“Hukanui Enviroschool”

Each of the five articles in *Connected* 2 2010: *Working with Nature* relates to specific science, technology, and mathematics curriculum strands. These are outlined in the table below, along with links to detailed notes for each individual text. The notes include the key ideas of the text, suggested learning goals, and achievement objectives in each curriculum area, learning activities, and useful resources. There are many links between the texts that can be explored and developed, and these are at times indicated within the notes.

Science in “Hukanui Enviroschool”

Possible achievement objectives

Nature of Science

Understanding about science (US)

L1 and 2: Appreciate that scientists ask questions about our world that lead to investigations and that open-mindedness is important because there may be more than one explanation.

Investigating in science (IiS)

L1 and 2: Extend their experiences and personal explanations of the natural world through exploration, play, asking questions, and discussing simple models.

Participating and contributing (P&C)

L1 and 2: Explore and act on issues and questions that link their science learning to their daily living.

L3: Use their growing science knowledge when considering issues of concern to them.

L3: Explore various aspects of an issue and make decisions about possible actions.

Living World

Life processes (LP)

L1 and 2: Recognise that all living things have certain requirements so they can stay alive.

Ecology (Ec)

L1 and 2: Recognise that living things are suited to their particular habitat.

Material World

Chemistry and society (C&S)

L1 and 2: Find out about the uses of common materials and relate these to their observed properties.

L3: Relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes.

Physical World

Physical inquiry and physics concepts (PI&PC)

L1/2: Seek and describe simple patterns in physical phenomena.

Planet Earth and Beyond

Earth systems (ES)

L1 and 2: Explore and describe natural features and resources.

Interacting systems (IS)

L 1/2: Describe how natural features are changed and resources affected by natural events and human actions.

Key ideas

Nature of Science

- Scientists observe and try to describe the world around them. (US)
- Scientists ask questions when they see patterns and anomalies in natural phenomena. (US)
- Scientists look for answers to their questions by designing investigations that gather evidence. (IiS)
- Scientists find ways to apply their ideas to real-life situations. (P&C)

Living World

- Living things need resources to grow, energy to live, and shelter to protect them from heat or cold, wind, dehydration, and predators. They need to get all this from their environment. (LP)
- Plants and animals are adapted to the environment they live in. Their bodies and behaviours have developed to fit the conditions they live in. (Ec)

Planet Earth and Beyond

- Natural features (physical environment) around the school, such as soils, shelter, shade, and moisture can explored and the findings recorded. (ES)
- Many natural features act as habitats for plants and animals. (ES, IS)
- People’s activities can affect natural features and resources that are used by other organisms in our biological community. (IS)

Physical World

- Energy comes in many forms, one of which is electrical energy. (PC)
- Electrical energy can be converted into other useful forms of energy such as light energy and heat energy. (PI)
- If electrical appliances are turned off or unplugged from the energy source, they do not use electrical energy. (PI)

Material World

- We use a range of different materials (chemicals) in our everyday lives because they have properties we find useful, for example, steel is strong and able to be shaped. (CS)

Developing the ideas

Learning goals (to be shared with your students).

In this activity we are:

- learning to view our school as a living environment. (LP, Ec, IS)
- learning how the different plants and animals in our school interact with each other and with the physical environment. (LP, Ec, IS)
- learning about what a sustainable environment can look like, feel like and sound like. (PaC)
- learning how we can influence the school environment, so that it is healthy and sustainable. (LP, Ec, IS, IiS, PaC)
- investigating ways in which our buildings can be more environmentally friendly. (IS, IiS, PaC)
- investigating ways in which the amount of waste water we use can be reduced. (IS, IiS, PaC)
- investigating how we can make our school more energy efficient. (IS, IiS, PaC)
- investigating how to reduce the amount of waste in our school (IS, IiS, P&C).

In all these different ways, we are using our research and what we find out as the basis for ACTION. (P&C)

The following activities and suggestions are designed as a guide to support students to develop scientific explanations of the phenomena observed and processes involved in sustainable ecological systems. There are three stages to this interactive approach.

Stage one: The focusing phase

The main purpose of this focusing phase is to arouse students' interest and support the students to develop questions about their school environment, its biological community, and wider issues of sustainability.

Begin by reading the article with the class. Highlight aspects that relate to your own school and draw comparisons. Then show the students an uncommon plant or animal seen in your school grounds. Perhaps tell a story of what the area was like in the past. You could invite a local historian or a kaumātua to describe what the school area was like years ago. Ask the students to think about what other plants or animals they have noticed: *How did they get here? Why do they stay? Are our school grounds alone providing enough to keep them alive?* Suggest to the students that the school is part of an even bigger environment and ask them in groups to discuss how "eco-friendly" they think their school is and whether the school community uses the environment in a sustainable way. Encourage them to think of questions they could investigate. These questions might include:

- How could we describe the different parts of the environment around our school (physical environment)?
- What is living around our school, apart from people (biological community)?
- What do the different plants and animals need from, and contribute to, our school's environment?
- Why can these animals live in our school grounds but so many others cannot live here (adaptation)?
- What comes into our school from outside the grounds? (Water, electricity, lunches, paper, food wrapping)
- What do we do with all this energy and resources?

Stage two: The exploratory phase

During the exploratory phase, the students actively participate in a number of hands-on activities that allow them to explore the phenomena and clarify their existing thinking. Encourage the students to identify any trends and patterns they notice as they undertake the different activities. Share scientists' explanations in answer to spontaneous questions from students. At this stage, encourage them to generate and record tentative new or modified explanations for the phenomena. Support them to use scientific terms and vocabulary when communicating their thinking about the phenomena involved.

During this stage, the students plan and carry out a scientific inquiry that will allow them to gather the evidence they need to inform their explanations. At levels 1 and 2, these inquiries can be carried out as whole-class activities. It is important that the processes they use and their thinking about their findings are communicated and evaluated by other "scientists" within the class and school community. This can be done in the "Talking about results" and "Probing students' thinking" sections.

Exploratory activities for investigating and clarifying students' thinking about biological communities and the environment

Activity 1: ***What's it like out there?***

Set a scenario that the students are landscape designers or plant ecologists and have to write labels to show the conditions that different plants need to grow well. Group the students and take them on a walking tour of the school grounds with a map. Help them to identify and record different aspects of the physical environment, such as soil condition, shelter from wind, sun or shade, and moisture and drainage. Get each group of students to choose one common plant and allow them 5–10 minutes to find and describe where it is found in the school grounds (using their maps and cameras). The group can then work out what physical environment these locations have in common and describe it. Students could repeat the activity looking for the habitats of common animals in the school ground. These animals are likely to be various birds and invertebrates.

Talking about their findings

The students can report back to the class using charts or slide shows. "My plant (or animal) likes …" (Introduce the term "adapted" if appropriate.)

Probing students' thinking

Facilitate a class discussion on how different plants (or animals) are better suited to different conditions. Ask questions that focus the students' thinking on adaptation to the environment. Questions could include:

- Why do some plants grow better in open areas and some in the shade, some in damp boggy ground and some in dry soil?
- What kinds of plants did the Hukanui students plant around their school?
- Why do you think they may have chosen those particular plants?

Introduce the terms "introduced" or "exotic" and "native" or "indigenous" if appropriate.

Activity 2: ***Exploring micro-environments: Compost and wormeries***

The students could learn about the biology of earthworms and their needs by designing living environments for them. They could work through the activity sequence on pages 100–106 of the Ministry of Education's *Making Better Sense of the Living World* (Learning Media, 2001). They could also carry out the investigation into worms' environmental preferences on page 55 of *Making Better Sense of Planet Earth and Beyond* (Learning Media, 1999).

One recycling environment that the Hukanui kids developed was a composting system. Your students could set up both compost bins and wormeries and relate their different features and internal environments to the life forms they can sustain. The students could compare how the by-products, worms and compost, work to enrich soils and explore the changes to the materials that are added to a compost bin or wormery. Compost bins are constructed so that, as the materials break down, they generate heat that destroys weed seeds, whereas in a wormery, the worms eat the bacteria that grows on decomposing organic matter and less heat is generated in the process. Some Building Science Concepts books explore these processes in depth. Refer to Books 23: *Fresh Food,* 24: *Preserving Food*, 53: *Mould are Fungi,* 60: *Rubbish* and 61: *Recycling*.

Talking about their findings

Give the students opportunities to report back to the class about what they discovered. Remind them that it is an important part of their work in science to communicate the methods they planned and used and their thinking about their findings to the other young scientists within the class. Professional scientists evaluate the work of their colleagues.

Probing students' thinking

Facilitate a class discussion on the different conditions found in the two micro-environments (compost heaps and wormeries). *Are earthworms animals? What might the differences in the micro-environments mean for the animals that live in them?*

Activity 3: ***How does our school depend on the world outside our gates?***

Begin with a class brainstorm about everything that comes into the school each day. If needed, prompt the students about the "invisibles" – water, electricity, gas, light and heat from the sun, and air.

Group the students into teams to find out how much of specific resources or energy come into the school (you may need to give guidance about things that are difficult to measure. Each team will need support deciding how best to obtain the information. For example, they may use school records (for water, electricity, or paper), surveys (for lunches, bird migrations), or measurements (of rain, wind, sunlight, classroom lighting). The students can then plan their investigation, check their plan with the teacher, and gather and record the information.

Talking about their findings

Teams can present their findings to the class through posters or slide presentations that explain the data that they have collected about their resource or energy. Use opportunities available at this stage to discuss and evaluate the methods and collected data of each of the teams.

Probing students' thinking

Facilitate a class discussion on what *open* and *closed* systems might mean. Compare the human with the *natural* communities around the school. What resources, energy, and living things might enter natural communities?

Activity 4: ***What happens to all the stuff that comes into the school?***

Again, begin with a class brainstorm about what happens to the things that comes into the school each day. The scope could be limited to the materials studied in the previous activity. Raise the question of waste and how to conserve each resource or energy.

