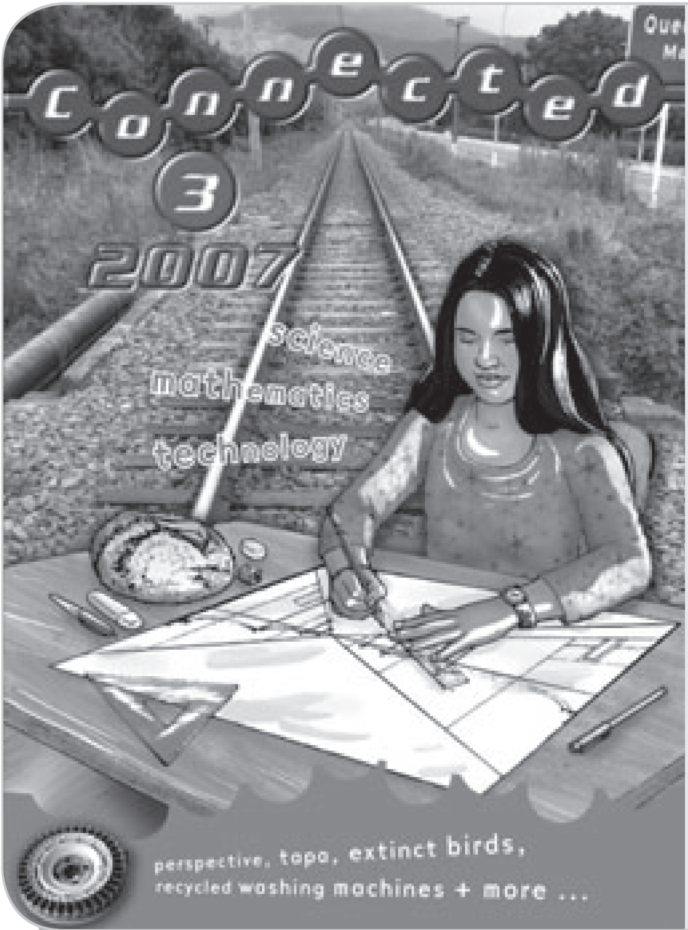
MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga



Notes for Teachers

Connected 3 2007

Contents and Curriculum Links

Introduction

Connected is a series designed to show mathematics, science, and technology in the context of students' everyday lives. The stories and articles are intended to stimulate discussion and to provide starting points for further investigations by individuals, groups, or a whole class. A **shared or guided reading approach** to using these texts will support students in their understanding of the concepts and the technical vocabulary.

Connected 3 is designed to appeal to **year 5–8** students who are working at **levels 2–4**.

General Themes in Connected 3 2007

1. The mathematics of visual perspective: using mathematical drafting techniques to create effective artworks
2. Technology and material culture: keeping Pasifika identity alive in New Zealand by developing new tapa-making techniques with materials that are readily available in this country
3. Rediscovering an "extinct" bird species: assembling enough data about a "mystery bird" to convince the Ornithological Society of New Zealand that it's a New Zealand storm petrel, which has been considered extinct for over 100 years
4. Recycling machine parts and developing eco-friendly methods of electricity generation: recycling washing machine turbines into water wheels that generate electricity without releasing greenhouse gases

Acknowledgments

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Back to the Drawing Board

Possible Achievement Objectives

Mathematics

Number

- Explain the meaning and evaluate powers of whole numbers. (Exploring number, level 4)
- Express a fraction as a decimal and vice versa. (Exploring number, level 4)
- Find a given fraction or percentage of a quantity. (Exploring computation and estimation, level 4)

Measurement

- Carry out measuring tasks involving reading scales to the nearest gradation. (Estimating and measuring, level 4)

Geometry

- Enlarge and reduce a 2-dimensional shape and identify the invariant properties. (Exploring symmetry and transformations, level 4)

Links with the Number Framework

Knowledge

Stage Seven: Advanced Multiplicative: Number Sequence and Order: The student orders fractions, including halves, thirds, quarters, fifths, tenths.

Stage Seven: Advanced Multiplicative: Grouping/Place Value: The student rounds whole numbers and decimals with up to two places to the nearest whole number or $\frac{1}{10}$, e.g., rounds 6.49 to 6.5 (nearest tenth).

Stage Eight: Advanced Proportional: Written Recording: The student records the results of calculations using equations, e.g., $\frac{3}{4}$ x 28 = 21, and diagrams, e.g., double number line.

Strategies

Stage Seven: Advanced Multiplicative (Early proportional) Part-Whole: Proportions and Ratios: Fractions, Ratios, and Proportions by Multiplication: the student uses a range of multiplication and division strategies to estimate answers and solve problems with fractions, proportions, and ratios.

Stage Eight: Advanced Proportional Part-Whole: Fractions, Ratios, and Proportions by Re-unitising: The student chooses appropriately from a broad range of mental strategies to estimate answers and solve problems involving fractions, proportions, and ratios.

Developing the Ideas

Perspective

Students will be aware, even if they haven't consciously thought about it, that the more distant an object is, the smaller it appears. Have them discuss this phenomenon, asking them to identify situations in which this effect becomes especially obvious. For example, when they're trying to read a street name at a two-block distance, making out the details of a house on a hill, or looking at a line of power poles stretching into the distance. This effect often makes things hard to see, but without it, we would have no visual sense of distance or depth.

Prior to the 15th century, artists tried to give their pictures a sense of depth by making distant objects smaller than nearer ones and by overlapping objects; for example, showing the arm of one person in front of the body of another. However, this wasn't enough to give a realistic effect and medieval paintings, although visually rich, look quite jumbled to a 21st century eye. It wasn't until the 1400s that artists discovered how to use perspective to give depth to their paintings.

The breakthrough was made by Filippo Brunelleschi, a Florentine architect and engineer. Having outlined the reflection of a building on a mirror, he extended lines through features such as lintels, rooflines, and windowsills (the "superficial edges" of the building). He discovered that such lines always meet at one or more vanishing points, which are on a horizontal line – the horizon. Once he had worked out the basic principles, artists everywhere could use them to structure their paintings. Brunelleschi himself created many perspective drawings of proposed buildings. In this way, his clients could see how a finished building would look when viewed from different angles.

Although perspective drawing and the mathematics of perspective quickly become very complex, all ideas related to perspective start from the simple fact that the further an object is from the viewer, the smaller it appears to be.

"Back to the Drawing Board" introduces students to three associated concepts.

- **Single-point (one-point) perspective**, which is most easily observed when a pair of parallel lines head directly away from the viewer. These two lines, and all those parallel to them, appear to converge on a vanishing point, through which the horizon can be drawn. In the street photo on page 3 of the story, there are many parallel lines, for example, the street markings, footpaths, rooflines, and window lines.
- **The relationship between perspective and ratio** is mathematically predictable. The diminution of objects conforms to a simple proportional relationship: as measured on paper, an object that's halfway from the vanishing point to the viewer will appear to be half its actual height. An object that's $\frac{3}{4}$ of the distance, as measured on paper, will appear to be $\frac{3}{4}$ of its actual height, and so on.
- **Two-point perspective**, which can be observed when the viewer is closest to the leading edge (corner) of a building and is able to see along the two walls that form it. All the parallel lines to the left of the leading edge will meet at one vanishing point, and all the parallel lines to the right will meet at a second vanishing point. Both vanishing points are on the horizon.

Further Activities

Actual or Apparent?

