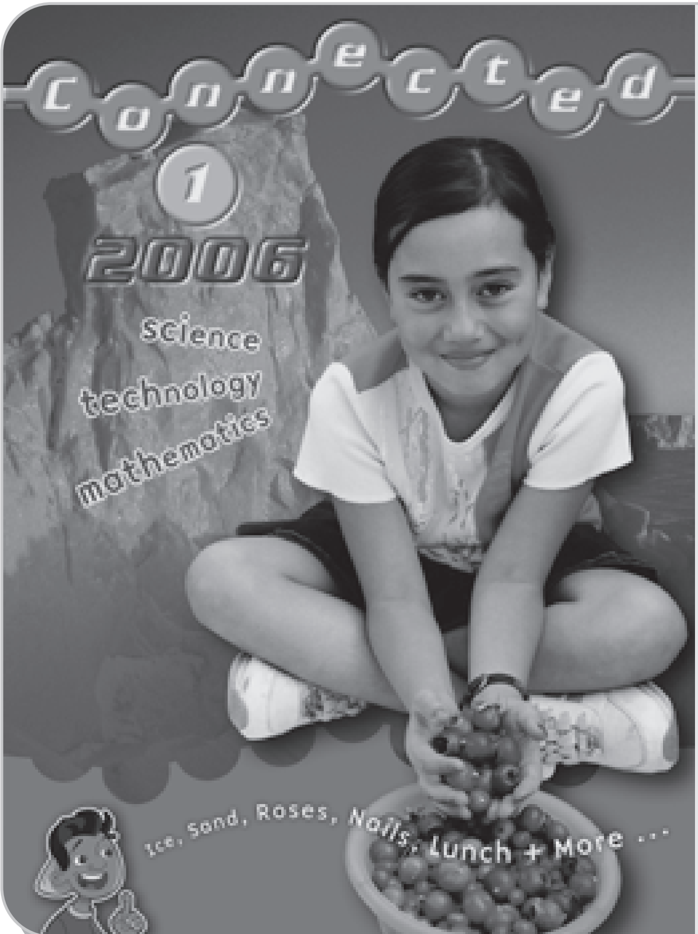
MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga



Notes for Teachers

Connected 1
2006

Contents and Curriculum Links

Contents	Curriculum Links	Page in Students' Book	Page in Teachers' Notes
The Ice Hotel	Material World; Physical World; Developing Investigative Skills and Attitudes	2	3
The Sands of St Clair	Physical World; Planet Earth and Beyond; Developing Investigative Skills and Attitudes	8	11
How to Drink a Rose	Food Technology; Materials Technology	14	14
Nailing It Down	Number; Measurement	22	22
What's for Lunch?	Statistics	26	25

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 1 is designed to appeal to **year 3 and 4** students who are working at **levels 1 and 2**.

General Themes in *Connected 1 2006*

1. Building Structures and Materials

The first two items in *Connected 1 2006* explore two unfamiliar but interesting structures: a hotel in Sweden that's made almost entirely from ice and the St Clair sea wall in Dunedin. "The Ice Hotel" explores the use of ice as an unusual but very effective temporary building material. The follow-up activities suggested in these notes guide students through an exploration of ice's physical and aesthetic properties and special techniques that can be used for shaping, colouring, and building with it.

"Nailing It Down" is a mathematics story that approaches the building theme from a different angle. Jono's helping Dad to build a fence. Dad asks Jono to help him work out how many nails and palings they'll need. Measuring them all out by hand would be tedious to say the least, so Jono comes up with some simple and very useful number strategies for working out how many palings and nails will be needed.

2. Building Structures, Landforms, and Erosion

"The Sands of St Clair" builds on "The Ice Hotel" by looking at a structure that's designed for a different protective function. Rather than protecting people from the harsh conditions of winter, the St Clair sea wall is designed to protect the beach and the adjacent land from sea encroachment. The notes suggest an approach in which students explore how erosion can change a landscape. Activities are also suggested to help them explore how buried "sand sausages" hinder the movement of sand away from the beach.

3. Healthy Eating

"What's for Lunch?" is a fun story that details the way in which a class devises a simple statistical survey to find out whether girls are healthier eaters than boys. In particular, the story explores how survey data can be gathered, presented in graphic form to give shape and meaning to the assemblage of numbers, and analysed in ways that help us to make informed decisions.

4. Developing New Recipes

"How to Drink a Rose" is an article that details how a teacher introduced her class to rosehip syrup, a traditional vitamin C supplement. After making a batch of syrup, the students were very motivated to develop tasty recipes that included the fruit syrup as flavouring and a source of vitamin C. The follow-up suggestions in these teachers' notes involve students exploring the process of fruit dehydration and then developing new recipes for the dried fruit they've prepared. In the process, they will need to call upon their scientific and technological knowledge about changing an ingredient's properties as it is processed, predict likely outcomes when testing their recipes, and develop a set of key attributes against which their new food products can be evaluated.

The Ice Hotel

Possible Achievement Objectives

Science

Material World

- 1.1: Explore simple physical properties and use them to describe and group everyday materials.
- 1.3: Investigate how familiar materials change when heated or cooled.
- 2.3: Investigate and describe everyday changes to common substances.

Physical World

- 1.1/2/3: Share and clarify their ideas about easily observable physical phenomena.
- 2.1/2: Investigate and describe their ideas about some everyday examples of physical phenomena.

Developing Investigative Skills and Attitudes

Make observations and simple measurements (Information Gathering, levels 1 and 2).

The Specific Learning Intentions

The students will be able to:

- describe the physical properties of ice, including its optical properties;
- explore methods of changing the optical properties of ice by using additives;
- explore methods of construction and test the relative strength and stability of various shapes that may be used in supporting structures.

The Key Ideas

- Water exists in three states: solid, liquid, or gas.
    - Liquid water and ice have different properties.
    - Additives can change those properties.
- Ice can be transparent, translucent, or opaque.
    - These properties are affected by the ice's thickness, by impurities such as tiny air bubbles, and by dissolved substances such as colourings.
- Substances change state in certain conditions. These changes are predictable.
    - When water cools below 0 degrees Celsius, we know that it will freeze; when ice warms up above 0 degrees Celsius, we know that it will melt.
- Because ice is a solid, you can build with it – but for safety reasons, you need to think very carefully about the type of ice you use and the design of the structures involved.

The Main Features of the Suggested Learning Sequence

- The students discuss similarities and differences between their homes and familiar short-stay/holiday accommodation, such as tents, caravans, baches/cribs, hostels, and tramping huts.
- They then consider unusual types of holiday accommodation in very cold places.

- After reading "The Ice Hotel" as a class, they list special features of ice that make it a suitable building material, including its optical and structural properties.
- They carry out practical investigations into the way in which ice's translucence is affected naturally by tiny air bubbles and can be altered artificially with additives.
- They carry out practical investigations into the shapes that are appropriate for supporting structures.
    - o You describe the ways in which forces are distributed within simple structures.
    - o The students investigate the different strengths of various pillars (circular, triangular, square, hexagonal, and so on).
- As a summative activity, they build a small ice structure of their own design, exploring how ice can be used as a temporary structural material, as an art medium, or as a combination of the two.

Developing the Ideas

Many of your students will be familiar with the concept of going on holiday. Some common types of holiday accommodation are very different from an ordinary house, for example, tents, caravans, baches/cribs, tramping huts, hotels, hostels, and boats. Before reading "The Ice Hotel" with the class, you could ask them whether the buildings they stay in on holiday are similar to their house. Focus on the materials that the accommodation has been made from, the shape and amount of space within the accommodation, and other differences from their own houses. You could pose a number of focus questions.

- "What are some key differences between warm-weather holiday accommodation and cold-weather accommodation?" If necessary, prompt the students by suggesting that they consider the materials and the architectural designs used.
- "What's the most temporary kind of accommodation you have stayed in?" "For example, has anybody stayed in a tent or a bivouac?" "Has anyone heard stories about people who have sheltered in an ice cave?"