In the same teams, the students can find out how much of a specific resource or energy might get wasted in the school. The teams may need help to decide how best to obtain this additional data. Set an additional task of deciding how to limit waste and increase recycling of resources.

Talking about their findings

The teams can present their findings, telling the class what they discovered about usage and wastage of their resource or energy within the school. They could also share their ideas about ways of conserving or recycling the resource.

Probing students' thinking

Facilitate a class discussion about what sustainability might mean. The students may also undertake some research through books or the Internet to find out about the raw materials that make up everyday materials, such as steel, plastics, paper, or concrete. The class could visit a wind farm, a hydro-electric scheme, or an aluminium smelter.

Stage Three: Reflecting on evidence-based science learning

The aim of this phase is to consolidate the learning that has been achieved in each strand of the curriculum.

Towards the end of the unit, draw the class together and have the students help you write a summary of all the things they have learned. This may reveal learning gaps, particularly in the Nature of Science strand. This step gives you and your students the opportunity to reflect on the scientific processes they have used. For example, you can review the initial questions that they generated, the methods they used to obtain the evidence, how they recorded data or observations, how they shared and evaluated their evidence, and how they used it to develop solutions to identified issues. It is critical that students contribute most of this information with guidance from you when required.

Ministry of Education resources

Alchin, Rupert (2002). "Hukanui Enviroschool" in *Connected* 3 2002.

Making Better Sense of the Living World (2001), pages 17–21 provides useful notes on key ideas appropriate to levels 1 to 4; and pages 43–49 provides notes and suggestions for a focus on the adaptations of common organisms (for example, birds) to their environment.

Making Better Sense of Planet Earth and Beyond (1999).

These Building Science Concepts books explore micro-environments:

Book 23, *Fresh Food,* item number 12640

Book 24, *Preserving Food,* item number 12641

Book 53, *Mould are Fungi,* item number 12670

Book 60, *Rubbish,* item number 12677

Book 61, *Recycling,* item number 12678

These Building Science Concepts books explore how animals and plants have adapted to their environments:

Book 6, *Soil Animals,* item number 126243

Book 7, *The Bush,* item number 126244

Book 60, *Rubbish,* item number 12677

Book 61, *Recycling,* item number 12678

Technology in “Hukanui Enviroschool: Ten Years On”

Possible achievement objectives

Nature of Technology

Characteristics of Technology (CoT)

L2: Understand that technology both reflects and changes society and the environment and increases people’s capability.

L3: Understand how society and environments impact on and are influenced by technology in historical and contemporary contexts and that technological knowledge is validated by successful function.

Technological Practice

Brief Development (BD)

L2: Explain the outcome they are developing and describe the attributes it should have, taking account of the need or opportunity and the resources available.

L3: Describe the nature of an intended outcome, explaining how it addresses the need or opportunity. Describe the key attributes that enable development and evaluation of an outcome.

Planning for Practice (PfP)

L2: Develop a plan that identifies the key stages and the resources required to complete an outcome.

L3: Undertake planning to identify the key stages and resources required to develop an outcome. Revisit planning to include reviews of progress and identify implications for subsequent decision making.

Outcome Development and Evaluation (ODE)

L2: Investigate a context to develop ideas for potential outcomes. Evaluate these against the identified attributes; select and develop an outcome. Evaluate the outcome in terms of the need or opportunity.

L3: Investigate a context to develop ideas for potential outcomes. Trial and evaluate these against key attributes to select and develop an outcome to address the need or opportunity. Evaluate this outcome against the key attributes and how it addresses the need or opportunity.

Key ideas

- Technological outcomes influence society and the natural world.
- Societal and environmental issues influence what people decide to make, how they undertake planning, their selection of resources, and how they make and test outcomes.

- A brief describes the physical and functional attributes of a technological outcome that allow it to address a particular need or opportunity.
- Planning for technological practice involves identifying and recording the key stages and resources required to produce an outcome. Often plans need to be reviewed to take account of current progress and changes that are needed.
- Materials are selected based on their performance properties and their suitability for use in the production of the outcome.
- The final outcome is evaluated against the key attributes it should have to determine how well it meets the need or opportunity.

Developing the ideas

Learning goals (to be shared with your students)

We are learning to:

- identify and describe how societal and environmental issues have influenced what technological outcomes people make and how they make them (CoT)
- describe how technology has impacted on the social and natural worlds over time (CoT)
- recognise that a brief contains a description of the physical and functional attributes of the outcome being produced (BD)
- identify the key stages in technological practice and to review our plan if it needs to be changed (PfP)
- evaluate the suitability of the materials used in our outcome (ODE)
- evaluate the final outcome against the key attributes in the brief (ODE).

Characteristics of technology

This section relates to the following learning goals. We are learning to:

- identify and describe how societal and environmental issues have influenced what technological outcomes people make and how they make them (CoT)
- describe how technology has impacted on the social and natural worlds over time (CoT).

"Hukanui Enviroschool: Ten Years On" focuses on the relationships between technology, the natural world, and the local community. The details about the ongoing development of the environment around this school provide opportunities for students to identify and describe the influences that society (the pupils, teachers, parents, and community) has on the technological practices undertaken to develop these outcomes. The article also illustrates the influences that the technological practice and resulting outcomes have had on the people involved in the project over the last ten years.

After a shared reading of this article, students can be prompted to identify how social and environmental issues have influenced the school's decision making about:

- how the planning would be done and what resources would be used
- what should be made and why
- how the outcomes could be constructed or assembled and tested and how they should be evaluated.

(For further support with these concepts, see http://www.techlink.org.nz/curriculum-support/indicators/nature/level3.htm).

The class could co-construct a graphic organiser similar to that below to help students identify and record details that show examples of influences on the outcomes discussed in the article.

The influences on the technological outcomes chosen by by Hukanui School

What should be made?	Why these things should be made?	How was the planning undertaken?	What materials were chosen?	How were materials assembled and tested?	How were outcomes evaluated?
Seats in the cultural garden	Old seats rotten	Working group	Treated wood from sustainable forest		
Boardwalk	Poor access to wetland			Built by the students with expert help	

This is a challenging activity, and students will need to make inferences and to summarise from the text in order to complete this task.

To consolidate the idea that society and the environment influence the choice of technological outcomes and how they are made, students could study other relevant *Connected* articles. "Sniff, Swing, Swipe" in *Connected* 2 2006 and "Room 5's Amazing Meeting Seating" in *Connected* 2 2005 are complimentary articles that provide opportunities for students to practise these analytical skills. Both articles describe environmental factors that influenced what and how outcomes were developed. "Room 5's Amazing Meeting Seating" also describes social issues that influenced the materials used in the seating and their design and placement.

The article "Gardens with Edge" in this issue of *Connected* can also be read to explore ideas about characteristics of technological outcomes.

It is important that students also recognise that technology impacts on society and the environment. Technological outcomes can change how people do things and influence what they choose to do. In this article, the creation of different physical environments provided places for students to meet and play. How the Hukanui students use these places will be influenced by the design and purpose of the outcomes developed. Students could reread the article with a buddy to find references to these relationships in the article (examples include the building of huts in the accessible bush area and the creation of places for students to hang out).

Students can go on to discuss how the development of technological outcomes influences how people think about things. For example, the establishment of the wormery may affect students' attitudes to disposing of waste products. Debating the use of treated timber allows students to explore balancing impacts on the environment with the costs, maintenance, and future replacement requirements of particular products.

Undertaking technological practice

This section relates to the following learning goals. We are learning to:

- recognise that a brief contains a description of the physical and functional attributes of the outcome being produced (BD)
- identify the key stages in technology practice, and to review our plan if required (PfP)
- evaluate the suitability of the materials used in our outcome (ODE)
- evaluate the final outcome against the key attributes described in the brief (ODE).

To undertake the learning opportunities outlined in this section, students need to be involved in a project that includes the development and production of a technological outcome.

The section titled The Living Room on pages 6–9 provides comprehensive details that the students can use as examples of the practices outlined above. As a class or in groups, they can discuss these details. This discussion should allow them to clarify what a brief is and to make suggestions about what the brief for The Living Room might have looked like. Debating which attributes are key will help them clarify which attributes might be important for the outcomes they are working on themselves. They can use some of the ideas in this section to inform their own practice when presented with an opportunity to make changes in their class or school environment or to create a different type of product.

Their discussion should range over questions such as:

- What sorts of things do the Hukanui students have in their plan?
- What is a progress review?
- Why is reviewing progress important?
- Why is it especially important in terms of both the planning for the completion of The Living Room and the school environment plan?

Working out answers to these questions will provide the students with a useful starting point for their own initial planning, help them to understand why identifying key stages and resources is important to success and encourage them to include progress review points into their own plans.

As the students continue in their development work they could return to The Living Room section for help to determine the factors that are important when selecting and evaluating their materials.

The wish list the Hukanui students compiled when they were planning The Living Room provided an ongoing record against which progress could be evaluated. This is a model that prompts students to recognise the importance of evaluating against their brief as they work on their outcome as well as when it is completed. When students practise ongoing evaluation and reflection, it becomes easier for them to determine which of the initial attributes they chose for their outcome are key to its success.

Further activities

Students need many experiences to embed the principles of technological practice into their own work. Provide a range of contexts that give them opportunities to explore and consolidate the ideas discussed in "Hukanui Enviroschool: Ten Years On". There are many possible outcomes that students can work on within the classroom. They could be asked to design and develop products such as:

- a toy for a local pre-school
- a card for a particular occasion
- a biscuit for particular age group or symbolic of a certain country.

Ministry of Education resources

For further support there are Explanatory Papers for characteristics of technology, brief development, planning for practice, and outcome development and evaluation under Curriculum at http://www.techlink.org.nz.

For an example of a technological practice unit that requires students to consider social issues when they develop their outcomes, go to http://www.techlink.org.nz/Case-studies/Classroom-practice/Materials/BP637-market-day/index.htm

Mathematics in "Hukanui Enviroschool: Ten Years On"

Possible achievement objectives

Geometry and Measurement

In a range of meaningful contexts, students will be engaged in thinking mathematically and statistically. They will solve problems and model situations that require them to:

Position and orientation

L1: Give and follow instructions for movement that involve distances, directions, and half or quarter turns.