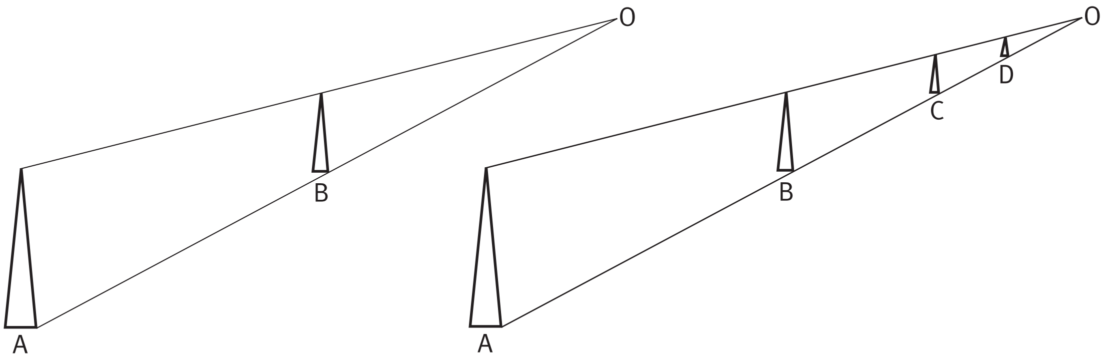
Note that, in the following activities, it's important to distinguish between *actual* distance/height and *apparent* distance/height. The first relates to the real-life measurements of an object, whereas the second relates to how things *appear to the eye*, especially when viewed in a photo or illustration. In the following activities, quote marks (as in "distance") are used to indicate apparent measurements if there's any ambiguity.

Activities Involving a Single Vanishing Point

1. Have groups of students discuss whether every scene has a vanishing point.

- This is not necessarily the case.
- Only scenes with at least one pair of parallel lines heading away from the viewer will have a vanishing point.
- Because pairs of parallel lines are very uncommon in natural landscapes, so are vanishing points. They're usually apparent only in landscapes that include human constructions such as roads, fences, or buildings.

2. An object that's "halfway" between the viewer and the vanishing point will appear to be only half its actual height. If the "distance" between the "halfway" mark and the vanishing point is itself halved, an identical object placed there will appear to be halved again. In the illustration below, B is halfway between the vanishing point, O, and object A. C is halfway between O and B. D is halfway between O and C.

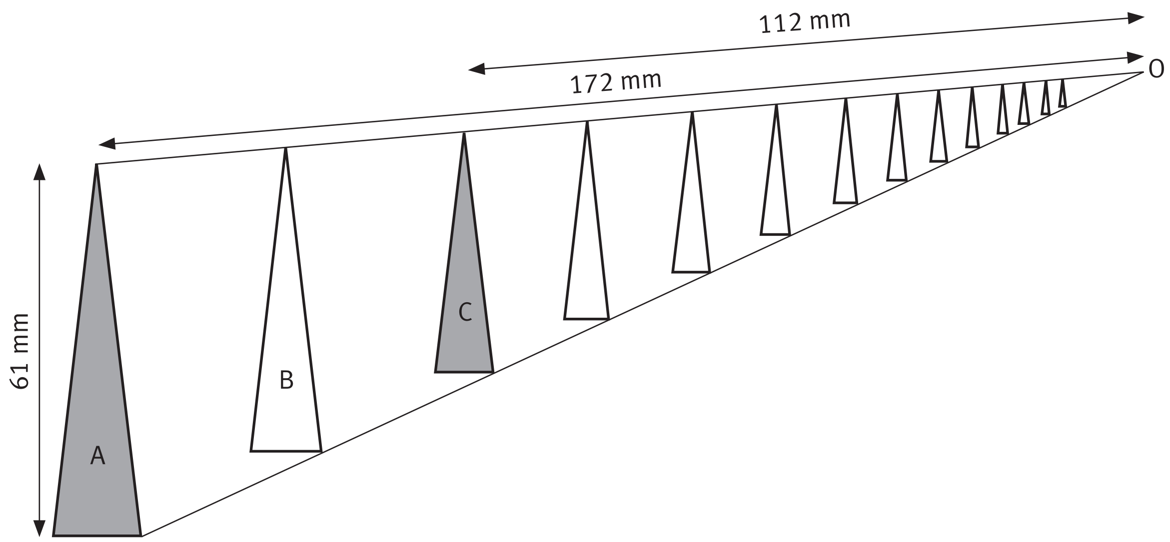


If we repeatedly "halve the distance" to the vanishing point, the relative heights of an object give us the following number sequence: 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ ... The numbers in this sequence can be rewritten in the form: 1, 1 x $\frac{1}{2}$ = $\frac{1}{2}$, 1 x $\frac{1}{2}$ x $\frac{1}{2}$ = $\frac{1}{4}$, 1 x $\frac{1}{2}$ x $\frac{1}{2}$ x $\frac{1}{2}$ = $\frac{1}{8}$ ...)

- Show your students how the numbers in the sequence can be written using exponents, as powers of 2, for example, $\frac{1}{32} = (\frac{1}{2})^5$.
- Challenge them to find out which term in this sequence is the first to be less than 1 millionth. (Term 1 is 1, term 2 is $\frac{1}{2}$, and so on.) They could use their calculators to find the higher powers of 2. (It's the 21st term.)
- If they were to add all the fractions in the sequence together, what would the sum (total) be? Let your students explore this on their own for some time and see if they come up with the idea of a *limit*. (The limit in this case is 2: every extra term they add on gets them closer to a total of 2, but no matter how many extra terms they add, they will never reach 2, because each further term is only half what is required.)
- Read or tell your students the king's chessboard parable. (An Internet search will give you details of the story if you don't have access to a print version.) In this story, a foolish king agrees to pay someone in grains of rice according to the squares on a chessboard. There will be 1 grain of rice for the first square, 2 for the second square, 4 for the third, 8 for the fourth, and so on. The king would be bankrupted long before paying out on the 64th square!
- Discuss how the sequences {1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$ ... } and {1, 2, 4, 8, 16 ... } are similar and how they're different. There are three main points:
  - o Both have an infinite number of terms.
  - o Both involve only powers of 2 (for example, $1=2^0$, $2=2^1$, $4=2^2$, $8=2^3$, $16=2^4$).
  - o However, the first approaches a limit (0), whereas the second approaches infinity.

3. A digital camera is an ideal tool for investigating perspective and its relationship with mathematical ratios. You don't need a special camera, but one with a panorama function will enhance the perspective effect. On a field or in a large hall, the students could place a row of traffic cones, cricket wickets, or another set of identical objects of such size. The students

should use a measuring tape to accurately space the objects at regular intervals. Alternatively, a length of fence with regularly spaced and sized posts could be used or even a line of parking meters on a city street. Whatever scenario is used, the students should take a photo from a suitable angle and print it digitally onto an A4 sheet of paper for measuring and investigation.



Using the illustration above as an example, you could ask three kinds of question.

- If a cone were placed exactly halfway between cone A and the vanishing point O, what would be its apparent height?
- In the illustration, cone A is 172 mm from O and cone C is 112 mm from O. How high is cone C? ($\frac{112}{172}$ = 0.65, so cone C must be 0.65 of the height of cone A: 0.65 x 61 = 39.7 mm.)

  o Use distance from the vanishing point, and ratio, to find the height of two other cones.
- Compare the heights of cones A and B as a ratio. (If the height of cone B is 50 mm, the ratio B:A is 50:61. To get this in a form that makes for easy comparisons, divide it by 61 with the help of a calculator. $\frac{50}{61} : \frac{61}{61}$ = 0.82 : 1).

  o Use this method to compare the heights of other pairs of cones. Is each cone 0.82 of the height of the one to its left?