Then broaden the discussion to other countries. In some parts of the world, you can stay in very unusual accommodation. Tell the students that they're about to read an article called "The Ice Hotel". The builders of the Ice Hotel have used the physical properties of ice (especially its solidity and translucence) to build a structure that's not only very stable but also very attractive. The Ice Hotel is designed to reflect its surroundings so that visitors can really live the winter experience.

Read "The Ice Hotel" with the class. Afterwards, ask the students to help you list the properties of ice that the builders have taken advantage of when trying to make their hotel special. These might include the following points:

- Water takes on the shape of its container, so you can freeze it in moulds to create interesting and useful shapes.
- Ice is solid but not particularly hard. This makes it easier to carve and file than many other solid building materials.
- The hotel is temporary because of the summer melt. This means that the builders can completely redesign the Ice Hotel each year.
- Ice can be transparent, translucent, or opaque. The amount of light that travels through ice depends on the thickness of the ice and on things that are mixed in with it, such as fine air bubbles and dissolved substances.
- Blocks of ice can be joined if you paste them together with water, which freezes in between to form a kind of "glue".

Further Activities

Activity: Seeing the Light

Introduce this activity by discussing the use of ice "windows" in the hotel. Have the students reread page 6 to find out about the special features of the ice windows. For example, ice from the river Torne is very clear. This is partly because workers sweep snow from the river ice as it forms to keep it as cold as possible.

You could show the students an ice cube, pointing out the areas where the ice is clear and glassy and those where tiny air bubbles make it appear frosty. You can demonstrate that clear, glassy ice lets more light through than frosty ice by placing an ice cube on a transparent glass dish, standing it on the platform of an OHP, and projecting its image onto a screen.

- This would be a good opportunity to introduce the term "translucent". The translucent sections of the ice cube let light through, but you can't see an image through them.
- You could place a small cube of wood or something similar onto the platform to demonstrate what "opaque" means.
- You could introduce the term "transparent" by placing an ice cube on top of a laminated sheet of bold text. The parts through which you can see the text reasonably well are transparent. Note that not even Torne River ice is as transparent as glass.
    - Explain that the windows of the Ice Hotel are translucent, which means that they let light in but you can't see through them.
    - The students could look at the photographs taken inside the Ice Hotel. Ask them to point out examples of transparent ice and translucent ice.
- Record the new terms on a reference chart.

Other lighting in the hotel is provided by electric bulbs that are placed behind blocks of clear ice. The following activity involves using ice moulds to explore the translucence of ice.

What You Need

- A microwave ring mould (or something similar) and four saucers
- Food colouring
- The equipment to make a simple, battery-powered electrical circuit (For circuit-making instructions, see the Ministry of Education's *Making Better Sense of the Physical World* [Learning Media, 1999] pages 68–70.)

What You Do

- In advance, fill the microwave ring mould with water and freeze it. Half fill four saucers with water. Add two or three drops of food colouring to the water in the first saucer, a quarter of a capful to the second saucer, a whole capful to the third, and none to the fourth. Place the saucers in the freezer until the water freezes. These will be the "lids" for the ice ring.
- When the water has frozen, take the ice ring out of the mould.
- Explain to the students that they're going to explore how air bubbles and other things in ice can affect the amount and the colour of the light it lets through.
- Place the bulb and circuit inside the frozen ring (wrapping it in a plastic bag to keep it dry). Switch on the bulb.
- Tell the students how you've prepared the sample ice lids, but before they see the lids, ask them to predict the brightness and the colour of the light that will come through them.

  "Do you think that any of the samples will look like the glass in a window pane or like the glass in a pair of sunglasses? In other words, will any of the samples be transparent?"

"Will any of the samples look like the glass in a frosted bathroom window? In other words, will any of the samples be translucent?"

"Will any of the samples look like the glass of a computer or TV screen that's switched off? In other words, will any of the samples be opaque?"

- The students can then test each of the four ice lids in turn.
- Afterwards, compare the students' predictions with the actual outcomes, discuss any differences, and pose some final questions.

  "What other things could we have added to the ice so that it let coloured light through?"

  "What could we have done to the ice so that it let little or no light through?" "What could we have done to let more light through?" "How might we design an ice window that's as transparent as possible?"

  "Ice art is one of the interesting things to see in the Ice Hotel. How might we make other interesting-looking ice by adding liquids or solids to the water before or as it freezes?"

What You Look For

- Do the students use words and expressions that show they understand the difference between translucent and opaque substances?
- Do they understand that the properties of the different ice samples are affected by the properties of the additives?
- Do they suggest that both the thickness of the ice and the additives in it could be changed if you wanted to increase or decrease its translucency?

Related Activities That Explore Ice

The following Ministry of Education publications provide background information for teachers and activities for students on the topic of water and its physical properties and on the topic of structures and building materials.

- **Melting, freezing, and the properties of ice** are investigated in *Ice*, book 58 in the Building Science Concepts series (Learning Media, 2004).
- **Ice and changes of state** are explored in *Making Better Sense of the Material World* (Learning Media, 2001), especially in Science Focus: Water on pages 23–33.
- **Insulation and insulating materials** are explored in *Keeping Warm*, book 46 in the Building Science Concepts series (Learning Media, 2003).
- Water and Ice, a level-1, Physical World exemplar, focuses on students **investigating ice melting** and offering explanations for their observations **(www.tki.org.nz/r/assessment/exemplars/sci/physical/pw_1b_e.php)**.

Discussing Important Ideas about Structures

The activities suggested in the next section will help the students to engage with Physical World and Material World ideas in a creative, hands-on manner. In order to gauge the students' current understandings and, if necessary, address their knowledge gaps or misconceptions, you could pose a number of questions for discussion.

Are all parts of a building affected by the same types of force? Begin by explaining that structures and materials in buildings have both pushing and pulling forces acting on them.

- If you wish to provide a very simple demonstration of pushing and pulling forces, you could push two plastic blocks together. The blocks will not crumple – in other words, they withstand pushing forces. Then pull them. They will move apart easily. This shows that the blocks don't withstand pulling forces.

- You could also demonstrate that string or wire can withstand pulling forces but not pushing forces.
- You could prompt the students by suggesting that they identify parts of the school buildings that are in compression or tension. For example, walls and pillars are compressed by their own weight and by that of the roof. Eves, balconies, ceiling lights, and so on are under tension because gravity exerts a pulling force towards the ground.

Do all parts of a building need to be equally strong? Look for the following ideas in the students' answers.

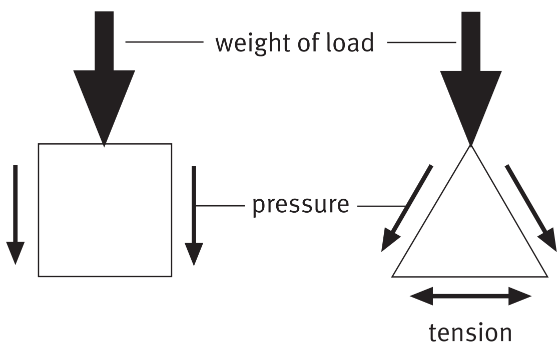
- Usually the frame of a structure needs to be made of especially strong materials so that the building holds together and stays upright.
- If the students have trouble answering the question, you could prompt them by:
  - asking whether they've ever seen a half-built house that lacks walls. This will focus the students' minds on the strong framework. In the Ice Hotel example, the walls, columns, and curved arches were used to support the roof.
  - showing them an oriental fan or a kite, both of which have small but obvious rods that support the softer materials.

What sorts of shapes do we often see in buildings? You could gather the students' initial thoughts and then show them a Connected photo-article that they can explore to identify a wide variety of building styles and shapes: "Finding Shapes in Buildings" by Clare Bowes (*Connected 1 2002*). (Bridges are another type of structure in which it's easy to identify simple shapes that are employed because of their strength.)