L1: Describe their position relative to a person or object.

L2: Create and use simple maps to show position and direction.

L2: Describe different views and pathways from locations on a map.

L3: Use a co-ordinate system or the language of direction and distance to specify locations and describe paths.

Possible links to the mathematics standards

Geometry and Measurement

After 3 years at school:

In contexts that require them to solve problems or model situations, students will be able to:

- describe personal locations and give directions, using whole-number measures and half- or quarter-turns.

By the end of year 4:

In contexts that require them to solve problems or model situations, students will be able to:

- describe personal locations and give directions, using simple maps.

By the end of year 5:

In contexts that require them to solve problems or model situations, students will be able to:

- describe locations and give directions, using grid references, turns, and points of the compass.

Key ideas

- Objects have positions in space relative to each other. These positions can be described using mathematical language.
- Maps, plans, and co-ordinates represent the relative position of objects.

Developing the ideas

This article revisits Hukanui School ten years after students began projects to make their school sustainable. The article describes projects that the students have designed and carried out and discusses the ways in which these projects have improved the environment.

The article focuses on the design and construction of several school structures, including The Living Room, a classroom where students can do their environmental projects. Six locations at Hukanui School are described (the gully, the cultural gardens, the wormery, the Circle of Friends, the deck, and The Living Room). Use this context to explore the mathematics of position and direction with students by selecting from the following activities:

Introducing position and direction

Learning goals (to be shared with your students)

We are learning about:

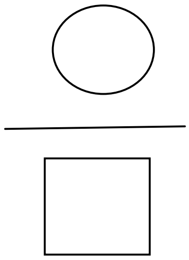
- position and direction
- a bird's-eye view.

In order to work with maps and locations, students studying at level 1 of the curriculum need opportunities to use position and direction vocabulary, such as "forward", "backward", "closer", "in front of", "behind", "quarter-turn", or "diagonally". They will find it easier to understand vocabulary that relates to themselves or to words that they already know:

Brainstorm with the class for words the students know that describe the position or orientation of an object. Record these words on the board. Ask the students to group the words that they feel describe similar things, for example, "behind" and "in the back of".

Use physical models. Introduce new vocabulary by positioning students appropriately, for example, place Jess "in front of" Mia. Place students in a line and ask them to describe where they are relative to the others in the line. Ask questions, such as: *Who is behind Tara?* or *Who is furthest from Jarrod?* Demonstrate vocabulary by giving simple directions, and encourage the students to take turns giving directions as well. Use examples such as: *Stand next to Tara*, or *Put the book in front of Josef*. Extend this work to include direction and paths by asking the students to follow a series of directions, for example: *Take two steps to your right, do a half-turn, take three steps forward, then take two steps to your left and do another half-turn.* Ask the students to work in groups taking turns giving and following a series of up to four directions.

Use collections of cardboard shape templates to describe position. The students can position the shapes according to directions they are given by a buddy. Students can then design their own patterns with the shape templates and describe them to their group. Group members could match patterns by following a student's directions without looking at the pattern that is being described to them. For example: *Put the* *circle above the square and put the triangle beside the square. Put another circle below the square and put a rectangle to the left of it.*



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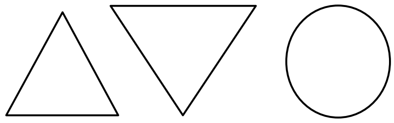


As their skills develop, the students can move from working with concrete materials to more abstract models. Ask them to imagine that they are a bird flying overhead. How can they show their positions and orientation on a piece of paper? (It is likely that they will draw students or write their names in their relative positions.) Discuss the ways they have done this and which ways are easier to understand than others.

Locating places on a map

Learning goals (to be shared with your students)

We are learning to:

- locate places on a map
- describe paths.

Using a map of Hukanui School or a similar map of your school, ask the students to work in groups to locate specific places on the map. (A map of Hukanui School can be found at http://www.hukanui.school.nz/uploads/71548/files/School_Map_2010_T_2.pdfNote that the front of the school is on Pickering Crescent while The Living Room is situated at the back. Also, not all the areas listed in the article are shown on this map.)

Focus your students' searches by asking questions such as:

- What is directly in front of The Living Room?
- What room is behind room 17?
- Describe something that is in the middle of the grounds.
- Where is the position of the school hall?

Download and take copies of a map of the school and the streets surrounding it. Using felt pens and OHP sheets placed over the maps, the students can draw and erase a variety of paths described by the directions you give them.

Introduce compass directions to extend the ways the students map paths. You could start by showing them the position of north and then asking them to turn to the directions south, east, and west. Emphasise the idea that north is a fixed position in relation to Earth and does not change, while left and right are relative and change according to the position of the person using the term. Broaden their vocabulary of orientation words by using other ways to describe orientation such as "quarter-turn" and "anticlockwise".

Students could complete this study by drawing a map of their school and illustrating or marking key places such as Room 8, the principal's office, the caretaker's storeroom, the adventure playground, and the toilets, in their relative positions on it.

Defining grid positions or co-ordinates and using them to describe points on a map.

Learning goals (to be shared with your students)

We are learning to:

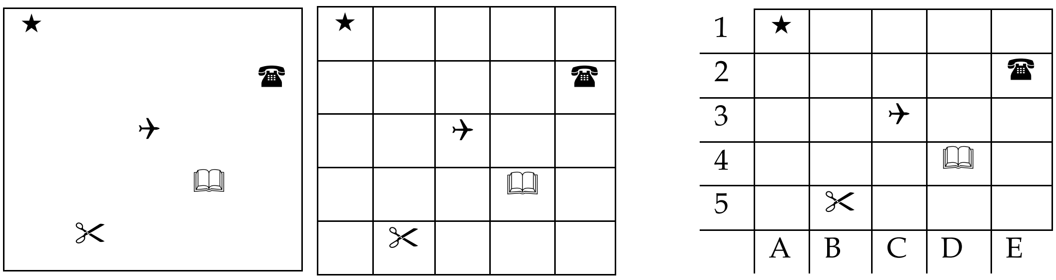
- define grid positions or co-ordinates
- use grid positions or co-ordinates to describe points on a map.

For students working at level 3 of the curriculum, introduce the idea of grid references and co-ordinates as a means to more accurately locate and describe places and objects on maps.

One way to do this is to give your students a sheet of paper with images of five different objects located at different points. Ask them to describe the positions of the different objects and then discuss how they described where each of the objects were.

Introduce the idea of adding a grid to make describing the location of the objects easier. Give them some tracing paper marked with a grid that they can superimpose over their data. Again ask them to describe the positions of the objects. Don't number the grid at this stage as some students may devise a system for themselves.

After discussion, introduce the concept of numbering and discuss the type of numbering or lettering that may be helpful to add to the grid. At this level, using a combination of letters and numbers may be easier for the students than using numbers both horizontally and vertically.



Encourage the students to draw their own grids to describe the positions of objects or provide a variety of maps with grids that they can practise reading. A quiz similar to that described in the "Further activities" could be included.

Further activities

A large range of maps and activities are available online. At these levels, learning should focus on position more than on scale or distance.

Students could be placed into teams or groups and challenged to locate specific places on different types of maps. Include maps of:

- your classroom
- your school and surroundings
- your nearest town or city
- New Zealand
- the solar system
- floor plans of a house
- fictional places (these are often published in children's novels).

It's helpful to display the maps for the class as you work through the answers so that the students can follow the locations as they're being described.

Ministry of Education resources

A wide variety of classroom activities and digital learning objects that support the learning of position and orientation can be found on the NZMaths website at

http://www.nzmaths.co.nz/position-and-orientation-units-work

These include:

- Directing Me where students can participate in a variety of activities aimed at describing position and orientation
  http://www.nzmaths.co.nz/resource/directing-me
- Amazing Mazes
  http://www.nzmaths.co.nz/resource/amazing-mazes
- Location Location
  http://www.nzmaths.co.nz/resource/location-location
- Photo Hunt (aimed at students working at level 3 of the curriculum)

  http://www.tki.org.nz/r/maths/curriculum/figure/index_e.php

References to appropriate Figure It Out activities can be found on the TKI website:

http://www.tki.org.nz/r/maths/curriculum/figure/index_e.php

The themed Figure It Out level 3 book, *At Camp*, includes a number of activities relating to direction.

“The Man in the Outside Office” and “Moturoa Students: They Grow and Share the Very Rare”

Each of the five articles in *Connected* 2 2010: *Working with Nature* relates to specific science, technology, and mathematics curriculum strands. These are outlined in the table below, along with links to detailed notes for each individual text. The notes include the key ideas of the text, suggested learning goals, and achievement objectives in each curriculum area, learning activities, and useful resources. There are many links between the texts that can be explored and developed, and these are at times indicated within the notes.

Science in “The Man in the Outside Office” and “Moturoa Students: They Grow and Share the Very Rare”

Possible achievement objectives

Nature of Science

Understanding about science (US)

L1 and 2: Appreciate that scientists ask questions about our world that lead to investigations and that open-mindedness is important because there may be more than one explanation.

L3 and 4: Appreciate that science is a way of explaining the world and that science knowledge changes over time.

L3 and 4: Identify ways in which scientists work together and provide evidence to support their ideas.

Investigating in science (IiS)

L1 and 2: Extend their experiences and personal explanations of the natural world through exploration, play, asking questions, and discussing simple models.

Participating and contributing (P&C)

L1 and 2: Explore and act on issues and questions that link their science learning to their daily living.

L3: Use their growing science knowledge when considering issues of concern to them.

L3: Explore various aspects of an issue and make decisions about possible actions.

Living world

Ecology (Ec)

L1 and 2: Recognise that living things are suited to their particular habitat.

L3: Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.

