Wonder Project

WHERE SCIENCE TECHNOLOGY ENGINEERING AND MATHS COME ALIVE.

Plant Challenge

Additional teacher support notes

Term 4, 2021

engineering new zealand

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New Zealand's Innovation Agency

Contents

Overview

This document provides some additional support for Plant Challenge lab book and learning hub activities, a key vocab glossary and some tips to help you use the resources and run the Challenge.

Please refer to the **teacher module overview** before using this document. Use the overview, and this document, to complement the online modules designed for students.

STEM skills

Some of the key STEM skills students will use throughout the Challenge are:

STEM skill	Description
Teamwork	Teamwork is working together with others to achieve an end goal. To be effective team members, students need to recognise each other's expertise and strengths, be flexible, work together to complete tasks, and make sure each team member has a job. Engineers work in teams to develop solutions because they each bring a different set of skills and expertise to a project.
Communication	Communication is about passing on information effectively, listening when others are sharing ideas, understanding instructions, and asking questions. It's about bringing different knowledge and experience to the table to improve results.
Open mindedness	Open mindedness is about being willing to listen, considering and accepting different ideas. It's about being open to new experiences and learning about the world around you.
Creativity	Creativity is about taking risks, ignoring doubt and facing fears. It's about using inventiveness and outside the box thinking to bring new ideas to life.
Problem solving	Problem solving is about thinking innovatively, being resilient, never giving up and trying lots of ideas to find the best solution.
Analysis	Analysis is about being observant, collecting and interpreting data, detecting patterns, brainstorming ideas, and making decisions based on the results.

Your resources

Unpack your Plant Kit

Items	When and how to use
1. 2 x A3 posters ○ From seed to harvest ○ The 4 Ds	<u>From seed to harvest:</u> • Display in the classroom from Module 2. • Use as a reference/reminder of what microgreens need to grow and what students should expect, and the actions they should take, at each stage of growth. <u>The 4 Ds:</u> • Display in the classroom from Module 3. • Use to prompt discussion on the 4 Ds of Design Thinking. Students should refer to the 4 Ds as they progress through the challenge.
2. 10 x Lab Books	Contains all 14 activities students will work through throughout the Challenge. Each rōpū (team) will share one book between them.
3. Sensor kit: ○ 4 x LED display modules ○ 4 x Battery holder ○ 4 x Main board ○ 1 x Humidity sensor ○ 1 x Light sensor ○ 1 x Conductivity sensor ○ 1 x Temperature sensor	Students will use the sensor kit in Module 1 to explore their environment; and from Module 2 to measure the conditions of their microgreen growing environment. Watch the 'How to use sensors' video for detailed instructions on how to set up and use each sensor. Refer to the ideal sensor readings chart on page 10 for an overview of the optimal readings at each stage of microgreen growth.
4. 12 x AAA batteries	These are required for the sensor kit.
5. 10 x Spray bottles	Used from Module 2 onwards for students to water their microgreens and to add nutrients in Module 4. Each rōpū will share one spray bottle between them.
6. 10 x Funnels	Used to add nutrient mix to the spray bottle in Module 4. Each rōpū will share one funnel between them.
7. Microgreen seeds: ○ 1 x Beetroot rainbow lights ○ 1 x Rocket ○ 1 x Mizuna ○ 1 x Basil Sweet Genovese ○ 1 x Radish Rambo	Five different microgreen seed varieties for students to grow, starting in Module 2. Please note each seed variety will grow at different speeds and react to growing conditions and methods differently. For a comprehensive guide on each seed to avoid disappointment, please refer to the 'Improving microgreen growth' table on page 14.
8. Hemp grow mat	The growing medium that students will plant their microgreens seeds on. It will be used once per microgreen trial in Modules 2 and 3.