Describing How Forces Act on Different Shapes

You could explain a little more about the ways in which forces act on structures. This information will be useful for the students when they carry out the hands-on activities that follow.

- In a square structure, the two upright sides bear the load.



- Triangular shapes are very strong structural elements because all three sides share the load. Compression acts equally on two sides of the triangle, causing the base to be pulled equally in two directions, which creates tension. Thus, all three sides of a triangle share the load.
- In nature, circles are often seen. They are among the strongest shapes because forces distribute evenly throughout a circular structure. Plant stems and tree trunks are examples of how circular shapes lend strength to plants.

Further Activities

Activity: Which Column Shape Is the Strongest?

This activity shows that if you shape exactly the same material in different ways, you can change how strong it is.

What You Need

- Four sheets of A4 paper
- Sticky tape
- Scissors
- Things you could use as weights, such as issues of Connected

What You Do

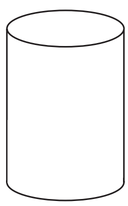
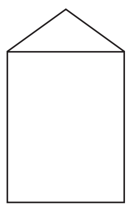
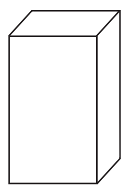
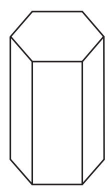
- Have the students make a circular, a square, a triangular, and a hexagonal column, using one sheet of A4 paper for each.
- When making the columns, they need to make sure that the join in each is made in the same way.

  "The columns are all made with pieces of paper that are exactly the same – so do you think they will therefore be equally strong?"

  "Do you think they will all collapse in the same way?"

  "How might they collapse?"

- Have them test each column in the following way.
  - Place the column upright on the floor.
  - Put weights onto the column.
  - Record the number of weights at which the column collapses.

Column				
Number of weights when column collapses				

- Pose some focus questions.

  "If some columns do turn out to be stronger than others, can you see patterns in the results?"

  "If you can see patterns, they can help you to make predictions. For example, do you think that an octagonal (eight-sided) column would be stronger or weaker than the ones you've already tested?"

  "Do the columns all collapse in the same way?" "If there are differences in the way the columns collapse, what patterns can you see in the results?"

Background Information

The clear trend is that the more sides or corners a column has, the greater the weight it can bear. The triangular column bears the least weight before collapsing. The octagonal column bears more weight than all but the circular column, which is significantly stronger. A key observation is that the columns always collapse at one of the corners. This observation is linked to the central principle behind the results: the more corners there are, the less weight each has to support. For example, if you place 1 kilogram of weight on a square column, each of the four corners has to support 250 grams. If you place the same weight on an octagonal column, each of the eight corners has to support only 125 grams. In a circular column, the weight is perfectly evenly distributed right around. There are no weak points in the column and no pressure points where the load is greater. This makes the circular column far stronger than any of the others.

- You should finish by placing the number of sides in context with other factors that determine column strength. For example, you could ask the class to help you list other factors that an engineer might need to consider, for example:
    - o the material the column is made of;
    - o whether the column is hollow or solid;
    - o whether more than one material is used in the column, and if so, how the different materials are arranged within the column;
    - o whether the column tapers or is an even width throughout;
    - o whether the column is tall and thin or short and wide.

What You Look For

- Do the students correctly predict that there will be differences in the strength of the columns?
- Do they identify a relationship between the number of sides and the strength of a column? Can they therefore correctly predict the relative strength of an octagonal column?
- Before testing the columns, can they suggest differences in the ways the columns collapse, in terms of concertinaing down, buckling in half, crumbling sideways, and so on? Do they suggest differences in the speed at which the columns might collapse, for example, suddenly or gradually over a period of time?
- Aside from the number of sides, do they suggest other factors that contribute to a column's strength, in terms of both shape and materials?

Activity: Building Ice Walls

In the following activity, the students experiment with ice structures. Tell them that you want them to use what they've learnt about the properties of liquid water and ice to build an ice structure of their own design.

What You Need

- Ice cubes
- Water
- Plastic trays or containers

What You Do

- Make plenty of ice cubes in advance and remove them from their tray.
- Ask the students to work in groups to design and build a structure such as a column, a wall,

a plain or decorative window, or possibly a simple ice sculpture. You could also make ice cubes of different colours that the students could join together to create walls or windows with simple patterns or pictures. (More types of ice might be required, depending on the students' ideas.)

- Note that the following suggestions are intended to give *you* an idea of the possibilities. Don't give these ideas out as suggestions or instructions. Rather, allow the students to come up with their own ideas. If they have trouble coming up with ideas of their own, you could hint at some of the following possibilities by posing open-ended questions.

- Depending on their choice, the students will need to plan how to build their structure in particular ways. You could give them some general guidance by suggesting that they think about the way water can be used to "glue" ice together. They might also consider the possibility of making a sculpture by joining together a number of units made from joined-up cubes.

    - For example, they might "water glue" cubes together one by one to make a column or sculpture.

    - Alternatively, they might join a large number at once to make the walls or windows of an ice house. This could be done by placing ice cubes in a brick-like pattern on the bottom of a tray, pouring over a small amount of water so that it fills in the gaps between the ice cubes, and placing the container in the freezer until the water glue has frozen the ice bricks into a solid wall.

- They might design ice windows by "water gluing" together coloured and clear cubes of ice. Alternatively, they could pour water into a glass plate or a glass tray and add one or two drops of different food colourings to see if they can create patchy or swirled designs. They could also make ice windows by crushing ice, tinting it different colours, making mosaic patterns with it on a flat surface, and refreezing it. (They may need to spray a little "water glue" over the mosaic to improve its cohesion when it refreezes.)

    - Coloured ice windows can be placed on the glass platform of an overhead projector and screened onto a wall with impressive results.

    - You could also hold an ice window in front of a bright bulb in a dark room to show how a coloured window suffuses a room with tinted light. This demonstrates how the ice windows fill the hotel with a faintly bluish light – not because the ice hotel windows were tinted but because water has a bluish quality naturally.

What You Look For

- Can the students describe the liquid and solid states of water and discuss the processes of melting and freezing?

- Do they recognise that these processes are reversible?

- Do they demonstrate an understanding of ice's physical properties and the physical changes it can undergo by planning ahead and making reasoned predictions about how the ice will behave (both structurally and aesthetically) in their planned construction?

- If things don't proceed as planned, can they solve the problems by drawing on their knowledge of ice's properties?

Further activities investigating the properties of building materials and exploring the structures of buildings are outlined in *Standing Up*, book 51 in the Building Science Concepts series (Learning Media, 2003).

The Sands of St Clair

Possible Achievement Objectives

Science

Physical World

- 1.4: Describe uses of items of everyday technology, and, in simple terms, suggest how they work.
- 2.4 Describe, in simple terms, how items of everyday technology work and affect our lives.

Planet Earth and Beyond

- 1.1/4: Share their ideas about some easily observable features and patterns that occur in their physical environment and how some of these features may be protected.
- 2.1/4: Investigate easily observable features and patterns and consider how the features are affected by people.

Developing Investigative Skills and Attitudes

- Use their science ideas and personal observations to make predictions or suggest possible solutions (Focusing and Planning, levels 1/2).

The Specific Learning Intentions

The students will be able to:

- discuss how the action of sea water can affect beaches;
- describe ways in which people can design and build structures to protect beaches;
- explore the relationship between the purpose of a structure and the way it is designed.

The Key Ideas

- The surface features of beaches are continuously changing as a result of weathering and erosion (and, conversely, of sand and stone accretion).
- Wave action and backflow are major causes of beach erosion.
- These processes and changes are natural.
- People can slow down the rates of weathering and erosion by using various structures.

The Main Features of the Suggested Learning Sequence

- You read "The Sands of St Clair" with the class.
- The class discusses the ideas for protecting the beach and how they work.
- They carry out a selection of landform and erosion investigations from Ministry of Education handbooks, including *Making Better Sense of Planet Earth and Beyond* (Learning Media, 1999), *Waterways*, and *Weathering and Erosion* (books 1 and 2 in the Building Science Concepts series, Learning Media, 2000).
- They make a very simple but effective filter in order to understand how the sand sausages function.
- You lead a discussion about the general principles of filtration, and the students suggest other familiar examples of filtering devices.
- The students compete in a challenge to build a reinforced sandcastle to agreed specifications.