Evolution (Ev)

L1 and 2: Recognise that there are lots of different living things in the world and that they can be grouped in different ways.

L3: Begin to group plants, animals, and other living things into science-based classifications.

Key ideas

Nature of Science

- Scientists are observant and notice small details.
- Scientists ask questions when they see patterns and anomalies in natural phenomena.
- Scientists look for answers to their questions by designing investigations that gather evidence.
- Scientists find ways to apply their ideas to help in real-life situations.

Living World

- Plants and animals are adapted to the environment they live in naturally. Their bodies and behaviours fit the conditions where they normally live.
- Many New Zealand plants and animals are adapted to living without mammalian predators and don't have the behaviours or bodies to cope with them.
- When possums, rats, and stoats were introduced to New Zealand, they posed a threat to many New Zealand native species. Over time some species were threatened and some became extinct.
- Threatened species can respond well (begin to breed, increase their numbers, and spread over larger areas of land) if people manage them or their environment scientifically.
- There are many types of animals in New Zealand and many different ways to group them, for example, predators and prey, herbivores and carnivores, plants and animals.
- Scientists often group similar animals and plants into families (which we think are related or have a shared whakapapa). This science is called taxonomy.
- Common animal groups are mammals, birds, reptiles, insects, spiders, and worms.
- Common plant groups are flowering plants (including many trees), cone-trees, ferns, and mosses.
- Scientists give each different kind of plant and animal its own scientific name, which has two parts, its genus and species (like a surname and given name).

Developing the ideas

Learning goals (to be shared with your students)

In this activity, we are learning to:

- recognise that some plants and animals were in New Zealand before people came here and others were brought here from other places
- investigate why some native plants and animals are becoming rare, and what can be done about it.
- understand how scientists (ecologists) make detailed observations, ask questions, suggest answers, and investigate them by looking for evidence.

The following activities and suggestions are designed as a guide for supporting students to develop scientific explanations of the phenomena observed and processes involved in sustainable ecological systems. There are three stages to this interactive approach.

Stage one: The focusing phase

The focusing phase is to arouse students' interest and to help them to develop questions about identifying and classifying native New Zealand plants and animals and finding out how endangered ones are managed in the wild.

Begin by reading "The Man in the Outside Office". Use a wall map to locate where the article is set and to highlight reserves, forest parks, or national parks in your area. Students should prepare questions to investigate further, such as:

- Are there any plants or animals in our area that are rare, endangered, or threatened? What are they?
- Why are these plants and animals under threat? What problems do they face?
- How did Jack (the ranger) use his science knowledge to find out what was damaging five-finger leaves?
- Are there any plants or animals from our area that have become extinct? (using the idea of *locally* extinct when an existing population disappears)
- How are these plants and animals monitored?
- Is there anything that we can do to help rangers?

Stage two: The exploratory phase

During the exploratory phase, the students actively participate in a number of hands-on activities that allow them to explore the phenomena and clarify their existing thinking. Share scientists' explanations in answer to spontaneous questions from the students. As they take part in the activities, encourage them to identify the stages in investigative science (observations, questioning, suggesting explanations, designing methods, gathering and recording data, analysing and discussing what the data means). At this stage, they should be encouraged to generate tentative new or modified explanations for the phenomena (for example, identifications or classification). Encourage the students to use scientific terms and vocabulary when communicating their thinking.

During this stage, the students plan and carry out a scientific inquiry that will allow them to gather the evidence they need to inform their explanations. At levels 1 and 2, these inquiries can be carried out as whole-class activities. It is important that the processes they use and their thinking about their findings are communicated and evaluated by other scientists within the class and school community. This can be done in the "Talking about results" and "Probing students' thinking" sections.

Exploratory activities for investigating and clarifying students' thinking about ecological systems and evolutionary relationships

Activity 1: *What's in our backyard?*

Suggest to the students that one of the first tasks of an ecologist is to get to know what plants live in the research area. Organise the students into small groups and give each group a plastic bag and some scissors or secateurs. Take them to a patch of bush close to the school grounds. Firstly, point out several different plants (trees, shrubs, herbs, ferns, mosses). At this stage you don't need to refer to the plants by their name or tell the students what plant types they belong to. Their task is to collect small samples of as many different plants as they can find. Show them how small a piece of plant material is sufficient and advise them about damaging plants by taking too much foliage.

After 30–50 minutes, return to the classroom and ask the groups to sort their leaves into families or sets that look similar and decide on a name for each family.

Talking about their findings

The groups can then share their families of plants with other groups, pointing out the features of the plants that they have taken account of in making their families. Introduce some scientific family names for plants, such as flowering plants, cone plants, ferns, and mosses. Have a range of reference books available (Andrew Crowe's series are excellent for students) and ask the students to try to identify their plants. The students can compare their groupings of plants with the groups identified by scientists. They can then attach their plants to sheets of paper or card and write their names beside them.

Probing students' thinking

Ask the students why they think their class groups made up differing families of plants. Ask: *What problems would arise if scientists used different names for the same plant? What are the problems of using common names for plants when there might be several common names for the same plant in different countries or even in the same country? How do you think the issue could be resolved so that we all use same system of plant identification?*

Explain that scientists use the International Code of Botanical Nomenclature for plant classification.
(http://www.bgbm.org/iapt/nomenclature/code/SaintLouis/0000St.Luistitle.htm).

Activity 2: ***What's in our backyard?***

Modify the above activity to search for birds or insects instead of plants. The method of "collecting" could include description or photography for birds. Use traps or collect forest litter, spread it out, and search in it for large insects.

Talking about their findings

Again discuss discrepancies in student classifications and identifications. What are the solutions?

Probing students' thinking

Ask questions similar to those suggested under activity 1. Explain that scientists use the International Commission on Zoological Nomenclature for animal classification (http://www.nhm.ac.uk/hosted-sites/iczn/code/index.jsp).

Activity 3: ***How can kids help rangers save threatened, or even common, native plants or animals?***

Read the article "Moturoa Students: They Grow and Share the Very Rare" with the class. Group the students and ask them to discuss what areas around the school might be suitable for planting with native plants. They could then list the steps they would need to follow to undertake such a project. The steps should include issues such as getting permission to use the land, choosing appropriate plants, sourcing them, funding their purchase, and planting and growing techniques. Many of the steps may need to include getting advice from experts. This could lead to a project similar to Moturoa's, although it may involve less critical plants.

Talking about their findings

Groups could report back and the class then decide on an action plan. Suggest that they include monitoring the plants in their plan. They could use photography, measure, or count tagged plants in their garden and observe and record birds, spiders, and insects that visit the plants.

Probing students' thinking

Ask: *How do plants reproduce in the wild? How are the seeds spread – by wind or birds or do they just drop? What kinds of birds spread seed best? Are there many of these birds around? How could scientists help?*

Stage three: Reflecting on evidence-based science learning

The aim of this phase is to consolidate the learning that has been achieved in each strand of the curriculum. Toward the end of the unit, draw the class together and, with the students, co-construct a summary of all the things they have learned. This may reveal gaps in their learning, especially in the nature of science area. This gives you the opportunity to encourage the students to reflect on the scientific process they used. They can consider the questions that sparked their inquiries, the methods they used to obtain evidence, how they recorded data or observations, how they shared their findings with their other class members, the feedback they received, and how they developed solutions to their problems. Encourage your students to actively contribute to this process so that they develop an understanding of the scientific process that they can bring to future projects.

Further activities

Carrying out ecological surveys

Students could carry out simple monitoring surveys of plant life in various parts of the school or in other local habitats that they wish to help protect or rejuvenate. In a school context, students might wish to carry out before and after surveys of plant (and possibly animal) life in areas of the grounds or other local habitats that they decide to care for over time, remembering that vegetation responds slowly to any managed changes.

The following activity notes are intended for guidance, use your professional judgement to modify according to your class.

Going bush

Locate an area of bush that includes a variety of plant types – from canopy trees down to smaller trees and shrubs in the understorey levels and to ground cover. Find a stretch of ground that appears to be representative of the bush. Ideally this would be chosen randomly. Lay out a 20–30 metre length of rope, knotted or marked at 1 metre intervals.

- This rope defines the sample. (A sample that is essentially points on a line is called a line-transect.)
- Divide your students into small groups, each of which will sample a quarter of the transect's length.
- The students should move slowly along their section of rope transect. As they pass each knot, they record the most significant plant within 50 centimetres of the knot. (They could record fern, tree, shrub, herb or collect a leaf sample, label it "knot 4", and put it in a plastic bag to identify later.)
- Have them use the list below as prompts to work out different plant's preferences. *What conditions characterise the environment around the sample?* Think about:
    - light levels
    - temperature
    - soil type: soft and friable, sandy, claylike, pebbly, and so on
    - moistness of soil
    - soil drainage
    - shelter from wind
    - proximity of still or running water
    - slope.
- Have them consider the following questions:
    - How have the ferns (for example) adapted to these environmental conditions?
    - How do the canopy trees change the environment for the understorey and ground-cover plants?

- How can we can we ask to see how "healthy" this bush is?

You could also carry out the same survey in another part of the bush that has different environmental conditions.

Ministry of Education resources

Making Better Sense of the Living World (2001). The unit titled Science Focus: Relationships among Living Organisms and Their Environment on pages 98–118 provides a range of exploratory, hands-on activities that are very suitable for supporting the ideas expressed in these *Connected* articles.

These Building Science Concepts books explore ways in which animals and plants have adapted to their environments:

Book 7, *The Bush*, item number 12624

Book 22, *Tidal Communities*, item number 12639

Book 35, *Is This a Plant?* item number 12652

Book 39, *Is This an Animal?* item number 12656

Further resources

Websites:

http://www.doc.govt.nz/

Andrew Crowe (1994). *Which Native Forest Plant?: A Simple Guide to the Identification of New Zealand Native Forest Shrubs, Climbers & Flowers*. Auckland: Viking

“Plants That Heal”

Each of the five articles in *Connected* 2 2010: *Working with Nature* relates to specific science, technology, and mathematics curriculum strands. These are outlined in the table below, along with links to detailed notes for each individual text. The notes include the key ideas of the text, suggested learning goals, and achievement objectives in each curriculum area, learning activities, and useful resources. There are many links between the texts that can be explored and developed, and these are at times indicated within the notes.