Schools to supply

Module	Activity	Resources required
Module 1: Future farms	Ambassador career story	Technology to display a PowerPoint presentation.
	Lab 1.2 Sensor time trial	A device with a timer.
Module 2: Grow	Lab 2.1: Microgreen trial one	Container with lid (1 per rōpū of 4). Something to soak microgreen seeds in – we suggest large yoghurt pots, cups, bowls or anything you have on hand. Classroom resources including scissors and pens.
Module 3: Flourish	Lab 3.1: Build your grow house	Plastic container with lid (1 per rōpū of 4). Large clear plastic bags/sheets.
	Lab 3.2: Microgreen trial two	Container with lid (1 per rōpū of 4). Something to soak microgreen seeds in.
	Lab 3.3: Making nutrients	Ingredients to make compost tea. We suggest things like banana skins, used green tea bags, Epsom salts, or baking soda. Bowl, large bottle (eg milk bottle with the top cut off), or spare ice cream containers.
	General	Classroom resources including scissors, pens, hot glue gun.
Module 4: Analyse	Lab 4.2: Feeding nutrients	Something to strain nutrient solution – you could use a sieve or a muslin cloth.
	Lab 4.3: Grow house glow-up	Material for the structure. This could be cardboard, plastic, or wood. Large clear plastic bags/sheets.
	General	Classroom resources including scissors, pens, hot glue gun.
Module 5: Innovate	Lab 5.2: Develop your farm of the future	Recycled materials to create farm of the future model. This could include: ○ Cardboard ○ Kitchen rolls ○ Coloured paper ○ Pipe cleaners ○ Recyclable plastic Classroom resources including scissors, hot glue gun, tape, ruler, decorative pens.
Module 6: Celebrate	Shared kai	Students to bring a plate for shared kai. For theme examples and options, refer to page 26.

Module 1: Future farms

Explore the future of growing our kai using innovation and the power of STEM thinking. In this module your students will meet their ambassador, unpack their Plant Kit, and head outdoors to explore environmental conditions that affect plant growth.

Use these notes on each lab book activity as a reference as you go through Module 1 in the student Learning Hub with your class.

Lab 1.1: Carbon footprint champions

Purpose

Introduces students to the ways our everyday food choices contribute to climate change and challenges them to shrink their carbon footprints by making sustainable choices at lunch.

Resources

- Students' own lunch
- Pen and paper

Getting into a rōpū (team)

Start by getting students into a rōpū (team) of four. There should be around eight rōpū per class, and a maximum of ten. Keep in mind that the Plant Challenge is team-based learning and students will remain in the same rōpū for the rest of the Challenge. Distribute one lab book to each rōpū.

Overview

Students assess their lunches by completing the multi-choice carbon footprint champions quiz. They will be asked:

- What their lunch is made up of
- What their food is stored in
- Where their food came from, or where it was made
- How much waste their lunch generates

Each multi-choice answer is worth a different number of points, as follows:

- Score 1 point for every "A"
- Score 2 points for every "B"
- Score 3 points for every "C"

Students will share the quiz in their rōpū and record their individual scores on a separate piece of paper. After taking the quiz, students add together their scores to form their rōpū score, add together each rōpū score to form the overall class score and record these in their lab books.

Challenge students to beat their scores by bringing a carbon friendly lunch to the shared kai in Module 6. This will help them understand how their food choices and the components of their lunch contribute to their carbon footprint.

Lab alternatives

If some of your students haven't brought lunch, you can ask each rōpū to assess a 'display' lunch that you place in front of the classroom. This could be your own lunch, a drawing of a lunch, a list of lunch items or the lunch of one of your students. Please choose the option you feel is most appropriate for your class. Alternatively, you can ask each rōpū to choose one rōpū members' lunch to assess.

Interpreting results

The lower the score, the more carbon friendly the lunch.

- "A" answers = most carbon friendly
- "B" answers = somewhat carbon friendly
- "C" answers = least carbon friendly

Get students to compare their scores and their lunch choices to interpret their results. Ask them why they think their answers are worth more or less points.

Concepts

Meals that include animal protein typically have a higher carbon footprint than meals that do not. This is because:

- The food and water required to raise livestock takes a lot of energy to produce. More energy means more emissions.
- When land is used for grazing, it can degrade and be difficult to restore. Mass production of crops can also cause degradation of land.
- The methane produced by livestock, especially cows, pigs, and sheep, is over 20 times stronger than carbon dioxide in terms of its contributions to global warming.

Pre-packaged or individually wrapped items and leftover food contribute to waste.

- Foods that end up in landfills release greenhouse gases as they decompose.
- It's estimated that 30% of purchased food ends up as waste.
- Only a small percentage of plastics are recycled each year. Many plastic items are non-recyclable.
- Many items that can be recycled still end up in the landfill because they are contaminated by things such as food waste, glue from labels, etc.

Transportation accounts for about 10% of food's carbon footprint.

- A lot of the food we eat travels across the country, and even from overseas, to get to our plates.
- Most mass transportation of food relies on fossil fuels like gas and oil, which produce greenhouse gas emissions.

Support students to continue their learning at home by distributing the '**Carbon quiz reflection**' sheet you'll find in **Module 1 of the Teacher Hub**.

Lab 1.2: Sensor time trial

Purpose

A hands-on activity to get students familiar with the sensors, encourage them to start thinking about how different environmental conditions affect plant growth and get them moving outdoors.