Developing the Ideas

After reading "The Sands of St Clair" with the class, ask them to help you list and describe the main ideas for protecting the beach and the adjacent land. You could organise and present the responses as a chart. For example:

Idea	How It Works
Build a new sea wall.	The sea wall is big and strong. It stops the waves washing away the land at the top of the beach.
Bolt rocks to the sea wall.	The rocks protect the sea wall. They take the first hit of the waves, lessening the impact on the wall.
Lay riprap.	The rocks protect the sand beneath. Also, they're carefully placed to take the impact of the waves and to slow them down. Because of this, the waves have a gentler impact when they reach the sand next to the riprap and the sea wall behind it.
Bury sand sausages.	The giant "sand stockings" act as filters. They let sea water pass through as it flows back to the sea, but they don't let sand through.

Further Activities

Activities That Explore Landforms and Erosion

You could select activities and investigations from Ministry of Education handbooks, including *Making Better Sense of Planet Earth and Beyond* (Learning Media, 1999), *Waterways*, and *Weathering and Erosion* (books 1 and 2 in the Building Science Concepts series, Learning Media, 2000). For example:

- **Changes to the landscape** are explored in *Making Better Sense of Planet Earth and Beyond*, especially in Science Focus: Landforms, pages 23–25 and 32–41.
- *Waterways* explores **how moving bodies of water contribute to landscape changes**.
- *Weathering and Erosion* explores **how a variety of agents shape the landscape**.

Activity: Filter Cloth

Explain to the students that, in this activity, they will explore how a filter lets water through but traps some of the things that are mixed in with it. This is how the sand sausages work. The students might be surprised at how effective even simple filters can be.

What You Need

Two bowls
A strip of muslin (cheesecloth), approximately 15 cm x 20 cm
Muddy water
Something to act as a stand

What You Do

- Have the students fill one bowl with muddy water and place it on a 5-centimetre-tall stand.
- Have them gently twist or fold the muslin cloth into a long roll and place one end into the bowl of muddy water.
- The other end goes into the empty bowl, which should be placed on the table top next to the stand so that it's below the level of the full bowl.
- Ask the students to predict what will happen. (Under the influence of gravity, the muddy water flows down through the cloth and into the empty bowl. Much of the suspended mud is filtered out by the cloth, which becomes noticeably grubby. The water that collects in the second bowl is noticeably clearer than the water in the top bowl. If you take the semi-clear water and re-filter it in the same way, it comes through looking completely clear.)
  - o Make sure that the students understand that this is not a method for purifying water on tramps or other outings. Explain that the cloth filters out soil particles but germs pass straight through.
- Afterwards discuss the results, encouraging the students to make connections with the sand sausages and with other familiar situations that involve filters.
  - o If you need to stimulate their ideas, you could prompt them by suggesting that they think about air filters as well as water filters. (Vacuum cleaners and the lint filters on some clothes dryers are familiar air-filtering devices.)
  - o You could also prompt them by suggesting that they think about any situation in which some things are allowed through but not others. The students might then mention nets. They operate on a filtering principle, letting water through but not fish. What about fences? You could discuss the notion that some fences are actually dog filters! The mention of screen doors might stimulate more discussion.
  - o Asking the students to consider things that filter light may also stimulate more ideas to do with blinds, screens, tinted glass, and the windows of the Ice Hotel, which also features in this issue of Connected.

What You Look For

- Can the students explain what's happening to the muddy water as it passes through the muslin cloth?
- Can they relate this to the way in which the sand sausages work?
- Can they relate the general principles of filtration to other familiar situations that may seem different but are actually similar?

Extension Activity

The students could carry out an investigation into the relative effectiveness of a selection of filtering materials. See Activity 25: Water Filters on page 53 of *Making Better Sense of Planet Earth and Beyond*.

Activity: The Great Sand Structure Competition

A sand structure competition could be a grand finale activity that links the ideas in both "The Ice Hotel" and "The Sands of St Clair".

What You Do

- Discuss important ideas about the structures and materials that have been explored in the previous activities.
  - o Focus part of the discussion on where physical forces act on the structures.
  - o You could record the main ideas on charts for the student builders to refer to and add to throughout the activity.

- The brief for the final structure should be negotiated and agreed upon by the class. Possible specifications could include:
  - o the materials other than sand that can be used for the structure, for example, sheets of cardboard, rocks, twigs, plastic pottles, and egg cartons;
  - o the purpose of the structure – making a sandcastle would be a purely recreational activity, but a more permanent structure could have a landscaping or decorative purpose;
  - o the minimum and/or maximum height for the structure;
  - o the weather conditions that the structure must withstand;
  - o the length of time for which the structure must remain standing;
  - o interesting features that the structure must incorporate:
    - – towers;
    - – multiple storeys or levels;
    - – decorative items or embellishments;
    - – roadways;
    - – flat patches or recesses in which decorations or living plants might be placed;
    - – a water course.
  - o the time limit for building the structure.

You could invite a local builder or landscaper to judge the overall winner and to award special prizes according to key specifications. You could record the building progress with a digital camera and use the images to construct a class book, folder, or wall display that has suitable annotations to document the process and the learning.

What You Look For

- Do the students draw on previously developed ideas about structures, forces, and materials?
- Do they follow the brief, building to the agreed specifications?
- Do they demonstrate creative thinking and problem-solving skills as they develop their sand structure?

How to Drink a Rose

Technological Areas

Food Technology

Materials Technology

(See the Specific Learning Intentions for links to relevant Achievement Objectives and Components of Technological Practice: Brief Development [BD], Planning for Practice [PfP], and Outcome Development and Evaluation [ODE].)

The Specific Learning Intentions

The students will be able to:

- demonstrate their knowledge of the properties of ingredients and understand the implications of those properties when developing new recipes (**AO 1, 2, 6 a–d/BD**);
- develop a brief to guide development work and to help them evaluate the outcomes (**AO 1–8/BD**);
- develop a plan of action to guide their project, taking account of the stages, activities, materials, money, people, and time involved in developing their outcome (**AO 5, 6 a–d/PfP**);
- produce an outcome and evaluate it against the requirements of the brief (**AO 1–8/ODE**).

The Key Ideas

The following aspects of technological practice are exemplified in "How to Drink a Rose". (Your students could use this case study to guide their practice in a wide range of situations. The suggestions here involve them exploring the process of fruit dehydration and then developing new recipes for the dried fruit they've prepared.)

- In the process of developing food products that incorporated rosehip syrup, the students in the article used their expanding scientific and technological knowledge about changing an ingredient's properties as you process it.
- Trial and error (adaptation and refinement) was a key aspect of the students' outcome development. They made well-reasoned plans and predictions – but there was also an element of just giving things a go to see what would happen. The more trials they conducted, the better they became at understanding the behaviour of ingredients and therefore predicting likely outcomes.
- The students came to understand that many ingredients have more than one function in a food product and that these all have to be considered when planning the new recipes.
- The students identified a set of key attributes against which their outcomes could be evaluated.
- They came to understand that, when developing a new food product, you have to balance priorities. In "How to Drink a Rose", the students were able to develop products that were very appetising and yet healthy if eaten in moderation.

Developing the Ideas

In order to focus your students' minds on the important aspects of technological practice exemplified in "How to Drink a Rose", you could discuss the following key ideas after they've read the text.

Developing and Applying Technological Knowledge

In the article, the students used their knowledge of how ingredients behave in familiar recipes to predict how they would work in new recipes that included rosehip syrup. They added to this knowledge as they went and used it to support their evaluation of ideas and outcomes.