Science in “Plants That Heal”

Possible achievement objectives

Living World

Life processes (LP)

L3 and 4: Recognise that there are life processes common to all living things and that these occur in different ways.

Evolution (Ev)

L3 and 4: Begin to group plants, animals, and other living things into science-based classifications.

L3 and 4: Explore how the groups of living things we have in the world have changed over long periods of time and appreciate that some living things in New Zealand are quite different from living things in other areas of the world.

Material World

Properties and changes of matter (P&CoM)

L1 and 2: Observe, describe, and compare physical and chemical properties of common materials and changes that occur when materials are mixed, heated, or cooled.

Chemistry and society (C&S)

L1 and 2: Find out about the uses of common materials and relate these to their observed properties.

L3: Relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes.

Nature of Science

Understanding about science (US)

L1 and 2: Appreciate that scientists ask questions about our world that lead to investigations and that open-mindedness is important because there may be more than one explanation.

L3 and 4: Appreciate that science is a way of explaining the world and that science knowledge changes over time.

L3 and 4: Identify ways in which scientists work together and provide evidence to support their ideas.

Investigating in science (IiS)

L1 and 2: Extend their experiences and personal explanations of the natural world through exploration, play, asking questions, and discussing simple models.

Participating and contributing (PC)

L1 and 2: Explore and act on issues and questions that link their science learning to their daily living.

L3: Use their growing science knowledge when considering issues of concern to them.

Key ideas

Nature of Science

- Scientists observe and describe the world around them thoroughly.
- Scientists ask questions when they see patterns and anomalies in natural phenomena.
- Many indigenous cultures hold traditional knowledge that has been gained from centuries of investigation, trial, and error.
- Scientists look for answers to their questions by designing investigations that gather evidence.
- Scientists find ways to apply their ideas to help in real-life situations.

Living World

- Many native (indigenous) plants are only found in New Zealand and scientists call these endemic. Sometimes they have unique and useful chemicals in their leaves or bark.
- When people get sick, some of their life processes are disturbed. These can sometimes be helped by taking different medicines. Some medicinal chemicals are found in parts of our native plants.
- Scientists from pharmaceutical companies often obtain useful information about potentially helpful chemicals by studying medicinal plants traditionally used by indigenous people.

Material World

- Some plants contain substances that are beneficial to humans.

- The fact that plant chemicals are natural does not mean that they are safe. Many plants are toxic to humans, and so the extraction and application of plant extracts must be carried out only under expert guidance.

Developing the ideas

Learning goals (to be shared with your students)

In this activity, we are learning:

- to recognise many native plants as living treasures (taonga) because of their healing properties. (Ev, C&S)
- that different parts of some plants contain medicinal chemicals and how some of these chemicals can be extracted (Ev C&S)
- to value mātauranga Māori as knowledge about the natural world gained over centuries of observation and use
- how scientists might narrow their search for potentially medicinal chemicals by investigating the effectiveness of traditional medicines (rongoā)
- to identify plants that can be used for medicinal purposes (C&S, PC)
- about the chemical and physical changes that take place in plant substances when we prepare them as perfumes or ointments. (P&CoM, C&S)

The following activities and suggestions are designed as a guide for supporting students to develop scientific explanations of phenomena. There are three stages to this interactive approach.

Stage one: The focusing phase

The focusing phase is to arouse student interest and support the students to develop questions about native plants, the nature of medicines, and traditional Māori knowledge.

Begin by reading "Plants that Heal". Highlight aspects of the text that relate to your school situation to draw comparisons between the schools in the article and your school. Then show your students a medicinal plant that grows in or near your school grounds. Explain what medicines might have been like before over-the-counter pills were available. You could invite local kaumātua or kuia to talk to the students about how illness was treated in the past. Encourage the students to think of questions they could investigate:

- How many native plants have healing properties? How can we recognise them? Are there plants like these in other countries as well?

- What is a chemical or pharmaceutical? Why are these chemicals in plants? How can you get them out of plants?
- What are some disorders or sicknesses that can be treated using medicinal plants as well as pharmaceutical products?
- How do scientists make medicines? Where do they get their ideas?

Emphasise that parts of many plants are toxic to humans and other animals and they must be examined with care and are not to be tasted.

Stage two: The exploratory phase

During the exploratory phase, the students actively participate in a number of hands-on activities that allow them to explore phenomena and clarify their thinking. Share scientists' explanations with the students as they seek answers to any spontaneous questions that arise. Encourage them to identify trends and patterns that they notice as they take part in the activities. At this stage, they should be encouraged to generate and record tentative new or modified explanations for the phenomena. Encourage the students to use scientific terms and vocabulary when communicating their thinking.

During this stage, the students plan and carry out a scientific inquiry that will allow them to gather the evidence they need to inform their explanations. At levels 1 and 2, these inquiries can be carried out as whole-class activities. It is important that the processes they use and their thinking about their findings are communicated and evaluated by other "scientists" within the class and school community. This can be done in the "Talking about results" and "Probing students' thinking" sections.

Exploratory activities for investigating and clarifying students' thinking about medicinal plants and healing.

Activity 1: ***Where's the chemist (pharmacy)?***

Set a scenario that the students are deep in the bush on a three-day tramp and one of their mates gets a really bad toothache. What can they do to help the pain and soothe that tooth? One of the group is a Māori student who learned about a special plant that dulled the pain of tooth-ache from his tipuna. The students can work in teams to research what plant they would need to look for, what special care would be needed when gathering the useful part of the plant, how it would need to be prepared, and how much of it is needed. The groups could, with supervision, search for the plant in a local reserve or patch of bush. Check that the plant(s) being looked for grow in the area before sending the students on a wild-goose chase!

You could suggest that each group researches a different plant by asking the students to find helpful treatments for diarrhoea or burns.

Talking about their findings

The students can report back to the class with photographs, a slide show, or samples of the plants they have discovered.

Probing students' thinking

Facilitate a class discussion on how early Māori might have developed this knowledge when they had never seen many of these plants before they arrived in

New Zealand. *What do they think is special about this particular plant? Why does it help? What is in medicines and pharmaceutical tablets? Where might scientists get ideas about what medicinal chemicals to research?*

Activity 2: *Extraction techniques*

Some techniques for extracting chemicals from plants are outlined below. The students could read about the range of methods for extracting plant oils and perhaps trying some out. In each case, encourage the students to consider what is happening to the extracts in terms of the physical changes the chemicals undergo. A physical change does not alter the chemical in any way except its physical form: solid, liquid, (or forming a mixture such as a solution or suspension) or gas. Physical changes are reversible. A chemical change is very different because the oil or other chemical is permanently altered into a new substance.

Safety Warning
Essential oils are very potent, and health and safety issues must be taken into account if you use or experiment with them in schools. They should never be ingested. Some should not be applied in any way to babies or pregnant women. The plants and techniques outlined here are safe to use, and any active ingredients will be present in low concentrations.

Warm Oil Infusion

Finely chop the plant material and place it in a saucepan. Cover it with a light carrier oil. (Carrier oils are light and mild, with neither a strong smell nor chemical properties. They act as solvents. Convenient carrier oils for the classroom include grapeseed oil, light olive oil, almond oil, avocado oil, and apricot kernel oil.) Heat the mixture gently on a hotplate. Don't allow it to boil, as this may destroy the delicate essential oils. Note that if this does happen, you have an unwelcome example of a chemical change. Keep stirring for about 30 minutes or until you can smell the essential oils in the carrier oil. Remove the saucepan from the heat and allow everything to cool and steep (soak) for at least an hour. The end product is a neutral carrier oil infused with fragrant essential oils. This technique suits many leafy or floral materials, for example, rose, manuka, eucalyptus, lavender, rosemary, clove, chamomile, peppermint, citrus peel, ginger, geranium, and thyme.

Expression

Peel, scrape, or grate the very outer layer of a grapefruit, orange, or lemon skin. Squeeze out the oil and use a small, clean make-up sponge to soak it up. This very simple technique is similar to commercial cold pressing and suits all sorts of citrus peel.

Water Infusion

When you make a cup of tea, you are creating a water infusion. Finely chop the plant material and place in a heat-resistant container. Pour boiling water over it and allow it to steep overnight. Strain off the solid matter and gently heat the liquid so that the water evaporates away, leaving the oils behind. This technique suits soft plant materials, such as chamomile flowers.

Decoction

Chop the plant material and cover with cold water. Bring it to the boil and simmer for at least an hour. Allow it to cool and then strain off the solids. This technique suits bark, twigs, and dried berries from, for example, cloves or cinnamon.

Follow-up: Commercial Methods

Students can research the many extraction techniques.

Background information for teachers:
Some methods involve heating the plant matter. Extracts from flowers are used in many perfumes. They're often very delicate, and heat can destroy them. For this reason, the commercial extraction of flower oils involves using volatile solvents such as hexane. Even in cold conditions, the oils from the plant matter dissolve in the solvent and can be separated off as liquid. Because the solvent is volatile, it evaporates away, leaving the oils behind. Discuss this method with the class, and talk them through a simple analysis of the physical changes. The changes could be summarised in a simple flow diagram. (The plant oils don't change their physical state. At all times they are liquid. The solvent, however, does change its state, from liquid to gas. There are no chemical changes.) The liquid oils are in a mixture of plant juices and solids – the oils dissolve into a solvent (the non-oily juices and solids don't) – the solvent changes to a gas (evaporation), leaving the oils behind.

Talking about their findings

The students can give presentations to the rest of the class about the extraction method they used, any difficulties they faced, and how they dealt with the difficulties. How helpful was it having methods provided? What could you have done if there was no method provided? How much chemical did you extract from your plant material?