4. Ask students to discuss their findings from activity 3 with other groups. Do others end up with the same ratio when they compare the heights (or lengths) of adjacent objects? Should this ratio be the same for all groups? If so, why? If not, can they explain why not?

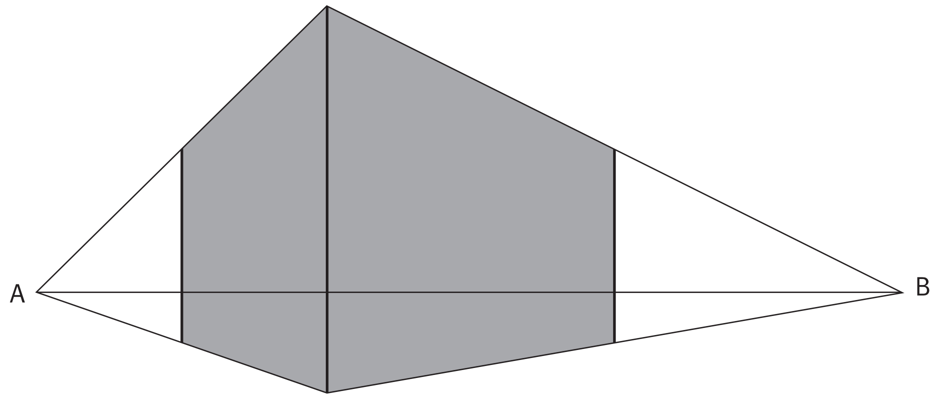
5. If your students are familiar with enlargement (one of the basic mathematical transformations), challenge them to relate single-point perspective to enlargement.

- The vanishing point in single-point perspective is the centre in enlargement.
- In a single-point perspective illustration the scale factor differs, depending on how close an object is to the vanishing point, but it is always less than 1 because apparent size diminishes as objects get closer to the centre.

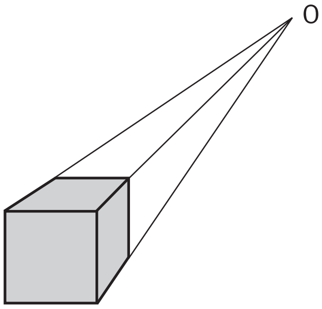
It will help to look at the diagrams for Activity 2. In this case, the scale factor for B is $\frac{1}{2}$ and for C, it is $\frac{1}{4}$.

Activities Involving Two Vanishing Points

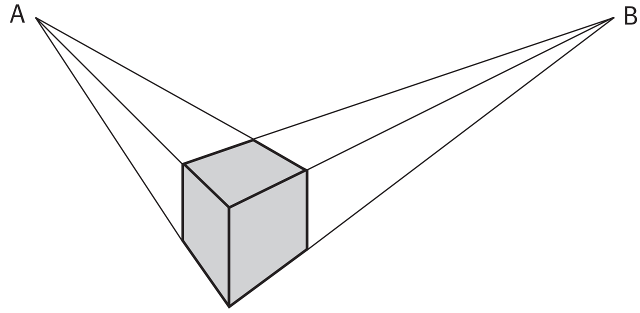
In two-point perspective, the viewer is positioned opposite the leading (closest) vertical edge of a building or group of buildings. In other words, the viewer faces a corner rather than a wall. The non-vertical parallel lines to the left and to the right meet at different vanishing points, which are both on the horizon. This effect is very easily observed.



1. Have your students draw a cube in one-point and then in two-point perspective, as shown below.



Cube: one-point perspective



Cube: two-point perspective

Challenge them to define what is the same and what is different about the two cubes as drawn. There are two main points of difference.

- In both cases, vertical lines remain vertical and parallel.
- In one-point perspective, we see a square and two trapeziums. In two-point perspective, we see no squares.
- In one-point perspective, the base is parallel to the horizon. This is not so in two-point perspective.

2. Have your students investigate what happens to the cube in two-point perspective when:

- it is positioned above the horizon rather than below it. (The viewer looks up at the cube rather than down onto it.)
- the two vanishing points are moved closer together or further apart. (The cube appears to move closer to the viewer or further away.)

Drexel University's mathforum website provides an applet that allows the user to observe what happens to an object as they drag the vanishing points into different positions.
See **http://mathforum.org/workshops/sum98/participants/sanders/TryPersp.gsp.html**

3. Challenge your students to use two-point perspective to accurately draw buildings on the corner of an imaginary street. They should start by drawing a horizon, then a vertical line (the leading edge) and two vanishing points. Next, they should draw a number of lines from each of the vanishing points. Each pair of lines should meet at the leading edge. These lines can then be used to locate the tops and bottoms of the buildings, which can then be drawn in. The students can make their street scene as simple or as complex as they wish.

4. Find a window that conveniently frames another building that's angled to present a leading edge to the viewer. Get a student to stand in a fixed position and use masking tape to create an outline of the building on the glass. (The outline can be as minimal or detailed as they wish.) When they've finished, get them to move away from the window and study their outline. Does it look right? (Only when they stand on the spot where they did the taping will all the lines of tape conform to those of the actual building. Thus, there's always an ideal position from which to view a perspective painting or drawing.)

5. Google Sketchpad, a program available for free download, offers exciting opportunities for students to explore perspective (including two-point perspective) drawing. Quite elaborate objects or structures can be created. The program comes with an excellent tutorial.

Other activities

1. The students could study Escher's famous staircase print (*Relativity*, 1953, which is shown on Wikipedia at: **http://en.wikipedia.org/wiki/M._C._Escher**). It will reveal how breaking the rules of perspective can result in an illusion. By ignoring some vanishing points and artificially creating others, Escher tricks our eye into seeing the impossible. Computer graphics and animation also rely on very complex mathematical tools to control perspective.

2. Using the Internet, the students could investigate how artists (most famously, Leonardo da Vinci) have used perspective to give a sense of depth and distance in their paintings. Try the search term "perspective paintings" as a starting point.

Other Resources

Many websites offer interesting background information and further activities, see, for example, **http://mathforum.org/sum95/math_and/perspective/perspect.html**

"A Vanishing Art" and "Tomorrow's Tapa"

Possible Achievement Objectives (NZ Curriculum: Draft for Consultation 2006)

Technology

Technological Practice

- Planning for Practice (L 3–4)
- Brief Development (L 3–4)
- Outcome Development and Evaluation (L 3–4)

Nature of Technology

- Characteristics of Technology (L 3–4)

Technological Knowledge

- Technological Modelling (L 3–4)
- Technological Products (L 3–4)

The Specific Learning Intentions

Nature of Technology

Students will be able to:

- describe ways in which technology reflects the culture or identity of the group that developed it, for example, through symbols, patterns, and images inherent in tapa. (CT)

Technological Knowledge

Students will be able to:

- understand that technological modelling is an important aspect of technological practice because small-scale, practical trials allow for the informed adoption, rejection, or refinement of design ideas at appropriate stages in technological research and development. (TM)
- describe how the properties of different materials work together to enable a technological product to carry out its function. (TP)

Technological Practice

Students will be able to:

- understand that a technologist works within a set of specifications determined by the needs and opportunities as well as the constraints specific to each situation. (BD)
- communicate their personal or group identity through a visual representation as they emulate the practice of tapa makers. (BD, ODE)
- apply the science principles of fair testing and experimentation to carry out and record results of systematic trialling in order to determine the optimal combination of factors for their own product. (PfP, ODE)

The Key Ideas

Nature of Technology

- Technology is embedded within an existing cultural context, in which needs and opportunities are recognised. (CT)
- Technology can play a key role in keeping cultural identity alive. (CT)