Knowledge-based planning isn't fail-safe, of course. Even carefully planned ideas can go wrong and have to be adjusted – but the need for refinement is minimised if you think things through carefully. A plan should provide a flexible framework within which to act. If the students had just rushed in with random ideas, the follow-up adjustments, if possible at all, would probably have involved fundamental rather than minor changes.

Trial and Error

Often we need to try things more than once before we get the result we want. Refining ideas and making adaptations to an evolving recipe can result in very successful outcomes. For example, Megan and Jayden didn't just give up when their first batch of ripple ice cream was unsuccessful. They adjusted their original method by almost freezing the ice cream mixture before adding the syrup. This adaptation was successful. In this process, Megan and Jayden overcame a problem by using their scientific understanding of the properties of both syrup and ice cream.

The Multiple Function of Ingredients

Often an ingredient has more than one function in a recipe. Eggs can be in a recipe for both flavour and texture in, for example, a quiche, or you might not taste them at all because they're only included as a textural/binding agent in, for example, meatballs. Rosehip syrup is also multifunctional. It could be included not only for its taste but also because it has textural, colour, and nutritional qualities.

Some students may have heard that boiling fruits and vegetables destroys the vitamin C. Vitamin C does denature slowly at high temperatures, but most of the depletion in boiled fruit occurs because vitamin C, which is highly water soluble, leaches from the food into the cooking water. The vitamins haven't been destroyed. They've simply changed location. In the recipe for rosehip syrup, all of the water in which the rosehips are boiled stays in the syrup, so the vitamins aren't lost. A small amount of the vitamin C may be destroyed when boiling the syrup, but given rosehips' extraordinary vitamin C content, the loss is not significant. (As a point of comparison, 100 grams of kiwifruit contain approximately 90 milligrams of vitamin C. The same quantity of rosehips contains approximately 2000 milligrams!) For a simple teacher demonstration of a vitamin C test, see the following website. Note that iodine is toxic in solid or gaseous form. Even in liquid form, you should treat it with care, demonstrating its use rather than allowing primary school students to handle it themselves.

www.rmsc.org/museum/kidsclub/experiments/vitaminC/vitaminC.htm

Fruit syrups store well and can be used as preserving agents because few microbes thrive in concentrated sugar solutions. In syrup-making, extra sugars are added, and the natural sugars are also concentrated when the mixture is boiled. One result, which can be viewed positively or negatively, is that the end product is very sweet. This was a great advantage in past times, when food was very scarce over winter and sweet (that is, high-energy) preserves could be a lifesaver. However, in modern times, we don't usually run low on food in winter, and the sugars in preserves can just become excess calories.

In terms of texture, the students observed that rosehip syrup functions differently in different conditions. For example, it semi-freezes when very cold – as Megan and Jayden discovered with their ripple ice cream. Casey's group found that if the syrup is heated for too long, it becomes hard and brittle. Jasper discovered that adding a banana counteracted the thinning effects of adding rosehip syrup to yoghurt.

Establishing Specifications and Appraisal Criteria

The specifications each group developed for their brief provided them with a guide for ongoing evaluation. They evaluated their prototypes and final outcomes against the criteria on a regular basis.

Balancing Priorities

Balancing the priorities of health and taste is an important aspect of food technology. The students came to understand that developers of healthy treats balance the ingredients in terms of those you can eat plenty of and those you should eat sparingly. Many common treats for children are heavily unbalanced in favour of unhealthy ingredients. A good analogy to discuss with young students could be to compare eating a lolly with eating a peach. Both treats contain significant amounts of sugar, but the peach contains natural (unrefined) sugars, and along with those, it provides vitamins, minerals, roughage, and so on. Most lollies provide only a massive hit of refined sugars and artificial flavours. Like the students in “How to Drink a Rose”, health food manufacturers strive for products that are appetising yet nutritious.

Further Activities

Developing Innovative Uses for an Abundant Food or Material

The technological practice described in “How to Drink a Rose” could support students’ projects in a variety of contexts in which they are seeking to develop worthwhile applications for using up an available material. (This situation is the opposite of cases in which the technological practice begins with a product concept for which suitable materials must then be sought.)

Authentic situations might be:

- You have been given a large box of apples, lemons, or bananas that need to be used up before they go rotten.
- The factory down the road has asked your class whether you have a use for offcuts of carpet, packing material, tinfoil, and so on.
- A parent has donated a large quantity of wool to your class.

The following suggestions focus on the first example but could be adapted for a wide range of similar contexts. The notes outline a generalised learning sequence and then provide three activities to support it.

Brief Development

In developing a brief, we need to consider a variety of issues, including our reason for developing the outcome, the availability of facilities and resources, and the necessary skills and knowledge. Most importantly, the brief needs to take account of the people who will be affected by the development or use of the outcome – that is, the stakeholders. In this context, a key reason for developing the outcome is to utilise a large quantity of nutritious fruit that will otherwise go to waste. There should be plenty of useful kitchen equipment on hand, and the students have a basic understanding of this sort of practice from having read “How to Drink a Rose”.

After reading and discussing “How to Drink a Rose”, your students could learn how to dehydrate fruit (see activity 2 below) and then develop interesting recipes in which the dried fruit would be a key ingredient. As part of the brief development process, the students would need to describe the product they wished to make and list (as specifications) the product attributes that they’d be trying to achieve.

Planning for Practice

In planning for practice, students need to consider how to organise the processes, materials, money, people, and time involved in developing an outcome. At an early stage, the students could divide their proposed project into important key phases, such as brief development, researching, prototype development, testing, refinement, and final outcome development. This will make the scoping more manageable for younger students, who may have trouble thinking through all the details needed for planning the project as a whole.

Make sure the students understand that these phases aren’t a “tick list” of consecutive tasks. Rather, they should expect to move back and forth between the phases, perhaps going back for more research when necessary and re-prototyping and testing a number of times to get things right. As their project proceeds in this way, they will need to revisit and adjust their brief on an ongoing basis by adding, removing, or adjusting specifications.

The students should record their initial plans. Encourage them to include simple descriptions of their proposed activities and the associated time, materials, outside help, and other resources. They could record these plans as a bulleted list, a table, or perhaps a simple Gantt chart. (Gantt charts are particularly useful in situations where a number of tasks run concurrently.) Make sure the students understand that these plans are just draft, and they'll have plenty of opportunity for returning to them and rethinking things as their project unfolds.

In "How to Drink a Rose", the students developed recipes by adapting the ingredients and methods used with familiar foods in order to include rosehip syrup. When making the syrup, they developed a lot of new knowledge, so they could base their initial plans on a general understanding of the syrup's properties.

Your students could follow a similar process. After reading "How to Drink a Rose", they could dehydrate some fruits and explore how this process changes the fruit's properties. At this stage, you could prompt them with questions about the fruit's key properties.

- "In what way does the fruit taste different when it's dehydrated?"
- "How will that difference in taste affect the amount you use in a recipe?"
- "Might the flavour change again if we used the dried fruit in recipes that need cooking or other processing?"
- "How could we test out that question?"

They could then plan a process for developing recipes that include dehydrated fruit. They would need to consider the different functions the fruit could have in a recipe. For example, they could use the fruit to enhance the flavour of a favourite food. Alternatively, they might focus on the long shelf-life and light weight of dehydrated fruits and take advantage of these attributes by developing tasty and nutritious recipes for taking on tramps or other such outings. They might be interested in the fact that dried fruit rehydrates easily. This property could make it suitable as a base ingredient for fruit tea or cordial.

Outcome Development and Evaluation

As the students develop their chosen outcome, they should regularly reflect on both the brief and their progress through the plan of action. The brief and plan may need to be adjusted more than once in response to this ongoing evaluation.

This type of ongoing evaluation was evident with all the groups in "How to Drink a Rose". As the students developed their product through trial and error, they reflected on their practice and made adjustments as necessary to achieve the outcome they wanted. These adjustments were possible because of their increasing knowledge and skills.

Teacher–student conversations are particularly critical at this stage. You could pose the following types of open-ended questions to help the students engage in critical thinking.