Watch the 'How to use your sensors' video with your students to learn how to use each individual sensor. Use the instructions on page 7 as a reminder.

Resources

- Sensor kit
- 12 AAA batteries
- A device with a timer

Overview

With one minute on the clock, students will race outdoors to try and get a higher reading on their allocated sensor than their opponent rōpū by measuring different environmental conditions.

Note: Students given the conductivity sensor will race to find the highest **total number** of conductive objects.

1. Start by supporting rōpū discussions on the best places to find a high reading. Make sure you outline activity boundaries so students don't travel out of bounds! Suggested things look out for are as follows:

Temperature	• Plants that are facing the sun • Plants that aren't crowded by other plants • Dehydrated plants
Light	• Vibrant green leaves • Plants in exposed areas with little shade • Shriveled-up leaves
Humidity	• Plants in shaded areas • Plants close to the sprinklers • Plants with lower leaves that are yellow • Wilted leaves
Conductivity	• Freshly watered plants or moist soil • Anything metal • Most plants will be slightly conductive – this will come down to individual testing

2. Line each rōpū up outside and support them to time each rōpū member while they collect their readings and record in their lab books. Make sure each rōpū member has a turn collecting readings.

3. After the activity, lead a class discussion on the results and support your ambassador to write the results on the whiteboard.

Interpreting results

At this stage of the Challenge, it's not important to explain the science behind plant growth in depth. Instead, spark students' curiosity by asking the rōpū with the best readings to explain what they measured, and why.

How to put together your sensors

1. Start by putting three triple A batteries into the pink battery pack.
2. Then, plug the battery pack into the pink connector hub.
3. Using the white cables, plug the green LED screen and the blue sensor into the connector hub.
4. Flick the switch on the pink connector hub and the LED screen should turn on!
5. Press the button on the LED screen so the code on the top left matches the code on the front of the blue sensor.

Using your light and humidity sensors

To use your light and humidity sensors, simply put the blue sensor into the environment you'd like to measure, wait a few seconds until the reading is steady and then record your results in your lab books.

Using your temperature sensor

To use your temperature sensor, attach the silver and black probe to the blue sensor. Place the silver probe into your growing environment, wait for the number to steady, and then record your data.

Using your conductivity sensor

Clip two alligator clips onto the blue sensor. Then, place the other end of each alligator clip into your growing environment. Make sure you don't touch the two alligator clip heads together as this is not safe.

If a lightning bolt pops up, this means your growing environment is conductive – record a 'yes' or 'no' in your lab book alongside a description of the growing environment.

You only need to get your sensors set up once – then they're ready to use throughout the Challenge.

Module 1 key vocabulary

STEM	Science, Technology, Engineering and Maths.
Sustainability	The ability of individuals, groups, and communities to meet their needs without compromising the ability of future generations to meet theirs. It's important to understand that our present actions will impact the welfare of the environment and future generations.
Climate change	Long term changes in average climate conditions and weather patterns, such as temperature, rainfall or wind.
Carbon footprint	The total amount of harmful greenhouse gases created and released by the products we use and the actions we take.
Greenhouse gas	Harmful gases such as **carbon dioxide** or **methane** that trap heat in the atmosphere and warm the planet, contributing to climate change.
Emission	The production and release of something, including gas.
Food production lifecycle	The process of growing, raising, making, moving, eating, storing and wasting our food. Greenhouse gases (like carbon dioxide) are released into the atmosphere at many points during food's journey from farm to table.
Sensors	Temperature: measure of hotness or coldness. Light: measure of the amount of light energy, usually generated by the sun, electronic devices or fire. Humidity: measure of the amount of water vapour in the air. Conductivity: measure of the ability to pass an electrical current. Dissolved salts and other nutrients conduct electrical currents so conductivity increases when nutrients are added.

Module 2: Grow

Dig deeper into the science behind plant growth, hydroponics, and the environmental conditions that plants need to thrive. Then, students will harness their new plant knowledge by sowing the seeds of their first microgreens trial and starting to collect daily data.

Use these notes on each lab book activity as a reference as you go through Module 2 in the student Learning Hub with your class.

Lab 2.1: Microgreen trial one

Purpose

In their rōpū, students plant their first microgreen trial to put their new plant science knowledge into practice.

Resources

- 5 x seed packets (1–2 teaspoons of seeds per rōpū of 4)
- Hemp grow mat (1 per rōpū of 4)
- Spray bottle (1 per rōpū of 4)
- Plastic container with lid (1 per rōpū of 4)
- Classroom resources including scissors and pens

Overview

Watch the 'Microgreen lowdown' video with your students to learn how to plant trial one successfully. Use the instructions in Lab 2.1 as a reminder.