Technological Knowledge

- In this context, the technologists needed to carefully appraise the material and chemical properties of the dyes and the paper in isolation, as well as investigating how they behave when they interact. (TM, TP)
- Linking the physical and chemical properties of a material or product with its performance is context-specific. For example, a dye that is unsuitable for tapa work might have properties that give it high performance when used for another purpose. Another example is that mordants often work by changing the acidity of a dye solution. (TP)

Technological Practice

- Technologists draw extensively from their own past experiences, but they also consult experts when needed. (BD, PfP)
- Technologists need to think creatively, but they also work systematically. (PfP, ODE)
- Technologists work within the constraints of a specific situation. To do this, they combine creative and critical thinking to ensure that they work successfully in innovative ways. Careful planning and the use of systematic techniques are often the key to realising innovative technological outcomes. (BD, PfP, ODE)

Developing the Ideas

Technology Is Embedded within an Existing Culture

Within any cultural context, social and economic needs and opportunities are recognised and technological outcomes are developed. In "A Vanishing Art", the original need is for a medium to enhance and convey family and community identity by recording symbolic images. Thus tapa can be seen as a technological outcome that's been developed to bind communities together. It has high value because of the skill and time required to make it and by virtue of the ceremony involved when it is passed on.

Focus Questions

- In your family, what precious objects are likely to be passed from one person or generation to another?
- What sort of objects are handed on when people marry, give birth, or pass away?
- What makes these objects so valuable – for example, their age, their expense, or the skills required to make them?

Throughout history, traditional ideas about local surroundings have often determined the symbols and media used to communicate identity. Patterns used in tapa are stylised but depict local features that are significant to the maker's culture and/or environment. Symbolic plants and animals can identify the family and maker of a piece of tapa.

Focus Questions

- What objects would you choose to represent your school? Your family? Your neighbourhood? Yourself?
- Why did you choose these objects? What's significant about them?
- How can a complex shape like that of a bird or a fish be simplified or stylised into a symbol?
- Can you recall banners, flags, and official documents that feature particular animals, plants, or other objects?
- What logos or emblems can you think of that include stylised images?

Expressing Ideas through Material Culture

Here are some starter ideas for stimulating discussion around methods of physical representation across history and cultures.

- Early Māori had no paper. They recorded their ancestry and stories through other media, for example, through moko, wood carving, and patterned weaving.
- On the Chatham Islands, ancient trees still bear carved figures made by the earliest inhabitants.
- Ancient Egyptians painted hieroglyphs onto stone tablets and parchments.
- Prehistoric Europeans left personal imprints by pressing an outstretched hand against a cave wall and blowing charcoal across it to create a negative image. Later they depicted the animals they hunted by painting on walls with burnt charcoal and ochre pigments.
- Much later, tapestries were used in Europe to record famous events such as battles. Given that medieval Europeans had writing, and later printing, why do students think they still used art to record historical events and religious images?
- Woven rugs in Persia still use traditional patterns that show which region they were made in.

Focus Questions

- What are the traditional raw materials used by Māori to make dyes?
- What do modern Māori substitute for some of these materials? Could these substitutes also be applied to tapa making?
- Is there an expert we could consult about the use of local pigments – for example, a potter, painter, or fabric artist?

Operating within the Constraints of a Specific Situation

In "Tomorrow's Tapa", a technologist identified a need relating to the specific historical situation and location: the need to keep the art of tapa making alive. This need requires that new pigments be found to replace those no longer available locally in the Pacific. Margaret Vlassoff also wished to identify substitutes available in New Zealand so that tapa makers are able to practise the tradition in this country.

- In this context, the constraints relate not only to the scarcity of traditional materials in the Pacific but also to populations that have migrated to New Zealand, where a completely different set of material resources is available.
- The situation represents an opportunity for innovative outcomes. Students who are challenged to make use of local resources to develop a functional product such as a paint or dye will be working within their own set of constraints.

Focus Questions

- What constraints did the technologist in the articles face?
- If we were to emulate the technologist's practice, what constraints would we face?
  - o Constraints are important factors, and the early identification of them will help the development of specifications during brief development.
  - o Some obvious constraints are money, the necessity for non-toxic ingredients, the local availability of materials, and durability when exposed to light and other damaging agents.
  - o Margaret Vlassoff needed the colours to be similar to traditional tapa pigments but, depending on the specifics of their projects, this would not necessarily be a constraining factor for your students.

Technologists' Own Experiences and Expert Consultation

Each person brings their own personal history and existing knowledge and skills to a new situation. These are augmented when technologists tap into expertise from a wide range of stakeholders.

Focus Questions

- What useful experience and knowledge did Margaret Vlassoff have before she started working with tapa?
- Which experts did she consult with in the early stages of her work?
- At what other stages did she decide to consult experts?
- Why did she involve a whole group of other teachers in the second article?

Creative Thinking and Critical Thinking

"Many artists are really scientific" and "the best scientists are very creative thinkers". These two statements from "Tomorrow's Tapa" are worth considering. Technologists often borrow ideas and systematic practices from science to help them develop their solutions. Two key science-related ideas mentioned in the articles are the use of fair testing to enable the comparison of outcomes and the need to record data systematically in order to communicate ideas. As well as this, both articles exemplify the way in which creative thinking helps to generate innovative outcomes.

In order to further explore the connections between technology and the arts, the students could read and discuss various *Connected* case studies in which technology combines closely with the arts. For example, "The Adventures of Gary the Worm" (*Connected* 3 2006) and its accompanying teachers' notes explore how primary school children developed an educational and entertaining video to inform young visitors to the Portobello Marine Laboratory near Dunedin. Their video, *The Adventures of Gary the Worm*, can be seen as both an ICT solution and an audiovisual artwork. (The accompanying teachers' notes refer to sections of *Exploring Language* [Ministry of Education, 1996] that guide students through character, script, and technical development in the context of film-making.) Other arts-technology case studies include "Room 5's Amazing Meeting Seating" (*Connected* 2 2005) and "Super Toy Makers" (*Connected* 1 2005).

Focus Questions

- In their tapa workshopping sessions, what were the teachers investigating?
- What components (types of ingredient) did they need to combine to get a usable paint or dye?
- If you took just one possible pigment source, such as acorns, how many trials would you need to do to try it out with every combination of mordant and binder in the lists?
- Can you think of any artists who have developed new techniques, used novel materials, or used existing materials in new ways to express themselves?

Further Activities

General Suggestions for Related Technology Projects

Possible contexts in which students could pursue technological practice based on “Tomorrow’s Tapa” include:

- A banner or flag might be developed for a school event, such as a sports day. Each team, house, or class might be represented by a different pattern or image that is significant to their group identity.
- Panels or mats of tapa might be created as a parting or a welcoming gift to an important person or group. Sections of tapa might be designed and printed individually then connected into a large “patchwork” or hung as a series of “flags”.
- Tapa design features may be the main focus, with modern printing dyes and techniques being used to produce a school book bag or another calico product.

Developing Tapa-like Patterns

Useful Websites

The following activity includes Internet research. The students will find many and varied sites that focus on tapa designs; the two suggested below are useful starting points.

http://media.dickinson.edu/gallery/Sect1.html
This site analyses some typical design elements, as seen on a special commemorative ngatu. The site is full of ideas for students to consider, with a focus on blending modern and traditional elements.

www.art-pacific.com/artifacts/nuguinea/barktapa.htm
This site presents images of tapa artefacts from Papua New Guinea and descriptions of the ceremonies in which they are used.