- "What would happen if …?"
- "Have you thought about …?"
- "Will this help you achieve …?"

Activity 1: Everyday Examples of Food Preservation

Dehydration has been an important means of food preservation since prehistoric times. Today, with refrigeration, vacuum packing, artificial preservatives, and so on, we have more options available for preventing food spoilage, but in many cultures, dehydrated foods are still common. They are often considered special delicacies.

What You Need

Picture sets that show people in different cultures and times gathering, preparing, and eating food (the Michael Leyden series mentioned earlier and the National Geographic series would be good sources for such images).

What You Do

- Ask the students to observe and describe what's happening in the pictures. "What things are familiar to us? What things are different?" Encourage the students to think in broad terms, including social, cultural, technological, and environmental factors.
- After observing and discussing the pictures in general terms, focus the students' minds on food preservation.

  "How long have people been drying food for?"

  "Why do people dehydrate food?" "Are the reasons the same today as they were in the past?" (Seasonal shortages used to be a major reason, but nowadays many people eat dried apricots, bananas, and so on even when the fresh fruits are available.)

  "What could be some advantages of dehydrating food?"

  "What could be some disadvantages?"

  "Do you eat dried food?" "If so, in what situations?"

  "Do you eat other sorts of preserved food?" "If so, in what situations?"

  "Are there any preserved foods you like more than the fresh version?" "Why?"

  "Are there any preserved foods you like less than the fresh version?" "Why?"

What You Look For

- Can the students compare the role of food dehydration today with its role in the past?
- Do they understand that preserving food can change its properties in significant ways?
- Do they mention that there are different reasons for dehydrating food?
- Do they understand that the usefulness of some foods depends on how well they suit the situation?
  - For example, grapes are a traditional food to take when visiting a sick person. Raisins might be more convenient, but many people would prefer fresh grapes if they're unwell.
  - Conversely, we might decide to take raisins on a three-day tramp rather than fresh grapes not because they taste better but because they're lighter to carry and won't spoil.
  - On a day tramp, however, we might decide on fresh grapes because we're not carrying such heavy packs, and the fresh grapes will provide thirst-quenching water along with their nutritional content.

Activity 2: Dehydrating Fruit

What You Need

- Fruit
- Utensils for preparing the fruit
- Dehydrators

(Dehydrators are readily available, moderately priced, very reliable, safe, durable, and easy to use. Alternatively, you can use an oven on a very low temperature or, in summer, dehydrate fruit in a very sunny spot in the classroom. There are many websites offering useful information about do-it-yourself dehydration. Whichever method is used, ensure that food safety and hygiene procedures are carried out.)

What You Do

- At the beginning, demonstrate safe cutting practices and discuss the preparation of fruit.

  "Why does some fruit go brown after it's cut?"

  "Does it look appetising if it's brown?"

  "How do you think we could stop it browning?"

- Have the students experiment with dehydrating a variety of fruits. (Apples, kiwifruit, nectarines, and bananas are particularly successful, but be adventurous! For example, try mangoes, coconut, and pawpaw.)
- Place the fruit in the dehydrator and leave for it several hours (overnight, if possible).
- The most exciting part is when the students open the dehydrator and see their fruit. The shrinkage is phenomenal.

  "What might have made the fruit shrink?"

  "Could we make it go back to its original size?" "How?"

  "Do you think it would taste the same as it originally did?"

  "What other foods could be dehydrated?"

What You Look For

- Can the students explain the process of dehydration in both procedural and scientific terms?
- Do they understand and follow the safety and hygiene procedures needed for the task?

Activity 3: Sensory Testing

Once the students have dehydrated their fruit, they should taste-test it. A visiting food technologist could help the students understand how new food products are taste-tested and why it's an important aspect of food product development. Make sure the students understand that this exercise is intended to inform their upcoming development of a new recipe.

What You Need

- A station set-up, with a selection of dehydrated foods at each station. (You may wish to present only fruits, or you could expand the scope to include other dehydrated foods, such as jerky or pasta.)
- A chart at each station on which to record appearance, smell, texture, and taste. (Make sure that tasting is the last task, otherwise you'll find you have no recordings for the other attributes!)

What You Do

- Discuss the senses used for enjoying food. Food needs to look and smell good as well as taste good. Collate a table of attributes, asking the students to suggest a useful range, for example, taste, smell, appearance, and texture.
- For each attribute, ask the students to provide a useful range of descriptors, for example, taste: sweet, sour, salty, bitter.
- In pairs or small groups, ask the students to carry out some sensory tests and record their findings on a chart. Begin by outlining the hygiene guidelines that apply to taste testing. In particular, stress the importance of clean hands. It's also important not to share foods or cutlery. (Allergies are another health and safety issue. It will be important to check that the students aren't allergic to any ingredients in the recipes they later develop.)
- The groups can then carry out the tests and share their findings with the class. Encourage the class to compare the groups' findings to determine what the favourite dehydrated foods were.

"What attributes made these foods popular?"

"What attributes made other foods less popular?" "Could these foods be improved by combining them with others that have different attributes?"

"When would it be a good idea to dehydrate food?" "When would it be better not to?"

What You Look For

- Can the students describe each dehydrated food in terms of multiple attributes?
- Do they take this information into account when they develop their recipe?
- Do they realise that sometimes it's advantageous to dehydrate food but sometimes it's not? Can they give examples of situations in which the advantages of dehydration outweigh the disadvantages and vice versa?

Useful References

The following resources explore, in other contexts, the key aspects of technological practice exemplified in this article.

Brief Development and Planning for Practice

The New Zealand Curriculum Exemplars: *Technology* (Learning Media, 2003, or **www.tki.org.nz/r/assessment/exemplars/tech/index_e.php**)
Level 2, Kidzdough

Developing and Applying Technological Knowledge

The New Zealand Curriculum Exemplars: *Technology*
Level 3, Too Much Citrus
Level 1, Cameron's Pterosaur
Level 3, Curious Cook

Michael Leyden Picture Series (Michael Leyden Publications, Auckland)
Family Interaction (1997) – Helping with the Hāngi
Living in the Cook Islands (1996) – Going Fishing
Food Production Processes and Occupations (2000) – From Paddock to Plate

Trial and Error

Techlink Case Studies (www.techlink.org.nz)
A Bit on the Side
Big Bikkie

The Functions of Ingredients

The New Zealand Curriculum Exemplars: *Technology*
Level 1, Muffins for the Visitors

Techlink Case Studies (www.techlink.org.nz)
A Bit on the Side

Establishing Specifications and Appraisal Criteria

The New Zealand Curriculum Exemplars: *Technology*
Level 1, Personal Posters
Level 2, Earthquake Damage Control

Nailing It Down

Possible Achievement Objectives

Mathematics

Number

- Demonstrate the ability to use the multiplication facts (Exploring computation and estimation, level 2).
- Write and solve story problems which involve whole numbers, using addition, subtraction, multiplication, or division (Exploring computation and estimation, level 2).
- Make sensible estimates and check the reasonableness of answers (Exploring computation and estimation, levels 1 and 2).

Measurement

- Carry out practical measuring tasks, using appropriate metric units for length, mass, and capacity (Estimating and measuring, level 2).

Developing the Ideas

Multiplication is a short form of addition, as skip-counting reveals. In the story, Jono suggests marking out the entire fence in paling widths and then counting the number of marks. With his father's help, he is able to use the information that 5 palings are needed per metre to calculate the number needed for the entire fence. The fence scenario is one that most students will relate to.

Links to the Number Framework

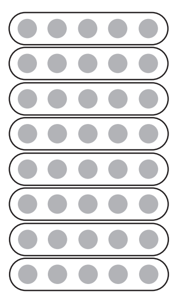
The scenario around which this story is based provides a context for assisting students who are ready to move from Stages Two or Three (Counting from One on Materials and Counting from One by Imaging) to Stages Four or Five (Advanced Counting [Counting On] and Early Additive Part–whole). The scenario and context can easily be varied to allow for practice at different levels of difficulty.