- Advise students that each seed will grow differently so they shouldn't compare their microgreens' progress to other rōpū. For example, basil takes a long time to sprout properly but will be just as successful as other varieties with time.
- Refer to the 'From seed to harvest' poster for the estimated time each seed needs to germinate.

Growing tips

- Ensure students remove the container lid once the seeds germinate to expose the microgreens to light.
- It is very important that the grow mat remains damp. The spray bottles do not release a lot of water with one spritz so encourage students to spray the seeds a few times each day, and always last thing on a Friday to protect microgreens over the weekend. They can also test the moisture levels with their humidity sensor.
- Try to mist the grow mat as opposed to the top of the microgreens to keep it moist. If the grow mat looks or feels dry, try adding water directly to the mat to moisten again.
- As they grow, some microgreens will develop white fuzz on their roots. This is normal. If you are unsure whether it is mould or root fuzz, spritz some water on the fuzz. If it starts to disappear, it's root fuzz.

- **If it's meant to be a sunny weekend, leaving your microgreens by the window can dry them out which will lead to disappointment. Ask students to move them to a more protected location before they leave on a Friday.**

Lab 2.2: Daily data

Purpose

Get students into the habit of measuring and monitoring their microgreen growing conditions daily with their sensors, and five senses.

Resources

- Sensor kit

Overview

Students will use each sensor in their sensor kit, and their 5 senses, to gather qualitative and quantitative data on their microgreens and their growing conditions, and record the data in Lab 2.2.

Students should try and measure their microgreens once every school day. It is helpful if they try to collect their data at the same time each day as this will reduce the variability in their data sets.

Why is it important to collect data?

It is important to monitor and measure the growing conditions of the microgreens as the results will provide insights as to what is going well, and what could be improved.

Ideal sensor readings

Refer to the following table for an overview of the ideal sensor readings at the two main phases of microgreen growth.

Phase	Temperature	Humidity	Light	Conductivity
Germination	18 – 22°C	50-80%	0–100	Not conductive
Growth	21 – 24°C	40-60%	700+	Conductive

Module 2 key vocabulary

Photosynthesis	A process used by plants to convert light, carbon dioxide and water into a special sugar (glucose) and oxygen that helps them grow.
Hydroponics	A method of growing plants without soil that uses just light, air and water to provide everything that a plant needs to thrive.
Germinate	The stage where a seed begins to sprout, grow and develop.
Mucilaginous	Having a viscous or jelly-like consistency. Basil seeds are mucilaginous.
Microgreens	The early shoots of vegetable and herb plants.
Qualitative data	Information you observe by using your five senses.
Quantitative data	Information in the form of numbers, or quantities.

Module 3: Flourish

It's time to think like an engineer to make those microgreens flourish. Students will use the '4 Ds' of Design Thinking – **Discover, Design, Develop and Deliver** to create and maintain the optimum growing environment. They'll also plant their second trial.

Use these notes on each lab book activity as a reference as you go through Module 3 in the student Learning Hub with your class.

Lab 3.1: Build your grow house

Purpose

Students learn about the importance of growing microgreens in an environment where the light, humidity, and temperature levels are controlled. Then, using STEM smarts, they'll build a basic grow house to create a controlled growing environment for trial one.

Watch the 'Discover' video with your students to discover some real-world examples of controlled growing environments. Then, students will use the instructions in Lab 3.1 to create their own.

Resources

- Plastic container with lid (1 per rōpū of 4)
- Large clear plastic bags/sheets
- Classroom resources including scissors, pens, hot glue gun

Overview

Material

Students are encouraged to think about the best material to use for their grow house walls and why. We suggest using recycled plastic as it is an accessible material that is efficient in trapping heat. To draw out student learning, here is an explanation on how grow houses work:

Large scale grow houses are made out of glass or plastic which is how they stay warm. This is because solar radiation (sunlight) can easily pass through glass/plastic, which heats the plants inside. But thermal radiation (the heat) cannot easily pass through glass/plastic which means it gets trapped in the grow house. Therefore, grow houses essentially harvest the sun rays and convert them into trapped heat.

Transferring microgreens

Students should be able to easily lift their grow mat and transfer into the base of their grow house. If the mat is dry and stuck to the bottom of the container, students should dampen the mat with water. Once sufficiently damp, the mat should easily lift out of the container, and into the grow house.

Be careful of roots! Some microgreens may have roots that have grown through the grow mat. Students should remove the mats carefully to avoid root damage.