The students might also find it useful to search online auction websites to explore the tapa artefacts that are being sold.

Activity: Dreaming Up Designs

What You Need

Internet access and/or reference books

Large sheets of plain newsprint

Cardboard

Sharp scissors or craft knives

A closed-cell foam sheet (sleeping mat)

Paints and brushes

What You Do

- Choose a main subject, such as an animal, plant, or object that is special to you. Examine its shape, outline, and details.
- Convert your subject into a stylised pattern that can be drawn in a single colour and used as part of a tapa design.
  - Websites and books could give you inspiring ideas about just how stylised tapa subjects can become.
  - When looking at examples of tapa, focus on the repeating geometric patterns, the linework, and the blocks of colour that are used for visual impact.

- o On the bookshelf, a good place to start would be the Patterns of Polynesia series by Ailsa Robertson (Auckland, Heinemann/Reed, 1989). The series includes separate books that focus on New Zealand, Niue, Sāmoa, The Cook Islands, and Tonga.
- o You could also look at books or websites about tessellation, which is the process of covering a surface by repeating a single shape and fitting it together without gaps or overlapping. The technique was made famous by the Dutch artist Maurits Escher.
- o You could try some activities from the Figure It Out books. For example, Pathway Patterns on page 4 of Geometry, Book One, Level 4 (Ministry of Education, 2004) and Escher Envy on page 2 of Geometry, Book Two, Level 4+ (Ministry of Education 2004).

- One way of structuring a tapa design is to fold a square sheet of paper in half then half again to create four sections of equal size and shape, then make repeated images by rotating the paper and drawing your stylised pattern in each of the four sections. It's also common on tapa to reverse an image on either side of a line to give a mirror effect.
- Add triangles and other geometric shapes to frame or highlight the main design. (Again, you could look at Internet examples for inspiration.)
- You may chose to hand-paint your images. Alternatively, you could cut out a stencil to keep the shape uniform in a repeating, and possibly rotating, pattern.
- Another option is to make a printing block from something like closed-cell foam. This foam will absorb paint or dye so you can use it as a printing stamp for creating a regular, repeating pattern.
- To make a simple kupesi, try cutting a pattern from a thick sheet of corrugated cardboard. Firmly glue this cut-out onto another sheet of cardboard. Tightly stretch the paper or fabric to be decorated across your kupesi and then dab on the dyes.

What You Look For

- Can the students explain how their selected subject symbolises an aspect of their culture, identity, or life experiences?
- Are they able to use the exemplar images provided from the two *Connected* articles and from websites as models for translating their selected subject into a stylised, tapa-like pattern?

Exploring Natural Pigments

Depending on the specific design and the cloth or paper to which the dye is to be applied, your students will need to determine their own set of specifications. "A Vanishing Art" and "Tomorrow's Tapa" describe a variety of mineral and plant materials that yield usable pigments. Students could add to this list by exploring local resources. For example, they could take a walk through the school grounds, scouting for colourful plants, then visit the art room to select clays that could be worked into a slurry with water and trialled – either separately or in combination with other pigments.

Safety Warning

All plant materials must be treated as potentially toxic. The students should avoid directly handling plant materials, instead manipulating them with gloves and implements unless they are known to be harmless. When students are working with plant materials, make sure they alert you if they experience any signs of irritation, such as sneezing, rashes, or tingling skin.

Useful Websites

www.pioneerthinking.com/naturaldyes.html
This site includes tips for extracting and applying dyes.

http://tilz.tearfund.org/Publications/Footsteps+21-30/Footsteps+21/Home-made+plant+dyes.htm
This site suggests plants from which pigments can be extracted and used for dyeing. It also provides recipes for some mordants.

Activity: Investigating Plant Pigments

This activity will show you that the colour of a pigment usually depends on the other chemicals in a dye bath. Because of this, mixing the same pigment with different binders and mordants is likely to produce a variety of colours.

What You Need

Flower petals (especially reds and blues, which tend to work well)

Many clean test tubes or small dishes for testing

Plastic eye-droppers

An acid, such as lemon juice or white vinegar

A base, such as baking soda dissolved in tap water

Clean, gritty sand to break up the plant tissue

A filter funnel lined with porous paper or muslin cloth

A mortar and pestle or a bowl and old spoon for grinding

What You Do

Part A: Practising with Pigments and pH

- You can extract the pigments from petals by grinding them with a few millilitres of warm water and a pinch of clean, gritty sand. Use a mortar and pestle if you have them but, if not, you could grind the plant material with the back of a spoon in a round-bottomed bowl. Keep grinding till the juice is coloured and the petals are completely minced, then strain the mixture through a funnel lined with filter paper, muslin, or a paper towel.
- Collect the filtrate (the coloured juice) and divide it evenly into three test tubes or shallow dishes.
- Add a different acidity regulator to each dish, for example:
  - a few drops of white vinegar or lemon juice – to produce an acidic solution;
  - a few drops of baking soda dissolved in water – to produce an alkaline (or basic) solution;
  - a few drops of tap water – which is neutral and therefore unlikely to change the acidity/colour very much.

Notes for Teachers

What to Expect

The colour changes observed in this activity reflect a key property of plant pigments: many of them are sensitive to the pH (acidity or alkalinity) of their surroundings. Generally, plant pigments appear red or pink in acidic solutions and blue or purple in alkaline solutions. A familiar example of this phenomenon is that hydrangeas grown in acidic soil produce red or pink flowers, but those grown in alkaline soil (achieved by applying lime) produce blue or purple flowers. On a smaller scale, in a fuchsia flower, which is part purple, part red, and part pink, the petals are maintained at different pH levels. Thus, each petal contains an identical pigment, and the various colours are purely the result of differing acidity.

continued ▶

Taking It to the Next Stage

The next step is for students to emulate the practice of the technologists in "Tomorrow's Tapa" by developing a usable natural paint or dye. To do this, they will need to test multiple combinations of the three major components identified in the article: pigment, binder, and mordant.

Focus Questions

- In their workshopping sessions, what were the teachers investigating?
- What components did they need to combine to get a usable paint or dye?
- If you took just one possible pigment, such as acorns, how many trials would you need to carry out in order to test it with every combination of mordant and blender in the lists?
- Can you think of any artists who have developed new techniques or used novel media to express themselves?
- Can you think of other examples in which technologists have relied on scientific techniques when developing a new product or material?

Part B: Testing Times

Background Info

The aim of fair testing is to gather and compare a variety of results in a situation where you run lots of trials, each differing by only one factor (or "variable" in science speak). That last point is very important. For example, if you wanted to find out whether you get better results if pigment A is combined with mordant J or with mordant K, you would do two trials: A with J and A with K. To produce useful and valid results, you must make sure that in the two trials, the only factor that varies is the type of mordant. The temperature, all ingredient quantities, timing, type of cloth, and so on must all be identical. If not, you won't be able to draw valid conclusions from your results.

What You Need

A variety of pigments for testing

A variety of mordants for testing

A variety of binders for testing

Bowls, stirrers, and so on

Pieces of calico cloth

Paintbrushes

What You Do

- You'll need to run quite a few trials to compare each pigment's performance with every possible combination of binder and mordant available.
    - o The first thing you'll need to do is find out roughly how much mordant and binder are needed for about 10 millilitres of pigment.
    - o Can you devise your own method for working this out?
- Once you've worked out the rough proportion of binder and mordant for an "average" pigment, take time to plan your fair test by filling in the left three columns of the results table below. Not only will this show which combinations will be trialled, but it will also reveal how much data will be generated. You'll have to be very systematic!