Probing students' thinking

Given the difficulty of getting large quantities of "active chemicals" from the plants many plant chemicals are now manufactured synthetically (using chemical reactions to produce the same chemical compound).

Activity 3: ***Our school garden***

The students could discuss the benefits and problems of setting up a small collection of medicinal plants in the school grounds. If they are enthusiastic, you could assist them to prepare a plot of ground (or planting pots), collect seed or seedlings, and plant them. Arrange a roster for students to water and weed their plants as they do at Hurupaki School.

Activity 4: ***What are the chemicals in these plants?***

The class can start by brainstorming about how they could find this information. Suggest that scientists often have to go to libraries or the Internet or contact experts to get specialised information. Organise students into specialist scientific teams with the task of finding out what chemicals are found in a range of native New Zealand medicinal plants. They could also research how pharmaceutical companies develop new medicines, how hard it is to trial them on humans or even animals, and how long it takes from discovery to production.

Talking about their findings

The teams can present their information to the class, explaining what they discovered about chemicals in plants.

Probing students' thinking

You could facilitate a class discussion on the ethics of testing medicinal remedies on animals.

Stage Three: Reflecting on evidence-based science learning

This phase consolidates the learning that has been achieved in each strand of the curriculum. Toward the end of the unit, draw the class together and co-construct, with the students, a summary of all the things they have learned. This may reveal gaps in their learning, especially in the nature of science area. This is an opportunity to encourage the students to reflect on the scientific process they used. They can consider the questions that sparked their inquiries, the methods they used to obtain evidence, how they recorded data or observations, how they shared their findings with other class members, the feedback they received, and how they developed solutions to their problems. The students can consider whether this is the only scientific inquiry method. Have other cultures made significant discoveries in different ways? Has western science always used this approach?

It is critical that students contribute most of this, with your guidance.

Ministry of Education resources

Piripi, Rāwiri (2002). "A Kawakawa Perfume Recipe" in *Connected* 3 2002.

Further resources

S.G. Brooker, R.C. Cambie, & R.C. Cooper (1987). *New Zealand Medicinal Plants* (3rd. edition). Wellington: Reed Books. [This reference book has adult level terminology, but the diagrams and information can be useful with teacher mediation.]

Mathematics in “Plants That Heal”

Possible achievement objectives

Number and Algebra

In a range of meaningful contexts, students will be engaged in thinking mathematically and statistically. They will solve problems and model situations that require them to:

Number Knowledge

L2: Know simple fractions in everyday use.

L3: Know basic multiplication and division facts.

L3: Know counting sequences for whole numbers.

Equations and expressions

L2: Communicate and interpret simple additive strategies, using words, diagrams (pictures), and symbols.

L3: Record and interpret additive and simple multiplicative strategies, using words, diagrams, and symbols, with an understanding of equality.

Geometry and Measurement

In a range of meaningful contexts, students will be engaged in thinking mathematically and statistically. They will solve problems and model situations that require them to:

Measurement

L2: Partition and/or combine like measures and communicate them, using numbers and units.

L3: Use linear scales and whole numbers of metric units for length, area, volume and capacity, weight (mass), angle, temperature, and time.

Possible links to mathematics standards

Number and Algebra

After 3 years at school

In contexts that require them to solve problems or model situations, students will be able to:

- apply basic addition facts and knowledge of place value and symmetry to:
    - combine or partition whole numbers
    - find fractions of sets, shapes, and quantities;
- create and continue sequential patterns with one or two variables by identifying the unit of repeat;

- continue spatial patterns and number patterns based on simple addition or subtraction.

Number and Algebra

By the end of year 4

In contexts that require them to solve problems or model situations, students will be able to:

- apply basic addition and subtraction facts, simple multiplication facts, and knowledge of place value and symmetry to:
    - combine or partition whole numbers
    - find fractions of sets, shapes, and quantities;
- create, continue, and give the rule for sequential patterns with two variables;
- create and continue spatial patterns and number patterns based on repeated addition or subtraction.

Number and Algebra

By the end of year 5

In contexts that require them to solve problems or model situations, students will be able to:

- create, continue, and predict further members of sequential patterns with two variables.

Key ideas

- Rates and proportions (the amount of one thing in relation to another) appear frequently in real contexts.
- Profit is income minus costs.
- The amount of ingredients required changes in proportion to the amount of product you want to make.
- Tables organise data and can help make calculations easier.

Developing the ideas

This article links a variety of different mathematical skills and concepts, including proportions and financial literacy, to the production of kawakawa ointment. After the students have read it they can discuss all the instances in it where mathematics has been used. Generate a list of these instances and use this as a starting point for further activities.

Using Proportion

Learning goals (to be shared with your students)
We are learning to: • use proportion to convert between kilos of olives and litres, millilitres, and cups of olive oil

Use the crop yield (litres per olive tree) to introduce and explore the ideas around proportion.

- Ask the class focus questions such as: *If seven kilograms of olives are needed to make one litre of olive oil, how many kilograms would be needed to make six litres?* If proportion is new to the students, keep the calculations at doubling or halving. Students working at more advanced levels in number strategy could be asked to determine what would be required to produce ten litres or asked to determine how much oil one kilogram of olives would make.
- Students could then make or complete a chart showing the various amounts, such as the one below.

Kilograms of olives	Litres of oil produced
7	1
14	2
21	3

- Link to other examples of rates in the text, for example, to the number of hectares of forest you can sponsor or the number of rat or stoat traps you can buy (page 25).

Adjusting the amounts of ingredients to produce different amounts of products

Learning goals (to be shared with your students)
We are learning to: • adjust the amounts of ingredients for different amounts of product.

Continue to explore proportion using the ingredients described in the kawakawa ointment recipe on page 23. Use measuring tools, such as kitchen measuring cups, to help students to visualise volume or tokens to represent quantities such as the number of kawakawa leaves.

Ask the students to look at particular measures and their relationships to each other. The article mentions that one cup is equal to 250 mLs. Ask: *How many cups will a litre hold?* Once they have determined that there are four cups per litre, they could add another column to their chart showing this information. To help students unfamiliar with the conversion between millilitres and litres, you could include a column that shows this:

Kilograms of olives	Litres of oil produced	Millilitres	Cups
7	1	1 000	4
14	2	2 000	8
21	3	3 000	12

To discourage the students from simply counting on to obtain these figures, extend the questions to specific values (divisible by 7), such as what the olive oil production would be for 700 kg, 1400 kg, 2100 kg, or 7000 kg.

Increase, by appropriate proportions, the ingredients described in the kawakawa ointment recipe. Again, encourage the class to show the original information in a table:

Ingredients	**Quantities**		
	½ cup **(125 mL)**	**1 cup** **(250 mL)**	**2 cups** **(500 mL**
Kawakawa leaves	6	12	24
Olive oil	½ cup	1 cup	2 cups
Beeswax	1/6 cup	1/3 cup	2/3 cup

Additional columns can be included that allow students to predict what the amounts will be for bigger quantities. The article also describes the volume of the individual jars as 50 mLs. Students could add this information, along with the amount of money made, to their table as shown.

Ingredients	**Quantities**		
	½ cup **(125 mL)**	**1 cup** **(250 mL)**	**2 cups** **(500 mL)**
Kawakawa leaves	6	12	24
Olive oil	½ cup	1 cup	2 cups
Beeswax	1/6 cup	1/3 cup	2/3 cup
Jars made	2*	5	10
Total money made	$10	$25	$50

- 2.5 but 2 full jars.

Calculating area

Learning goals (to be shared with your students)

We are learning to:

- find the area required to grow a 60 tree olive grove, given that each tree needs 6 square metres for good growth.

The article explains that Oturu School has 60 olive trees. Students can investigate the area required to grow the trees.

Ask students to calculate the area that would be needed if the trees were grown in lines of 6 by 10. Provide them with a 6 by 10 grid similar to that below to assist them in their calculations.

6						
6						
6						
6						
6						
6						
6						
6						
6						
6						
	6	6	6	6	6	6

Change the geometry to give the students more practice in this type of calculation. For example, ask students to find the length and width of an olive grove where 60 trees are planted in rows of 15.

Learning goals (to be shared with your students)

We are learning to:

- calculate the income, profit, and costs for products sold at different prices.

The students in Room 2 at Kaeo School have listed the costs for the ointment they made. Use the terms "income", "costs", and "profit" and the mathematical calculations introduced here for further activities associated with costing products.

Discuss the terms used in the article and relate them to mathematics. Focus questions could include:

- They sold the ointment for $500. Why do they say they got only $400 profit?
- If the students sold all the ointment for $50, how would they describe this result? (making a loss)
- If the cost of wax increased to $13, how much profit would they make?

- Is the proportion of profit they made by selling 100 jars the same as the proportion they would make by selling 200 jars? This question will not be suitable for students working at levels 1 and 2 of the curriculum, but it is a useful guided activity to conclude the discussion.

Further activities

Students could investigate recipes for other products, such as lemonade, that can be made from local ingredients. They could calculate the amount of each ingredient required to make a specific quantity of the product and calculate the total cost of making the product. A school gala or fund-raising event provides an authentic context for these activities. After working out their costs and setting a sale price, they can then calculate any profit they might make.

Ministry of Education resources

You can find references to related Figure It Out activities on the TKI website:

http://www.tki.org.nz/r/maths/curriculum/figure/index_e.php

The Figure It Out level 3 books *At Camp*, *Gala*, and *Number Sense and Algebraic Thinking: Book One* include activities relating to costing. The activities Counting the Costs from *Gala* and Cup Fever from *Number Sense and Algebraic Thinking: Book One* encourage students to investigate the relationship between profit and loss. They include problems where students can use more than one operation to find an answer. Links to these activities can be found on the NZ Maths site:
http://www.nzmaths.co.nz/resource/counting-costs
http://www.nzmaths.co.nz/resource/cup-fever

Further resources

Further activities and questions relating recipe ingredients to proportion can be found on the website
http://www.teachingideas.co.uk/maths/files/ratioproportionrecipes.pdf

“Gardens with Edge”

Each of the five articles in *Connected* 2 2010: *Working with Nature* relates to specific science, technology, and mathematics curriculum strands. These are outlined in the table below, along with links to detailed notes for each individual text. The notes include the key ideas of the text, suggested learning goals, and achievement objectives in each curriculum area, learning activities, and useful resources. There are many links between the texts that can be explored and developed, and these are at times indicated within the notes.