Location

Your microgreens will grow best in a sunny spot. Try and put all of the grow houses by a window and ask students to rotate them every couple of days to maximise sun exposure.

Example

Lab 3.2: Microgreen trial two

Purpose

Students plant another microgreen trial to try and enhance and improve growing methods using STEM smarts and the insights from their data in Lab 2.2.

Resources

- 5 x seed packets (1–2 teaspoons of seeds per rōpū of 4)
- Hemp grow mat (1 per rōpū of 4)
- Spray bottle (1 per rōpū of 4)
- Funnel (1 per rōpū of 4)
- Plastic container with lid (1 per rōpū of 4)
- Classroom resources including scissors and pens

Overview

Start by encouraging students to brainstorm ways to improve microgreen trial two. They should think about what they've learnt so far about plant growth and use their data to find insights on what could be improved.

Improving microgreen growth

Each seed grows slightly differently and prefers slightly different growing methods. Here's a summary on each seed to support your students to improve their microgreen growth for trial two:

Seed type	Days to germinate	Soak	Harvest	Cover	Tips/notes
Beetroot	3–5 days	Soak for 8–10 hours for best results.	Ready to harvest in 10–20 days.	Requires complete darkness to germinate.	Beetroot has white fuzz in early stages of growth.
Rocket	3–4 days	Soak for a few hours for best results.	Ready to harvest in 5–14 days.	Requires darkness to germinate.	Do not sow rocket seeds too densely or add too much water or you will get mould.
Mizuna	2–3 days	Soak for a few hours for best results.	Ready to harvest in 7–14 days.	Requires darkness to germinate.	Mizuna has white fuzz in early stages of growth.
Basil	3–5 days	Soaking is not necessary. Students can soak for 5 minutes to see the seeds come to life.	Ready to harvest in 14–20 days.	Not necessary to cover.	It takes a long time for basil to make progress. Students may not get proper leaves for 5–7 days. Ensure they stick with it and don't compare their results with other rōpū in early stages.
Radish	2–3 days	Soak for 8 hours for best results.	Ready to harvest in 6–14 days.	Needs complete darkness to germinate.	After planting, try not to lift the lid until 3 days have passed.

Watering

Try to mist the grow mat as opposed to the top of the microgreens to keep it moist. Ensure that it is damp at all times, but not saturated, as this may kill the microgreens or attract mould.

To protect microgreens over the weekend, make sure they are watered well on a Friday.

Location

It does not matter where the microgreens are placed while they are germinating. When your plants have begun to sprout their first leaves, remove the cover and ensure they're in a well-lit location. **You may want to add your microgreens to a grow house earlier to maximise their light exposure.** Students will be able to observe the shoots changing colour once exposed to light.

A reminder that if it's meant to be a sunny weekend, leaving your microgreens by the window can dry them out which will lead to disappointment. Ask students to move them to a more protected location before they leave on a Friday.

Lab 3.3: Making nutrients

Purpose

All plants need a balance of minerals for their overall health and strength. Plants usually get these minerals from the nutrients that naturally occur in soil. So, when you grow plants hydroponically, you need to add nutrients yourself.

Students will create a nutrient solution that will be added to trial two to improve microgreen growth, using the instructions in Lab 3.3.

Resources

- Ingredients to make compost tea – we suggest things like banana skins, green tea, Epsom salt, or baking soda
- Bowl, large bottle (eg milk bottle with the top cut off), spare ice cream containers

Overview

Support students as they decide on ingredients to make compost tea.

Ingredients

Students can bring in whatever ingredients they would like to make compost tea. Make sure they tap into their science smarts to choose ingredients that won't harm their microgreens. We have provided some suggestions in the lab book and have included some additional options in the following table:

Ingredient	Benefits
Banana skins	Bananas are rich in plant-friendly nutrients including potassium, phosphorus, and calcium. Plants use potassium at every stage of growth. It helps them use the sugars they absorb, and aids in building up energy reserves which supports their development.

Used green tea bags	Green tea contains tannic acid and other nutrients which are natural fertilisers. It also improves oxygenation which helps roots thrive.
Epsom salts	Epsom salts are made up of magnesium and sulphur which allows plants to better absorb valuable nutrients like nitrogen and phosphorus. It also helps in the creation of chlorophyll.
Baking soda	Baking soda can prevent mould from growing on plants.
Crushed eggshells	Eggshells contain high levels of calcium which helps plants develop a strong structure.
Coffee grounds	As coffee grounds are acidic, they develop acetic bacteria which contains 2% nitrogen and many more beneficial nutrients. When plants lack nitrogen, they cannot grow taller, or produce enough food which turns them yellow. Be careful though! Too much acid can kill plants.