Worksheet for Recording the Results of Fair Testing Dyes

Fabric used: ______________________________

Student(s): ______________________________

Make-up of Dye			**Criteria Evaluated**				**Overall Rating**
Pigment	Binder	Mordant	Colour	Dark or pale 1–5	Fade-proof 1–5	Ease to apply 1–5	

- Your evaluation of results will be "qualitative".
  - That is, you'll be judging results like "dark red", "mid red", or "light red". So your choices will have an element of opinion in them.
  - This problem doesn't occur when we're recording "quantitative" data, which is made up of numerical measurements.
  - Because you'll be judging qualitative results, before you begin, you'll need to agree on just what constitutes a 1, 2, 3, 4, or 5 for each of the qualitative factors. Turning qualities like the darkness of a colour into numbers requires all researchers to discuss and agree if results are to be compared between groups later on. Here are some useful focus questions:
- How will we decide what is a "good" result? What criteria will we apply to help us decide whether "good" quality has been achieved in each trial?
- For example, does the colour last or does it fade?
- Does it run across the cloth, seeping along the fibres, or does it stay where we applied it? (Is this a good thing or not?)
- How easy is it to apply?
- How strong/deep/dark is the colour? How strong/deep/dark do we want it to be?
- How will we decide exactly what colour we have achieved in each trial?
- At the end of your investigation, share your results and your conclusions about which are the best combinations with the rest of the class.
  - Can all the groups collaborate to devise a set of conclusions that the whole class agrees on?
  - Are your favoured dyes effective for their purpose? How do their physical and chemical properties make them suitable for decorating tapa in New Zealand?
  - What about the less suitable dyes? Although unsuitable for tapa work, do the chemical and physical properties of these dyes make them suitable for other applications? If so, how?

Notes for Teachers

The students could cut out squares from a commercial paint chart and make their own key so that there is consistency in assigning a number or a name to each shade. The students may well suggest this approach themselves, but if not, you could prompt them by suggesting that they think about the names that have been given to commercial paints.

What You Look For

- Do the students recognise that fair testing and other scientific techniques are a common feature of technological research and development?
- Are they able to use their knowledge of fair testing and other scientific principles to devise an effective method of working out a generally applicable pigment:binder:mordant ratio?
- In terms of the main investigation, are they logical in planning their approach and then systematic in implementing that plan?
- Do they record their results efficiently? Are they able to use that data to support their conclusions about the best dyes?
- Can they construct a simple table to combine their own results with those of other groups?
- Can they relate the use of acidic or basic mordants to differing petal colours in various soil pH conditions?

A Bird in the Hand

Possible Achievement Objectives

Science in the New Zealand Curriculum

Living World

- 3.1: Distinguish between living things within broad groups on the basis of differences established by investigating external characteristics.
- 4.1: Investigate and classify closely related living things on the basis of easily observable features.
- 4.3: Investigate and describe patterns in the variability of a visible physical feature found within a species.

Developing Investigative Skills and Attitudes

Information Gathering

- 3/4: Record observations and measurements.
- 3/4: Locate information in the community or libraries.
- 3/4: Use information sources purposefully, asking coherent, directed questions of people and media sources.

Processing and Interpreting

- 3/4: Use organised data and scientific ideas to suggest an answer to their selected questions and problems, and make an evaluation of their investigation.

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Living World

Evolution

- 1/2: Recognise that there are lots of different living things in the world and that they can be grouped in different ways.
- 3/4: Begin to group plants, animals, and other living things into science-based classifications.

Nature of Science

Understanding about science

- 1/2: Students will 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.
- 3/4: They will identify ways scientists work together and provide evidence to support their ideas.

Investigating in science

- 3/4: Students will build on prior experiences, working together to share and examine their own and others' knowledge.
- 3/4: They will ask questions, find evidence, and carry out appropriate investigations to develop simple explanations.

The Specific Learning Intentions

The students will be able to:

- make careful observations of the external characteristics of living things and use these observations to distinguish between broad groups of organisms;
- record observations and data and make links between this information and other scientific findings;
- communicate their ideas, justify their thinking, and back up their ideas with appropriate evidence;
- use their findings to suggest an answer to their question or investigation.

The Key Ideas

- All the individuals within any one group of living things share a number of features.
- Some features used for classification are readily observed, but others can only be observed with the use of scientific equipment.
- Observable features can be used to create keys to name and group species.
- Less readily observable features are used as evidence for debating and refining our ideas about relationships between living things.
- Scientists carry out planned observations, which are recorded and carefully catalogued so that the information can be retrieved.

- Scientists work as a community, sharing findings with each other. Shared data can then be used as evidence for or the proof of a theory.
- It is important that members of the scientific community be open-minded.
- Scientific findings must withstand rigorous peer review before being accepted.

Developing the Ideas

Several Nature of Science themes support thinking and working scientifically. Before the first reading of "A Bird in the Hand", discuss the following Nature of Science themes in student-friendly language. One way to make the discussion more meaningful would be for groups to collect newspaper and magazine articles that report scientific activities and findings. Discuss the articles as a class and suggest links between the articles and the Nature of Science themes. Encourage the students to think about:

- the methodology of scientific investigations;
- the ethical challenges scientists face;
- the need to replicate research results;
- peer review and resulting challenges;
- the evidence required to convince members of the public, who may have limited scientific understanding.

Scientific Evidence and Debate

The "A Bird in the Hand" case study is all about evidence and debate. Some current media topics that focus on scientific evidence and debate include:

- scientists using climate theories to predict what's likely to happen if global temperatures continue to rise (and the debate about whether current data does in fact signify a warming climate);
- scientists collecting data to inform the debate about whether transmission lines or cellphones adversely affect human health;
- scientific investigations providing evidence for the debate about fluoridated drinking water;
- scientists collecting data to predict the pathways of near-Earth objects and debating the feasibility of proposed options for deflecting or destroying any objects that are likely to hit the Earth.

This activity could develop into a long-term project in which students collate media reports on a particular science issue. The media reports could be used as an ideas bank to focus the students' minds on the impact of science and scientific ideas on people's everyday lives. Another angle would be the ways in which scientists work and the challenges they face.

The Nature of Science themes are available on the Ministry of Education's Science IS website. See **www.tki.org.nz/r/science/science_is/nos/index_e.php#propList**

The following themes are particularly relevant to the storm petrel case study.

- **Scientists' predictions are based on their existing science knowledge.** Existing science knowledge is made up of known science ideas that are supported by adequate data and accepted by the wider scientific community.
- **When scientists carry out investigations, they aim to collect adequate data.** Adequate data can be used to create a convincing case in support of the proposed scientific explanation (when subject to peer review).
- **Scientists think critically about the results of their investigations.** When reviewing the results of an investigation, scientists compare their observations with their predictions. They

also consider other scientists' explanations for what they have observed. This critical review helps them to decide what answers they may have found and what further questions need to be asked.

- **Scientific explanations must withstand peer review before being accepted as science knowledge.** Peer review involves scientists (working in the same or related fields) exploring and discussing the proposed explanation. The explanation may be accepted as science knowledge when there is general agreement that it is a valid way of conceiving the world around us.
- **Open-mindedness is important to the culture of science.** Open-mindedness allows for creative insights (beyond what is already known or conceived) and supports productive collaboration with other scientists. One aspect of open-mindedness is the ability to suspend judgment. This helps scientists to observe what is happening and identify patterns that emerge, even when these differ from their predictions.

