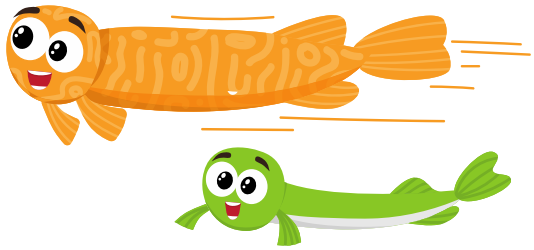
Reflection

- Discuss and compare your results with another group. Why might some groups have different results than others?
- How does the process of flocculation help to clean water and make it safe to drink? Ask students to write about this idea and share the findings of their experiments with other groups.

Extending learning

In some water treatment, an acidic component is added which should speed up flocculation.
What did the lemon juice do to the water?
Most suspended solids such as dirt have a negative charge at their surface. These particles repel each other when they are all negatively charged (like repels like). When an acid like lemon juice is added, this introduces hydrogen ions, which are positively charged. Opposites attract and the hydrogen ions attract the negatively charged dirt, forming clumps of flocculation.
Acids are not official flocculants but they do help to speed up the process of flocculation.

Student Activity Sheet 4
Observations of flocculation



Prediction

Method

Results

Observations	After 5 Minutes	After 10 minutes	The next day
Bottle 1: Control- only dirty water			
Bottle 2: Salt and dirty water			
Bottle 3: Salt, lemon juice and dirty water			

Conclusions