Module 3 key vocabulary

4 Ds – Design Thinking	A process engineers use to solve problems in a creative way. Discover – I wonder what the problem is? Design – I wonder what the solution is? Deliver – I wonder how to bring the solution to life? Develop – I wonder how we can share our solution with others?
Grow house	A structure that creates a controlled growing environment for plants.
Nutrients	Something that provides the nourishment plants use to grow stronger and live longer.

Module 4: Analyse

The first batch of microgreens should have reached its full potential. Use the data students have collected to help them understand what worked well and what could be improved for trial two. Continuing the 4 Ds, students will then design their farm of the future.

Use these notes on each lab book activity as a reference as you go through Module 4 in the student Learning Hub with your class.

Lab 4.1: Data dig

Purpose

Students analyse the data they've collected to figure out what they did well in trial one, and whether they could improve anything for trial two.

Some of the parameters of a successful trial are:

- 3–7 cm in height
- Even growth pattern
- Microgreens sprout quickly – this should be within 3–5 days depending on the seed you choose
- Vibrant in colour
- Growing straight upwards and not falling over

Resources

- Calculator

Overview

Data dig one: Range

Students will calculate the range of their quantitative data sets. They can do this with their humidity, temperature, and light data.

The **range** is the difference between the lowest and highest values. You can find the range using the following equation. Students also have this equation in their lab books.

Highest reading – lowest reading = range

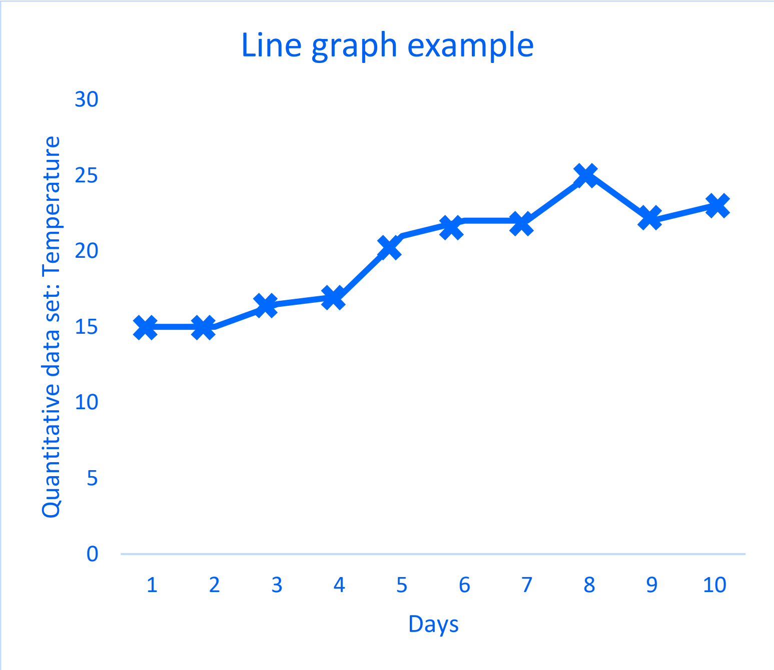
Interpreting results

The purpose of calculating range is to see whether students managed to maintain a controlled growing environment for their microgreens. In a controlled growing environment, you should expect little fluctuation in your data sets. Therefore, if the range is a **large** number, there was fluctuation in the data, and the environmental conditions were not controlled.

To find out whether the range result is a **large** number, each rōpū should compare their results with other rōpū. Facilitate a class discussion on what rōpū with **lower** range results than other rōpū did to control their growing conditions.

Data dig two: Plot a graph

1. Students will choose one of their quantitative data sets to plot on the line graph template supplied in their lab books. They can do this with their humidity, temperature, or light data.
2. Along the horizontal x axis, students should plot the days they collected data for. If you run these modules weekly, there should be 10 days' worth of data, starting at Module 2.
3. Along the vertical y axis, students should plot the numbers from one of their quantitative data sets.
4. They will then plot their results by marketing an **x** in the right place for each day, and drawing a line to connect each **x**.



Interpreting results

The purpose of plotting a line graph is to develop a visual representation of students' data sets, and again to see whether they managed to maintain a controlled growing environment. If their growing environment was controlled, the data should have minimal fluctuation, and the line should be relatively **flat**.

Data dig three: Correlation

Students will compare their quantitative and qualitative data sets to find **correlations** between the data, and note these down in their lab books.

Correlation means the relationship between two or more things.