After reading "A Bird in the Hand", ask the students to devise a timeline of the scientific process involved in either verifying or disproving the existence of the New Zealand storm petrel. Start with the initial sighting of the mystery bird near the Mercury Islands through to the final submission to the OSNZ with all the recorded data. Note the activities the scientists engaged in, the data collected, and the challenges they faced through this process. Use the Nature of Science themes above to help you identify how scientists think, work, and act.

Biological Specimen Banks

Landcare Research Manaaki Whenua is the custodian of a number of nationally significant biological collections and resource databases that are available to scientists and the public. See **www.landcareresearch.co.nz/databases/index.asp**

These collections and databases are vital sources of information for many agencies such as the Department of Conservation, the Ministry of Agriculture and Forestry, and the Ministry for the Environment. Plant and animal collections and databases are important for research, resource management, biosecurity risk assessment, and species management.

Discuss specimen collections and databases as an aid for identifying new species and confirming the rediscovery of species previously thought extinct. For example, in the storm petrel context, ornithologists compared photographs of and tissue samples from the unidentified bird with the skins held in Paris and London.

Another interesting New Zealand database is the Antarctic Killer Whale Identification Catalogue, founded by Dr Ingrid Visser in 2001. This is the first collaborative photo identification project for killer whales, (also known as orca). Information, including sighting records, photographs, and video, is collected from various sources, such as tourists and researchers. By analysing the photographs and video, the scientists can identify individuals, track their movements, and monitor their wellbeing. See **www.orcaresearch.org/**

The Royal Botanical Gardens at Kew in London house some of the most important botanical collections in the world, and many areas in Kew are dedicated to carefully assembled collections of living specimens. In addition to the wealth of living plants at Kew, there are many carefully curated collections of seeds, pressings, and plants (unsuitable for pressing) stored in preserving fluids. Like the bird skins described in "A Bird in the Hand", these herbaria and other collections are an invaluable resource for taxonomists and other scientists around the world. The students could visit Kew's website to explore the living and preserved collections. See **www.rbgkew.org.uk/collections/index.html**

Creating Your Own Biological Databases

Using photographs, video, and drawings, the students could create their own databases of plants or animals – perhaps focusing on those found in the school grounds, in the local region as a whole, or in particular local ecosystems. Discuss the types of information about particular local species, or local biodiversity in general, that would make the database useful for specific people, including scientists, students, and other individuals or groups.

Related Activities from Ministry of Education Resources

- *Making Better Sense of the Living World* (Ministry of Education, 2001) includes Activity 5: Wanted Poster on page 31. In this activity, students create a wanted poster for a tree by recording the observable characteristics of the tree without naming it. The aim is for a fellow student to find the tree by using the information on the wanted poster. Background information for teachers is provided on pages 22–24.
- Activities relating to the defining features and classification of mammals are provided in *Mammals*, book 55 in the Building Science Concepts series (Ministry of Education, 2004).
- The features used in naming and classifying plants are investigated in *The Bush*, book 7 in the Building Science Concepts series (Ministry of Education, 2001).
- Trotter's Bush, a level 3 New Zealand Curriculum Exemplar, is based on students observing plants and using that information to develop a dichotomous key to help identify plants in a stand of native bush. See **www.tki.org.nz/r/assessment/exemplars/sci/living/lw_3b_e.php**

NZCER's Assessment Resource Bank (ARB)

This large and varied resource includes material that supports students' learning about classification. The following steps will allow free access to the ARB.

- **http://arb.nzcer.org.nz/nzcer3/nzcer.htm**
- Search the Banks: Science
- User name: arb
- Password: guide
- Specific tasks can be looked up by number through the "free-text search" function.

The ARB has two tasks for exploring the collection, recording, and interpretation of data:

- In LW0044, a level 3 task, students carry out a survey on the eye-colour of their classmates. They put their results into a table then graph and comment on the data.
- In LW1042, a level 4 task, students gather data on the height of individuals and the length of their feet. They need to write up a method, record their results in table form, graph those results, and make a conclusion.

Two ARB tasks explore classification:

- In LW0010, a level 4 task, students use observation and a key to identify native plants. The task also focuses on processing and interpreting information.
- In LW0014, a level 4 task, students use a key to identify and classify which major group four plants belong to.

Further Activities

Activity: Let's Create a School Collection of Living Plants

What You Need

- Patience and time to locate and access a range of plants
- A suitable planting area
- Garden tools
- Reference material

What You Do

- Identify a good location for your garden and decide on a focus for your living plant collection. The more specific the focus, the more manageable will be the number of plants to be collected. Your choice of plants will also depend on the soil type, the sunniness of the site, and climatic factors, such as frosts and seasonal rainfall. The focus for a living plant collection could be:
  - plants with a perfume;
  - plants that attract insects;
  - plants used for medicinal purposes;
  - kitchen herbs;
  - flax and other plants suitable for weaving and/or other craftwork;
  - edible plants;
  - plants that produce dye pigments;
  - plants that produce flowers, fruits, seeds, and/or pods;
  - mosses;
  - ferns;
  - plants that thrive in a wet environment;
  - plants that thrive in a dry environment.
- For each plant selected, make up a simple fact sheet or card that includes the criteria necessary for identifying it. (Most of these criteria will relate to the plant's physical features.)
- If the plants are related in some way, for example, if your collection is made up of ferns only, comment on some of their shared features. Have these features been used by scientists to group the plants?
- Explore possible sources for the plants. For example, plants could be collected as cuttings, seeds, or seedlings from local gardens or bought as seeds, seedlings, or mature plants from a garden centre.
- Think again about the focus of your living plant collection and decide how to communicate key messages to visitors. For example, you may wish to inform visitors about:
  - how you've selected the plants;
  - their botanical classification;
  - the physical features that allow people to identify the plants;
  - how you've arranged them within the planting area and why;
  - any specific purposes for which you intend to use the plants.
- Prepare the site appropriately. (It would be great if you could get advice from keen gardeners in the community.)
- Invite visitors to view your collection and enjoy watching it grow!

What You Look For

- Can the students communicate clearly the criteria used to identify the plants they have chosen for the garden?
- If the students have collected related plants, can they link the physical features of the plants with how they've been scientifically classified?

A New Life for Old Machines

Possible Achievement Objectives

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Nature of Science

- 3/4: Students will use their growing science knowledge when considering issues of concern to them. (Participating and contributing)
- 3/4: They will explore various aspects of the issue as they make decisions about possible actions. (Participating and contributing)
- 3/4: They will engage with a range of text types and begin to question the purposes for which these texts are constructed. (Communicating in science)

Physical World

- 3/4: Use some scientific ideas to explain physical phenomena, such as movement, forces, electricity and magnetism, light, waves, sound, and heat. (Physical enquiry)

Science in the New Zealand Curriculum

Planet Earth and Beyond

- 4/4: Investigate a local environmental issue and explain the reasons for the community's involvement.

Material world

- 3/4: Research the use and purpose of technology in the disposal, or recycling, of some common materials.
- 4/4: Investigate the positive and negative effects of substances on people and on the environment.

The Specific Learning Intentions

The students will be able to:

- discuss the difference between renewable and non-renewable resources;
- explain why it is important to develop alternatives to fossil fuels;
- identify ways of generating electricity that do not release greenhouse gases into the atmosphere;
- develop effective questions when evaluating an issue;
- evaluate non-fossil-fuel sources of energy in terms of their impact on the environment;
- explore ways of reducing electricity usage;
- identify and contrast the advantages of recycling for the community, Fisher&Paykel, and the planet as a whole.

The Key Ideas

- Various sources of energy can be used to turn turbines to "generate" electricity.
- Sources of energy may be renewable or non-renewable.