Technology in “Gardens with Edge”

Possible achievement objectives

Nature of Technology

Characteristics of Technology (CoT)

L2: Understand that technology both reflects and changes society and the environment and increases people’s capability.

L3: Understand how society and environments impact on and are influenced by technology in historical and contemporary contexts and that technological knowledge is validated by successful function.

Technological Knowledge

Technological Products (TP)

L2: Understand that there is a relationship between a material used and its performance properties in a technological product.

L3: Understand the relationship between the materials used and their performance properties in technological products.

Key ideas

- The materials used in technological products are selected because of their specific performance properties and how they can be manipulated (cut, shaped, and joined).
- Materials can be described by their performance properties. These properties can be measured subjectively and objectively.
- Properties that are subjectively measured are measured according to people’s perceptions of how they look, taste, feel, smell, or sound.
- Properties that can be measured against a standard or comparative scale are objectively measured. These are properties such as hardness, ultraviolet resistance, transparency, or colour.

- The properties of all the materials used in a product combine to make the product both technically feasible and socially acceptable.

Developing the ideas

Learning goals (to be shared with your students)

We are learning to:

- identify materials and describe how they can be manipulated (TP)
- describe materials using subjective and objective measurements of their performance properties (TP)
- recognise that the subjective and objective properties of all the materials used in a product combine to help the product work as it should and be acceptable to people (be "fit for purpose" (TP).

Understanding Common Materials

This section relates to the following learning goals. We are learning to:

- identify materials and describe how they can be manipulated (TP).

Students should be given opportunities to play with, research, and experiment with a range of common materials. Developing successful technological products relies on a good understanding of the materials they could be made from. The Explanatory Paper on http://www.techlink.org.nz/curriculum-support/papers/knowledge/tech-products/index.htm and the Indicators of Progression on (http://www.techlink.org.nz/curriculum-support/indicators/knowledge/index.htm) will support your knowledge and understanding of this aspect of the technology curriculum.

In "Gardens with Edge", many materials are mentioned (wood – treated and untreated, concrete, cement, aggregate, water, plaster, iron sulphate). It may seem obvious but it is important initially to establish that technological products are made from materials. Ask the students to identify things that are technological products in the classroom or throughout the school. (Clarification of what makes an object a technological product is available on http://www.techlink.org.nz/curriculum-support/indicators/nature/level2.htm . Ask the students: *What materials have this desk/wall/stapler been made from?* The students could list the materials used in making a building, a room, or a collection of objects.

After reading the article, ask the students to list all the materials mentioned in it. Ask: *What did the students in the article do to the materials to make the garden edges?*

Discuss as a class or in groups how the materials used to make a building or a room have been manipulated to make the products.

Use the mixing of water, aggregate, and cement in the article to make concrete as a focus for a discussion on the making or formulation of a material.

Describing common materials

This section relates to the following learning goals. We are learning to: • describe materials by their performance properties that are measured subjectively and objectively • recognise that properties of materials that are measured subjectively and objectively are combined in products to help them work as they should and be acceptable to people.

As a class, discuss what "describing a material" means. *What words could we use?* Choose two materials and describe them as a class. As the students suggest and agree on properties to ascribe to the materials, record them in a list on a whiteboard. Categorise each property according to whether it is objective or subjective.

Properties of Polar Fleece		**Properties of Copper Wire**	
Subjective	**Objective**	**Subjective**	**Objective**
warm-looking	blue	attractive colour	reddish-brown colour
cuddly	stretchy		bendy
good because it's made from recycled materials	slightly waterproof		2 mm in diameter
fashionable			conducts electricity and heat
			hard
			shiny

Provide the students with samples of a range of materials (paper, wood, bamboo, calico, polar fleece, nylon fabric, plastic, cardboard, foam rubber, wholemeal flour, rice, icing sugar) to investigate. After they have spent some time examining and manipulating these materials, ask them to list two or three properties of each of the materials. In groups, the students can then compare their lists and compile a group list for each material. In a second lesson, the students can again work in their groups to discuss and decide which of the properties they've ascribed to the materials are subjective and which are objective.

As a class, reread the article. Discuss the properties of the materials used making the garden edges. Ask the students to describe how the properties of these materials helped the garden edges to "work".

Establish why it is important to describe materials by using both their subjectively and objectively measured performance properties. This idea leads on to more complex ideas related to material evaluation at higher levels in the components of technological products, characteristics of technology and technological modelling. However, at level 3 of the curriculum students need only to begin to understand the difference between objective and subjective measurement and that the properties of all material used in a product combine to ensure the product is both technically feasible and socially acceptable. For example, a soft toy made from calico will work in a technical sense, but it will be more cuddly and warm, and therefore more acceptable, if made from polar fleece.

Further activities

Read "Room 8's Rice Craze" in *Connected* 2 2007. In this article, students explore rice and explain how they worked with it to make a number of different technological products. Your students could choose to experiment with some of their activities. Practical work with different materials gives students the experience to describe materials and how they can be manipulated to make different products. They might also enjoy experimenting with different types of flours.

Encourage students to explore and describe the performance properties of materials they use in the classroom. Allow them to manipulate products and find out what their properties allow them to do. Discuss whether there are other materials that have similar properties that could be used perform the same functions.

It is helpful to make links between technology and science when learning about the material world in science. In turn, exploring the science of materials will support the material understandings in the curriculum component, technological products.

Ministry of Education resources

You can find Explanatory Papers and Indicators of Progression for technological products under Curriculum at http://www.techlink.org.nz.

These Building Science Concepts books explore the properties of materials:

Book 16, *Sand, Salt, and Jelly Crystals,* item number 12633

Book 23, *Fresh Food,* item number 12640

Book 32, *Introducing Metals,* item number 12649

Book 46, *Keeping Warm,* item number 12663

Book 48, *Fabrics,* item number 12665

Mathematics in "Gardens with Edge"

Possible achievement objectives

Geometry and Measurement

In a range of meaningful contexts, students will be engaged in thinking mathematically and statistically. They will solve problems and model situations that require them to:

Measurement

L2: Create and use appropriate units and devices to measure length, area, volume and capacity, weight (mass), turn (angle), temperature, and time..

L2: Partition and/or combine like measures and communicate them, using numbers and units.

L3: Use linear scales and whole numbers of metric units for length, area, volume and capacity, weight (mass), angle, temperature, and time.

L3: Find areas of rectangles and volumes of cuboids by applying multiplication.

Shape

L2: Identify and describe the plane shapes found in objects.

L3: Classify plane shapes and prisms by their spatial features.

L3: Represent objects with drawings and models.

Number and Algebra

In a range of meaningful contexts, students will be engaged in thinking mathematically and statistically. They will solve problems and model situations that require them to:

Number Knowledge

L2: Know how many ones, tens, and hundreds are in whole numbers to at least 1000.

L2: Know simple fractions in everyday use.

Possible links to mathematics standards

Measurement

After 3 years at school

In contexts that require them to solve problems or model situations, students will be able to:

- measure the lengths, areas, volumes or capacities, and weights of objects and the duration of events, using linear whole-number scales and applying basic addition facts to standard units;

By the end of year 4

In contexts that require them to solve problems or model situations, students will be able to:

- measure the lengths, areas, volumes or capacities, weights, and temperatures of objects and the duration of events, reading scales to the nearest whole number and applying addition, subtraction, and simple multiplication to standard units.

Key ideas

- Objects can have many different shapes, perimeters, areas, and volumes.
- We can use standard or non-standard measuring devices and units to measure objects.
- The dimensions of objects play an important part in designing things such as gardens and buildings.

Developing the ideas

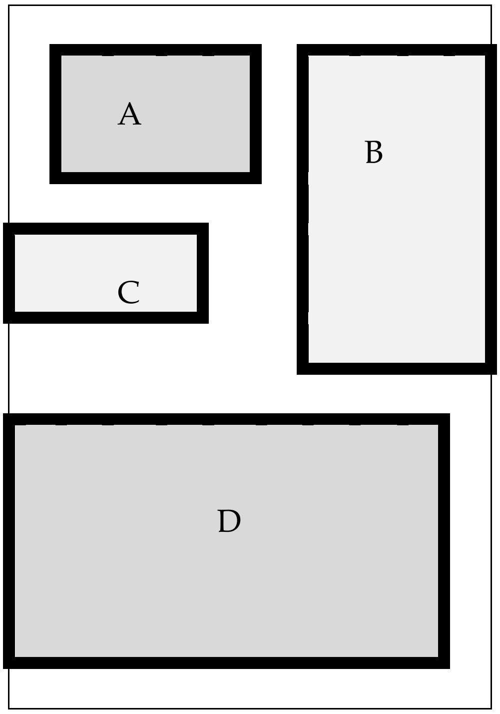
This article describes the building of raised beds for a vegetable garden at a school. It includes a calculation of the volume of the soil that will go into the finished beds. It also records the use of ratio in making the concrete for the edges of the beds. "Gardens with Edge" provides multiple entry points at level 2 of the curriculum, as well as rich opportunities for students to work at higher levels.

Learning goals (to be shared with your students)

We are learning to:

- describe objects by their dimensions.

Objects come in many sizes. How do we describe the differences? Introduce students studying at level 2 of the curriculum to perimeter, area, and volume measurement with a simple plan of shapes such as those shown below. These can be easily created on a computer, using the table function as the basis for the grid, which can then be hidden using the border functions.



Ask the students to measure each shape without using a ruler. (They might use pencil lengths, finger widths, or the number of times their eraser fits into the space.)