For example, yellow leaves can be a sign of an unhappy plant. If there was a day that students saw their leaves turn yellow, they should look at what their quantitative data showed on that same day. If their light levels were low, the correlation would be:

When our light levels were low, our microgreens' leaves turned yellow.

Interpreting results

Students should use their correlations to inform improvements to their second trial. Using the example above, students might change the location of their microgreens to increase sun exposure.

Harvest trial one

Purpose

Celebrate the success of the first trial by harvesting and taste testing microgreen trial one.

Resources

- Scissors

Overview

Microgreens are typically harvested when they've sprouted their first **true leaves** or when they've reached 3–7cm in height.

True leaves are smaller versions of what the larger mature leaves would look like if you let the microgreen plant continue growing. Circled below are examples of true leaves. Not every first true leaf has frilly edges like the picture below, but all will look more like mature leaves.

The other leaves in the picture are called **cotyledons** which are the first leaves produced by plants.

To harvest, students should snip the microgreens 1cm from the grow mat and give them a good rinse before taste-testing.

Make sure each rōpū shares their microgreen variety with peers who chose to grow a different variety. Students should use their 'senses' when tasting the microgreens and record observations in their lab books to help determine which seeds to grow in the next trial.

Lab 4.2: Feeding nutrients

Purpose

Students add the compost tea they created in Module 3 to their second microgreen trial to understand how nutrients enhance plant growth.

Resources

- Something to strain the nutrient solution
- Spray bottle (1 per rōpū of 4)
- Funnel (1 per rōpū of 4)

Overview

Following the instructions in Lab 4.2, students will add the compost tea they made in Lab 3.3 to the microgreens.

Students should continue to mist their microgreens daily with this solution. If they notice negative changes, they should replace the compost tea with water, think about what may have caused the problem, and brew an improved compost tea.

Lab 4.3: Grow house glow-up

Purpose

Using the insights from their data, and what they've learned so far in the challenge, students will engineer a better grow house solution for their second trial.

They should consider how their grow house will create a controlled growing environment and help to maintain the optimum levels of temperature, light and humidity.

Resources

- Material for the structure – this could be cardboard, plastic, or wood
- Large clear plastic bags/sheets
- Classroom resources including scissors, pens, hot glue gun and calculators

Overview

Use the table in Lab 4.3 to brainstorm potential improvements to grow house number two. Then, follow the instructions to bring the glowed-up grow house to life.

Example

Suggested improvements

Growing condition	Improvement
Light Increase the amount of light plants receive	• Put the greens in a place that gets lots of sunshine for most of the day. • Change the material used for the walls. Make sure it's transparent! • Add a wall of tinfoil to the back of the grow house to reflect and intensify the sunshine. • Make an angled roof that catches the sunlight. • Put the greens under an artificial light source if required. • Add the microgreens to the grow house earlier.
Temperature	• Change the material used for your walls. Make sure it's transparent! • Put the greens in a warmer spot in the classroom.

Regulate temperature, insulate plants, and prevent heat loss	• Lift the grow house off the ground so there is air flow between the grow house and the surface it's on. • Place the grow house on pebbles or other materials that will absorb and hold the heat of the sun.
Humidity Regulate humidity levels	• Create a special roof or dome. • Make sure the grow house walls are stuck down properly so you're not losing too much condensation.
Air flow Increase air flow without compromising temperature	• Make a door to let the breeze in. • Adding more or less holes.

Lab 4.4: Design your farm of the future

Purpose

Using knowledge built throughout the challenge, students will imagine and design a farm of the future that solves the Challenge question:

'I wonder how to grow food sustainably?'

Encourage them to be as creative as they'd like and harness the STEM skills and examples they've learned throughout the Challenge.

Resources

- Classroom resources to help brainstorm concepts and ideas including paper, pencils, coloured pens, etc.

Overview

Before students begin their designs, facilitate a discussion on different ways their farms of the future can solve the Challenge question. Ask the following questions:

Where is your farm located?

Example answers: in the middle of the CBD, on a spaceship, in their favourite country, in a carpark, in an office building.

What is your farm growing?

Example answers: microgreens, different vegetables or fruits, the ingredients to their favourite salad.

What method are you using to grow your food?

Example answers: hydroponics, vertical farming, automated farming with robots, local farming.

Who will your farm of the future feed?

Example answers: their whānau, their classmates, people from lower socio-economic communities, the homeless population.

Module 4 key vocabulary

Range	The difference between the lowest and highest values of a data set.
Line graph	A type of chart that uses lines to connect individual data points. It is used to show information that changes over time.
Correlation	The relationship between two or more things.
True leaf	A small version of what the larger mature leaves of a plant look like.
Cotyledon	The first leaves produced by plants.