- Renewable sources of energy include the Sun, geothermal activity, wind, and moving water.
- Non-renewable sources include radioactive minerals and fossil fuels, such as coal, oil, and natural gas.
- When fossil fuels are burned, carbon dioxide is released as a by-product. This is one of the main greenhouse gases. Most climate scientists believe that greenhouse gases contribute to global warming.

Developing the Ideas

"A New Life for Old Machines" includes science concepts and vocabulary that will be unfamiliar to many in the class. So, before reading the article with the students, you may wish to lead a discussion and organise practical activities that help them to reflect on what they already know about electricity. This exploration will also give them the opportunity to identify questions they want answered. The hands-on activities described below are intended both to motivate students and to help them develop background knowledge that will make the article more accessible. These preparatory activities are not, however, designed to meet the specific learning intentions outlined above, which focus on the Nature of Science rather than the Physical World.

- Set up learning centres where students can explore ideas related to electricity, magnetism, and the harnessing of kinetic energy. For example, you may wish to set up the following four learning centres:
  - o Making Simple Windmills and Water Wheels, page 9, *Windmills and Waterwheels*, book 54 in the Building Science Concepts series (Ministry of Education, 2004).
  - o Three activities from *Making Better Sense of the Physical World* (Ministry of Education, 1999):
    - Make the Bulb Go, page 71;
    - Floating Magnets, page 96;
    - Electromagnet, page 99.
- As a class, brainstorm all the electrical appliances we use in our everyday life. Then brainstorm the following questions.
  - o How would our lives be different without electricity?
  - o What sorts of activities would be difficult without electricity?
  - o What sorts of activities would be impossible?
- Discuss the following questions.
  - o Where does our electricity come from?
    - In New Zealand, hydroelectricity is the commonest form, but some of our electricity is generated from solar, geothermal, and wind energy. Electricity is also generated by burning fossil fuels such as natural gas, coal, and oil – particularly when drought affects New Zealand's hydro lakes.
    - Note that it is not scientifically accurate to describe energy being "generated". Electricity is a form of energy. Energy cannot be created or destroyed. When we talk about "generating" electricity, we are really talking about one form of energy (kinetic) being changed into another (electrical). It is common in everyday communication to use words in a way that is not strictly correct scientifically. For example, we talk about the Sun rising and setting, though in scientific terms it is the Earth that moves, not the Sun.
  - o Why is burning fossil fuels to generate electricity a problem?
    - Fossil fuels will eventually run out.
    - Burning fossil fuels generates greenhouse gases, which contribute to global warming.

- o How can we get the electricity we need without harming the planet?
  - Look for students' suggestions about exploring alternative sources as well as reducing how much electricity we use.
  - Read the article with the students. During the reading, ask them to identify the alternative energy sources mentioned. While reading, the students can also identify unfamiliar vocabulary. Compile a class glossary of "science words" after the reading.

Further Activities

Activity: Evaluating the Alternatives

What You Need

A wide range of reference materials about generating electricity

What You Do

- As a class, make a list of all the ways in which you know electricity can be generated.
- How would we decide if a particular way of generating energy is a good alternative or not? What questions would we need to ask?
- As a class, add suitable questions to the following template. (Your answers will be a useful summary of your findings.)

Method of generating electricity:	
Questions about whether it's an environmentally sustainable method	**Answers**

- Divide yourselves into groups. Each group will investigate one way of generating electricity by answering the questions about environmental sustainability.
- You will need to get your information from a range of sources, for example, books, articles, and websites.
  - o Why do you think it's important to know who collected and wrote up the information from each source?
- At the end of the research, share your findings with the rest of the class.
  - o From the viewpoint of environmental friendliness alone, what are the most suitable options for generating electricity in New Zealand?
  - o Taking all viewpoints into account, and paying particular attention to cost and efficiency, which are the best options?
  - o Were your answers the same for each of the two questions above? Why/Why not?

Notes for Teachers

The World Wildlife Fund provides useful teacher background information on climate change and alternative energy sources. This information may also be useful for older students. See **www.wwf.org.nz/climatechange/solutions.cfm**

Also, as the students come up with suitable questions to help them evaluate the environmental sustainability of various energy sources, allow them to take the lead as much as possible, but ensure they cover the following ideas.

Is it a renewable source?

Does it add to global warming?

Does it have other negative impacts? If so, what are they?

Does it produce harmful waste? If so, how is it harmful?

What You Look For

- Can the students explain why we need sources of energy other than fossil fuels?
- Do they understand the importance of environmentally sustainable energy sources?
  - o Do they take account of both renewability and pollution?
- Do they consider a range of factors when evaluating each alternative?
- Do they realise that an article might be biased, depending on the author's perspective and their purpose for writing it?
- Can they explain their thinking when justifying their opinions?

Activity: Exploring Different Perspectives

What You Need

A range of resources that give multiple perspectives on one way of generating electricity

What You Do

- Choose one way of generating electricity – ideally, one that's used locally, for example, a wind farm, geothermal power station, or hydroelectric power station.
- As a class, brainstorm the groups or individuals that might have opinions about the method.
- Divide yourselves into groups, each of which will explore a different perspective.
  - o For example, groups could look at the views of local residents, of environmentalists, of electricity companies, and of local iwi.
  - o *School Journal*, Part 4 Number 3, 2005 has an article called "To Spray or Not to Spray?", which you could use as a model for assembling different views.
- Set up a role play in which each group has to present its views to the New Zealand Environment Court. (Alternatively, you could write the sort of letter each interest group might send to the local newspaper, explaining its perspective.)
- Taking on the role of an Environment Court judge, come up with a list of questions to ask each group. These questions should be the same for each group and should be designed to help you make an informed decision about the pros and cons of each group's case.

Note for Teachers

If you wish to integrate literacy assessment into this unit of work, you could develop learning outcomes based on persuasive language and identifying the writer's purpose and point of view. The teacher notes of the Assessment Resource Bank (ARB) task WL2549 (which is in the English Resource Bank) provide information about persuasive language. The breakout section in "A New Life for Old Machines" about the relationship between magnets and electricity and the workings of a hydro dam is written in a different register from the rest of the article. This breakout text is a good example of scientific language. You could ask your students to compare that text type with the rest of the article. (Further information about the features of scientific language can be found on the ARB website. See **http://arb.nzcer.org.nz/nzcer3/supportmaterials/language_of_science.htm)**

The following steps will allow free access to the ARB.

- **http://arb.nzcer.org.nz/nzcer3/nzcer.htm**
- Search the Banks: Science
- User name: arb
- Password: guide
- Specific tasks can be looked up by number through the "free-text search" function.

What You Look For

- Can the students identify multiple perspectives on the chosen issue?
- Can they define the sorts of information they need in order to make an informed decision on the issue?
- Are they able to logically weigh up the different perspectives on the issue when coming to a personal standpoint?

Activity: Conserving Electricity

What You Need

Information about ways to conserve energy – for example, see:

- The Energy Efficiency and Conservation Authority website, which has information about alternative power sources: **www.eeca.govt.nz/renewable-energy/index.html**
- The Mercury Energy website, which includes an information pack for students, including references to other sites. For a free download, access: **www.mercury.co.nz/downloads/School_Project_Information.pdf**

What You Do

- As a class, draw up a checklist of ways to reduce the use of electricity.
- As a class, use the checklist to "audit" the electricity used at school, or as an individual, in your own home.
- Set yourself a personal goal for conserving electricity.

What You Look For

- Can the students identify ways of reducing electricity use?
- Are they aware that they can make a difference by reducing their personal energy consumption?
- Can they set suitable and achievable goals and actions to that end?
- Are they motivated to take action?

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