To demonstrate how the use of these units of measurement is not ideal, ask individual students to describe one of their shapes without letting the class know which shape they are describing. In many instances, the class will struggle to establish the correct one, particularly when describing shapes A and C which are similar in size.

Show the class three objects – a length of string, a piece of paper, and a cube. Ask the class which one of these they would choose to measure the length of the sides of the shapes. *Why would you choose the string rather than the piece of paper? Why not use the cube?* Explain that the unit used to measure length has to be linear too. Go on to ask the students which of the three things they would use for measuring area and volume. Each time, ask why they have picked the object they have. *Why would the length of string or the piece of paper not be suitable for measuring how much space is inside a cereal carton?* Ask the students if it is the same for area and volume. Generate working definitions for length, area, and volume.

Learning goals (to be shared with your students)

We are learning to:

- estimate and measure objects using non-standard units.

Set up some workstations with a variety of objects and different lengths of string and sizes of paper (label them A, B, C, and so on). The class can move among the stations estimating and measuring the dimensions of the objects set out at them. Ask individual students to choose which piece of paper or string would best describe the area of a specific object and which would best describe the length of a side of an object. Suggest that the students estimate the measurement before they measure each object. After measuring, they can compare the actual measurement with their estimate. Their individual estimates and checks could be recorded on a table like that below.

Object	Estimate		Actual		Was my estimate correct?
	Length	Area	Length	Area	
1	String B	Paper A	String B	Paper C	I got the length correct, but I thought the area was larger than it was.

You could extend this investigation to measuring volume using cubes or prisms. Measurements can be confirmed by dunking the object in a bucket of water and comparing the change in water level to the displacement caused by each cube.

If students are working at level one of the curriculum, you may wish to continue using non-standard measures. Students who are working at higher curriculum levels should use standardised units for describing measures.

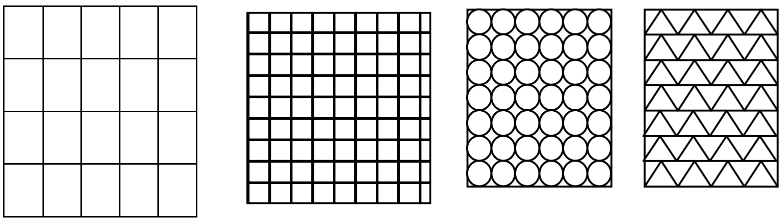
Learning goals (to be shared with your students)

We are learning to:

- compare and contrast non-standard and metric units.

Use focus questions to prompt the students to compare the variation in the sizes and lengths of the objects that they used to make their measurements, so that they realise the need for standard units of measure. *Which measurement is the best way to describe the object? What problems would arise if non-standard measures were used to describe things that a person could not see, for example, a block of land measured by the number of paces or strides? If everyone measured the same way, how would this be helpful?*

If possible, provide students with a variety of different-shaped grids photocopied onto sheets of paper. Examples are shown below.



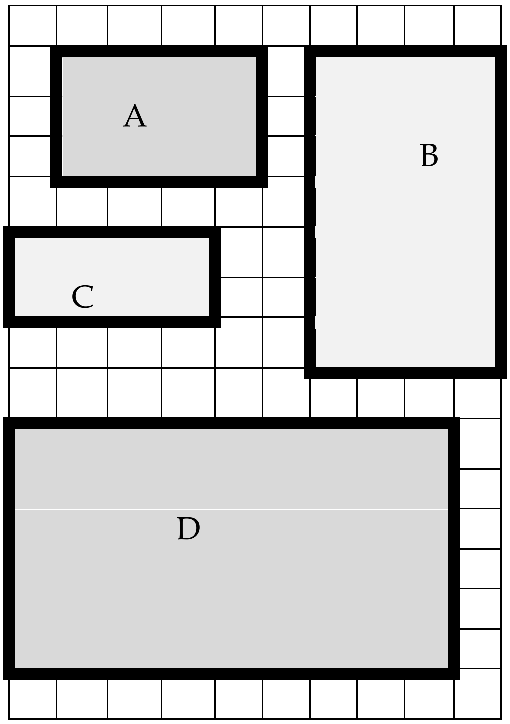
Rectangles Squares Circles Triangles

Using the rectangles from the previous activity or ones they have drawn themselves, get the students to measure and describe the area of one rectangle using the shapes on each of the sheets. Ask the students which shape they feel most accurately describes the area of the rectangle. Questions could include:

- What made the use of the circles difficult?
- Were there any other shapes that had the same problem?

- Which shapes would be better if they were partitioned to describe smaller units of area?
- Why have square units been chosen over the use of rectangles and triangles?

Provide the class with shapes placed on a square centimetre grid, as shown below. Get the students to describe the distance around the edge of each object and how much flat space it is taking up, using the squares as a guide. Ask individual students to describe their shape and get other class members to guess which shape they are referring to, using formal units. Compare the results using a centimetre grid with the results using non-standard measures.



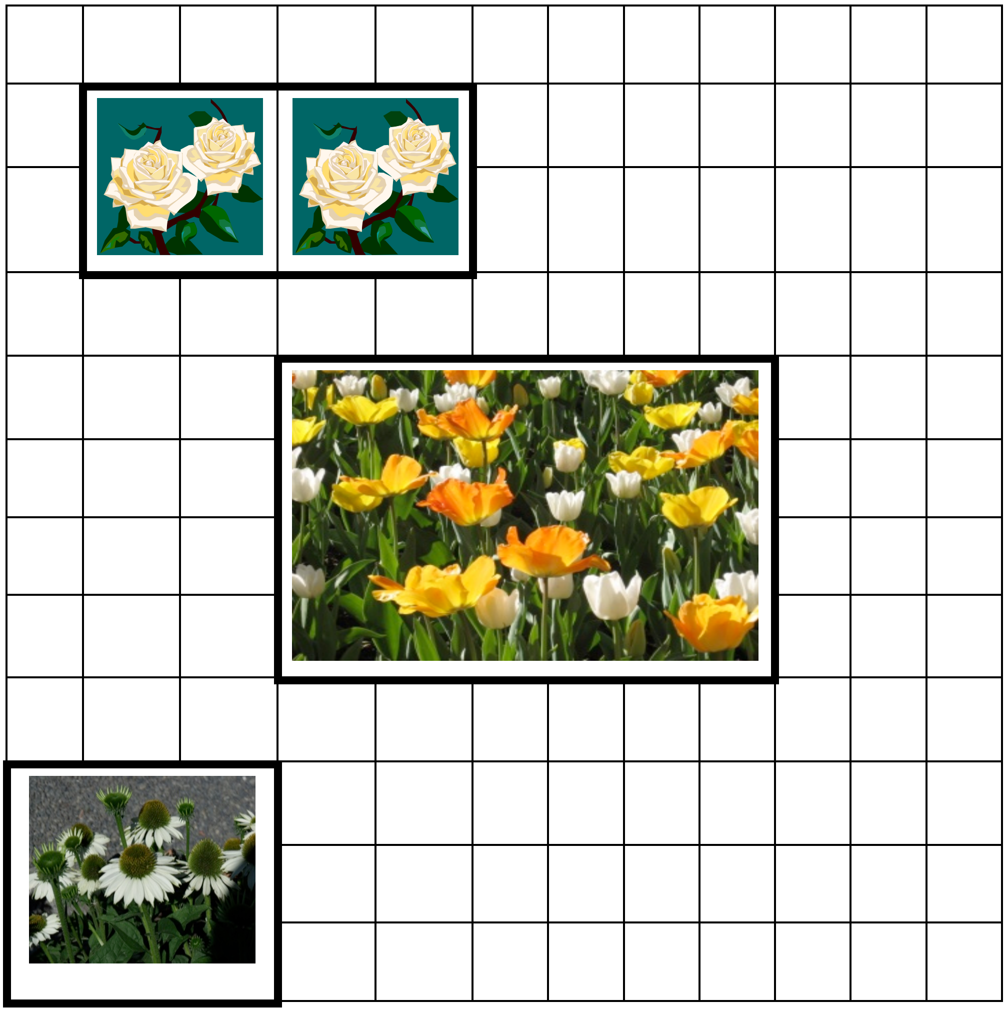
Students working at level 2 of the curriculum could now explore measuring a number of different objects using standardised units. Ensure that the students measure shapes that vary in size so that they understand the need for different units to be used according to scale.

Learning goals (to be shared with your students)

We are learning to:

- measure perimeter and area of sections of a map of a garden.

The discussion about garden design in the article provides an opportunity to explore simple scale drawings and maps. You could provide each student with a simple map, such as that below with plots laid out on it in a basic scale such as 1 centimetre to 1 metre.



The students could measure the plots in response to questions such as:

- How long is the plot containing roses?
- What length of wood would be required to edge the plot containing tulips?
- If the tulip garden and rose garden were joined together, what would the size of the new garden be?

Further activities

Students could also explore the concept that the area of an object can vary while the perimeter remains the same. A simple way to illustrate this is to give each student a length of string and ask them to draw as many shapes as they can that the length of string can make. Use grid paper to make calculation of area easier. Ask the students to find the shape that provides the largest area for that perimeter.

At level 3 of the curriculum, students will be using the units of the metric system. Suitable activities to develop and build this knowledge can be found on the NZMaths site at http://www.nzmaths.co.nz

Ministry of Education resources

You can find further links to the curriculum, teaching ideas, and resources at the NZMaths site http://www.nzmaths.co.nz

Links to digital learning objects that allow students to explore area and volume and the units associated with them, can also be found at the NZMaths website or by going directly to http://www.nzmaths.co.nz/learningobjects/315/3

Links to related Figure It Out material can also be found there as well as at the website http://www.tki.org.nz/r/maths/curriculum/figure/index_e.php

Further resources

A number of interactive ratio games are available on the internet. The BBC website http://www.bbc.co.uk/skillswise/numbers/wholenumbers/ratioandproportion/ratio/flash1.shtml includes a game about ratio understanding and notation appropriate for students working at levels 1 and 2 of the curriculum.