Students working at Stage Two (Counting from One on Materials) may need support imaging bundles of 5 palings and skip-counting them. To help them with this, lay out 8 bundles of iceblock sticks, with 5 to a bundle, and then have the students skip-count in 5s, using the bundles:

5, 10, 15, 20, 25, 30, 35, 40 iceblock sticks (8 x 5 = 40)

1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = 8 bundles (8 x 1 = 8)

It's important to stress the link between skip-counting 8 bundles of 5s and the expression of this operation in the form 8 x 5: "Eight bundles of 5 iceblock sticks equals 40 sticks altogether." Students will find it helpful if you show or remind them that 8 bundles of 5 can be represented as an 8 x 5 array:



8 x 5 = 40

Vary the number of bundles of sticks to create different skip-counting exercises, then remove the sticks as students gain confidence.

Another way of helping students learn to skip-count by imaging is to have them create a number line with the skip steps highlighted or written in a different colour, as below. (The students could also lay the iceblock sticks along a number strip.)

Skipping in 2s

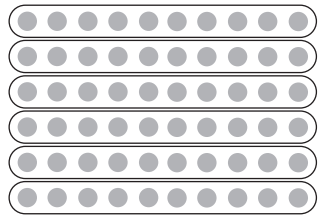
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 →

Skipping in 5s

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 →

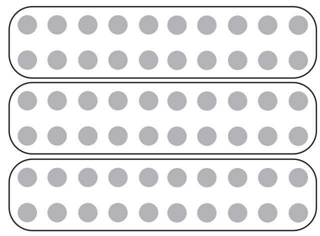
Students can use a variety of counting strategies to work out the number of palings needed to fill in the remaining 60 centimetres of fence. Encourage them to see that they can easily adapt skip-counting in 10s and be skip-counting in 20s:

60 = 10 + 10 + 10 + 10 + 10 + 10. (6 x 10 = 60). This can be read as "Six groups of 10 palings equals 60 palings."



6 x 10 = 60

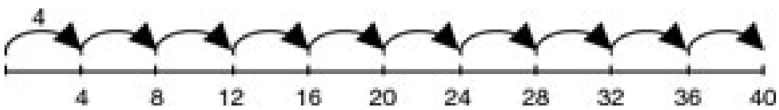
60 = (10 + 10) + (10 + 10) + (10 + 10) = 20 + 20 + 20 = 3 palings. (3 x 20 = 60). This can be read as "Three groups of 20 palings equals 60 palings." Again, both these multiplications can be modelled as arrays.



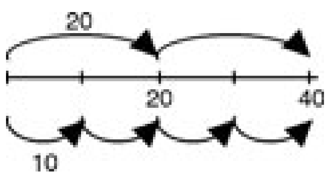
3 x 20 = 60

To give students further confidence in calculating the number of palings required, have them work with different lengths of fence. For example, how many fence palings will be needed for a fence that is 4 metres and 80 centimetres long? It could be a useful exercise to let the students measure the length of the school's front fence and determine how many of Jono's palings would be needed if the fence were to be replaced.

To discover how many nails are needed, students again need to use skip-counting and repeated addition. The number line shows skip-counting in 4s to find how many nails are needed for 10 palings. The process could equally well be represented by a 10 x 4 array.



An alternative is to begin by considering just the tops of the palings. In this case, we have 2 nails to each paling. So 10 palings will have 2, 4, 6, 8, 10, 12, 14, 16, 18, 20 nails (a simple case of skip-counting in 2s). But the palings need to be nailed at the bottom too, so 10 palings will require double this number of nails: 20 + 20 = 40 (or 4 x 10) nails. On a number line, the counting in 20s can be represented like this:



Alternatively, consider using an array.

There are (4 x 10) + 3 palings, and so the nails could be calculated by means of skip-counting in forties and fours:

40, 80, 120, 160

4, 8, 12

160 + 12 = 172

The number of nails needed can also be calculated by using repeated addition or by doubling and then doubling again:

40 + 40 + 40 + 40 + 4 + 4 + 4

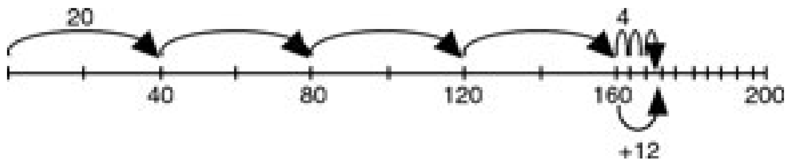
= (40 + 40) + (40 + 40) + 12

= 80 + 80 + 12 (part–whole strategies would be useful at this point)

= 160 + 12

= 172

On a number line, the process can be represented in this way:



Using the same context, you could have students work out the length of fence that a particular number of palings would cover, or the number of palings that could be fastened by a particular number of nails.

Further Activities

As a follow-up to this exercise in determining quantities, you could give your students a practical task, such as working out the number of 0.5 metre x 0.5 metre carpet squares it would take to cover the floor of their classroom.

The task could be carried out either by measuring the length and width of the room with a metre rule or tape or by using a square of paper or cardboard cut to the size of a single tile. If the room is about 6 metres x 8 metres, it will take 12 tiles to complete a single row along the short side and 16 along the long side. This means that it will take 12 rows of 16 tiles to cover the floor. The situation presents itself as an array. Students calculate the number of tiles needed using any combination of skip-counting or doubling strategies but not by counting in ones. Students can practise using similar strategies to find the number of tiles stuck on a bathroom wall, the number of seats in a theatre, and in countless other situations where items are set out in the form of a rectangular array.

Your students may be interested to know that there are professionals known as quantity surveyors. Their responsibility is to help construction companies (especially those involved in large projects) to accurately plan how much of each item is needed to create or complete the project. This is a very important role as it helps the company to cost the job accurately and to get the best prices from suppliers by buying in bulk rather than going back again and again for more of the same thing. If you have students who are interested in building or construction, you could challenge them to find out more about what a quantity surveyor does and then to report back to the whole class.

For further activities that focus on skip-counting in a variety of contexts, see also *Number*, Figure It Out, Levels 2–3, page 6 (skip-counting building-blocks in a tower) and pages 14–16 (skip-counting the seats in an aeroplane, the wheels on a number of vehicles, and the stepping stones over a stream). "Out of Step" by Vince Wright (*Connected 1 2002*) is a story about various animals jumping across a canyon on stepping stones. The skip-counting involves the additional challenge of taking into account the fact that, because the stepping stones are crumbly, each can take only a certain number of landings before collapsing.

What's for Lunch?

Possible Achievement Objectives

Mathematics

Statistics

- Collect everyday objects, sort them into categories, count the number of objects in each category, and display and discuss the results (Statistical investigations, level 1).
- Collect and display category data and whole number data in pictograms, tally charts, and bar charts, as appropriate (Statistical investigations, level 2).
- Talk about the features of their own data displays (Interpreting statistical reports, level 2).
- Make sensible statements about the situation represented by a statistical data display drawn by others (Interpreting statistical reports, level 2).

Developing the Ideas

This story poses an interesting question that is open to statistical investigation: *Do girls have better eating habits than boys?* The story goes on to explore how a group of students could gather appropriate data and, by using it appropriately, try to answer the question. Given the context, the story could be used as part of a unit of work on nutrition.

Initial discussion (which could be either whole-class or small-group) could focus on what the students in the story did and why. Further discussion could consider whether the aim of the exercise was achieved and what could have been done differently or better.

If your students are not yet familiar with the statistical enquiry cycle, use this story as a basis for introducing it. Its four steps should be used to structure every statistical investigation. The steps are:

1. Pose the question.

In this case, the question is not explicitly posed. Ask your students to work out what it is and to write it down. Then get them to justify, change, or refine it as they participate in whole-class discussion.

2. Gather data.

Data is the raw material of any statistical investigation. "Interrogating" it (asking questions of it) reveals the stories it has to tell. But these stories will only be true if the data is what it claims to be.