Module 5: Innovate

The second microgreen trial should be almost all grown up. Use data to investigate which microgreen trial worked better, and how the growing conditions affected this result. Students will also bring their farm of the future design to life by continuing with the 4 D design process and creating a model.

Use these notes on each lab book activity as a reference as you go through Module 5 in the student Learning Hub with your class.

Lab 5.1: Data dig 2.0

Purpose

Students analyse their trial two data and compare it to their trial one data to form a conclusion on which trial was more successful.

Again, they should refer to the following parameters of success:

- 3–7 cm in height
- Even growth pattern
- Sprout quickly – this should be within 3–5 days depending on the seed you choose
- Vibrant in colour
- Growing straight upwards and not falling over

Refer to the teacher support notes under Lab 4.1 for a refresher on each 'data dig' and how to interpret the results.

Resources

- Calculator

Overview

Students will compare the results of each 'data dig' to form their conclusions on which trial was more successful based on the above parameters of success. This information will be used to help them develop their farm of the future.

The conclusion should show the ideal temperature, light and humidity levels, and whether microgreens prefer a conductive or nonconductive growing environment.

Students should also be able to form links between the actions they took in each trial (eg adding nutrients, evolving the grow house, soaking the seeds longer, etc) and the success of their microgreens.

Farm of the future

The conclusion should also give students ideas for their farm of the future – the possibilities are endless:

- If they found a humid environment worked best for their microgreens, they might like to include an 'auto spray' device to ensure their greens are constantly being misted with water
- If they found their microgreens liked a high level of air flow, they might like to add a high-powered fan

Lab 5.2: Develop your farm of the future

Purpose

Using the knowledge they've built from the Plant Challenge so far, and their design in Lab 4.4, students will make a farm of the future model to help them explain their STEM solutions to the challenge question.

Resources

- Recycled materials to create farm of the future model. This could include:
    - Cardboard
    - Kitchen rolls
    - Coloured paper
    - Pipe cleaners
    - Recyclable plastic
- Classroom resources including scissors, hot glue gun, tape, ruler, decorative pens
- Technology if students are making a digital model

Overview

It is up to you what type of model your students create, based on the resources you have available in the classroom. You may ask them to create a physical model using recycled materials, or a digital model using computers.

If your students choose to create a digital model, you can set your class up with the following free online kid-friendly 3D modelling programme:

https://www.tinkercad.com/

Trial trivia

Purpose

Test students' understanding of key Plant Challenge concepts using a quickfire quiz.

Resources

- Trial trivia quiz sheet – you will find this in **Module 5 of the Teacher Hub**
- Something to record rōpū scores

Overview

- Get students into their rōpū and ask them to choose a noise that represents their team.
- If you have an ambassador, they should be the quiz master. They should ask the questions supplied in Module 5 of the Teacher Hub. If students know the answer, they need to make their rōpū noise to buzz in.
- Keep a tally of rōpū scores on the whiteboard or a piece of paper.

Module 6: Celebrate

Ka rawe! It's time for students to reap the rewards of their hard work. They've grown and harvested microgreens, created their own grow houses and designed and developed their farm of the future. Now let's reflect on the journey, share successes by delivering a presentation, and enjoy a shared lunch.

Use these notes on each lab book activity as a reference as you go through Module 6 in the student Learning Hub with your class.

Lab 6.1: Deliver

Purpose

Reflect on learning to date in a 5-minute class presentation.

Resources

- Rōpū farm of the future models
- Any technology students may require for their presentation
- Plant Challenge certificates – you can find these in **Module 6 of the Teacher Hub**

Overview

Support students to structure their presentation in their lab books and encourage each rōpū member to have a turn speaking.

After each presentation, hand out student participation certificates – you can find these in the Plant Challenge Teaching Hub.

Kai time

Students can now tuck into shared kai to celebrate the completion of the Plant Challenge. You can choose any theme for the shared lunch but some options include:

- Carbon friendly kai
- Family recipes
- Local or seasonal kai
- Plant-based kai
- Kai using microgreens
- Kai that represents students' culture

Spring fever

Purpose

Optional take home activity for students to continue Plant Challenge learning over the summer holidays.

- Distribute activity sheets supplied in **Module 6 of the Teacher Hub** by printing/emailing to students or parents.
- Students will choose one activity to complete over the holidays, following the instructions provided.
- Share plant knowledge and Spring Fever progress with friends and whānau over the holidays.