Encourage your students to think critically about the data gathering as described in the story. Is the data collected *quality* information? Students may be able to raise questions such as these:

- Will those surveyed be able to sort their food into the correct category? (Is the meaning of words like "lean", "etc.", or "wholegrain" sufficiently clear?)
- Does the idea of a "serving" (a non-standard unit) make sense, and does it mean the same to each person?

3. *Sort and display data.*

The information about student lunches forms a jumble until the food items are sorted and recorded. The sorting and displaying processes are aimed at revealing features and patterns. It is these features and patterns that tell us where to look for the story or stories. Appropriate graphs allow others to read these stories for themselves – maybe even stories the maker hadn't noticed were there.

The students in Mr Kenna's class collect and summarise their data in tally charts, which are a convenient way to collate small amounts of data. Then they convert their tallies into numbers (which are frequencies or counts). At the end of the week, Mr Kenna collects the data from each individual, and a group of students collate it in the form of a whole-class database.

The story does not go into this level of detail, but the whole-class information should be collated in a way that preserves the original data for each student. Here is one possibility:

		Lunchtime eating survey (Girls' data)											
Student		**Name 1** (or a number)						**Name 2** (or a number)					
Day		M	T	W	T	F	TOT	M	T	W	T	F	Total
		Servings						Servings					
Pyramid category	Top	1	3	$2\frac{1}{2}$	3	2	$11\frac{1}{2}$						
	Middle	3	2	$1\frac{1}{2}$	4	2	$12\frac{1}{2}$						
	Bottom	$2\frac{1}{2}$	3	2	1	$3\frac{1}{2}$	12						

The challenge of collating the class information in a database highlights the complexity of working with a surprising number of variables (servings, pyramid category, gender, student, day). If students go on to replicate the kind of investigation carried out in Mr Kenna's class, they should discuss for themselves the best way of managing the task and be encouraged to come up with their own system.

Once the students in the story have collected and collated the data, it is displayed in two forms: a traditional bar chart and a variation on a bar chart that resembles a pyramid.

Have your students discuss in their groups the method used to transform the original bar chart into the pyramid (cutting and rearranging). Ask them to explain how they know that the rearrangement doesn't destroy the information. (The length/area of the bars is what matters. This attribute doesn't change when the bars are cut up and organised differently.)

When your students draw graphs, encourage them to design their own, including the labels. Class discussion will reveal which graphs are most effective.

4. *Communicate findings.*

It is very important for students to learn that a statistical investigation is not finished the moment a graph has been drawn. In this final stage, they look at their representations of the data and ask themselves what, if anything, they can conclude. Does the data gathered contain information to answer the question posed at the beginning? How certain can they be about this? Does their investigation give them answers to questions that they didn't ask? Conclusions can be written up or conveyed orally. Students should also critique their investigation. Mr Kenna's class have an informal discussion at the conclusion of their investigation. Could they have done better?

A Real-life Nutritional Investigation

Your students could explore the question *Do girls have better eating habits than boys?* for themselves, starting with data gathered in a snap survey. This would provide baseline data, which could then be used in conjunction with later surveys to show whether any change in lunch-eating habits has occurred over time.

The exploration should follow the statistical enquiry cycle.

If you do this, work through an example with the class before they fill in their charts. As far as possible, the students need a common understanding of what is meant by a serving; they also need a common approach to classifying composite foods such as filled rolls, which are made up of components from more than one food group.

There is no need to collect names with data. Although the students probably know the lunch-eating habits of their classmates, they may not want them to be given unnecessary publicity. It must however be clear, given the question being investigated, which data comes from boys and which from girls.

The tally marks could be collated in two tables on the whiteboard or an OHP. If your students are new to fractions, you should check that they understand the meaning and use of "$\frac{1}{2}$". The half marks are a little inconvenient but can easily be managed if gathered together in a row of their own, as in this example:

Boys		
Pyramid group	**Tally**	**Servings**
Sweets, fats, etc.	~~||||~~ ||| $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	9 $\frac{1}{2}$
Fish, low-fat dairy, etc.		
Fruits, vegetables, wholegrain foods, etc.		

There are a number of ways in which the data could be displayed in double histograms (combining the boys' and girls' data) or in single histograms (presenting each gender's data separately). The following two options have the advantage that their shape can more easily be related to the food pyramid:

- a stacked strip graph, as shown in the story;
- symmetrical, stacked pictographs made using counters or place value blocks, like this:

Pictograph 1 [girls]

@@@@@@@@@@@@@@@@@@@@	Sweets, fats, etc.
@@@@@@@@@@@@@@@@@@@@@	Fish, low-fat dairy, etc.
@@@@@@@@@@@@@@@@@@@@@@@@@@@@	Fruits, vegetables, etc.

Pictograph 2 [boys]

@@@@@@@@@@@@@@@@@@@@@@@@	Sweets, fats, etc.
@@@@@@@@@@@@@@@	Fish, low-fat dairy, etc.
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@	Fruits, vegetables, etc.

However the students represent the data, the discussion needs to focus on shape and on how this shape relates to the pyramid ideal. Taking the data as a whole, is there enough evidence to answer the question posed at the beginning, *Do girls have better eating habits than boys?* If your students conclude that the evidence favours the girls, what might be the reasons for their better lunchtime eating habits?

A class investigation of this kind could lead to a wider investigation involving other classes. This would enable comparisons between classes and between age levels. You could consider changing the focus of the investigation to, for example, consumption of soft drinks, sugar-laden products, or fast food. The links between such foods, lack of exercise, and obesity are also worth exploring in detail.

Further Activities

Students can learn from an early age to ask questions about statistical methodology and the validity of conclusions. Here are some suggested areas for discussion and further work:

- If the class does not have equal numbers of boys and girls, what does this do to the data? Should we compensate for this, and if so, how? A simple way of compensating for more girls than boys would be to survey all the students but put the girls' results in a hat and pull out the same number of data sets as there are for the boys. Only these randomly selected girls would contribute data to the survey. Other methods of compensating for unequal numbers are likely to involve ratios.
- The food pyramid is intended to guide people about their diet. A person's diet is their overall pattern of consumption. Are the students' lunchtime eating habits necessarily a good indicator of their total diet? Perhaps they eat sugary foods at school but lots of fruit and vegetables at home. How might students explore this issue further?
- What influences determine students' lunchtime eating habits? (Parents, peers, convenience, advertising, knowledge about healthy eating?) Is this subject open to statistical investigation? If so, how might the students design a qualitative survey to gather appropriate data?

For many relevant activities, see *Statistics*, Figure It Out, Levels 2 and 3.

Links to the Number Framework

The skills required for the collation of individual data are Stage Five (Early Additive Part–Whole). Adding tally marks grouped in 5s is a form of skip-counting (Stage Four), but students also need to be able to work with the fractional form "$\frac{1}{2}$".

Compiling and working with the whole-class database will require Stage Six (Advanced Additive Part–Whole) skills.

Acknowledgments

Learning Media and the Ministry of Education thank Mary Loveless, School of Education, The University of Waikato, for writing the notes for "The Ice Hotel" and "The Sands of St Clair"; Brenda Weal, Faculty of Education, The University of Auckland, for writing the notes for "How to Drink a Rose"; and Ken Benn, freelance consultant, for writing the notes for "Nailing It Down" and "What's for Lunch?". Thanks also to Barbara Benson, Dunedin College of Education, for reviewing the science notes; Dr Vicki Compton, Faculty of Education, The University of Auckland, for reviewing the technology notes; and Lynn Tozer, Dunedin College of Education, and Mike Camden, STATSNZ, for reviewing the mathematics notes.

Series Editor: Rupert Alchin
Maths Editor: Ian Reid

Published for the Ministry of Education by
Learning Media Limited, Box 3293, Wellington, New Zealand.
www.learningmedia.co.nz

ISBN 0 7903 1249 1
Item number 31249
Students' book: item number 31056