“Staying Warm, Keeping Cool”

While *Connected* 1 2010: *Staying Warm, Keeping Cool* includes five articles, they are well integrated and flow well in sequence. The teacher support materials have been developed to relate to specific science, technology, and mathematics strands. Within each learning area, much of the material has been written as a set of common activities that link all the texts in a holistic way. Focus on one learning area or integrate them to meet the needs of your students. Teacher support materials for each learning area includes a discussion of the key ideas, suggested achievement objectives, activities you can use with your students to explore those ideas, and useful resources.

Science in “Staying Warm, Keeping Cool”

Possible achievement objectives

Nature of Science

Communicating in science (CiS)

L1 and 2: Build their language and develop their understandings of the many ways the natural world can be represented.

Material World

Chemistry and society (C&S)

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

Living World

Ecology (E)

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

Physical World

Physical inquiry and physics concepts (PI&PC)

L1 and 2: Explore everyday examples of physical phenomena, such as movement, forces, electricity and magnetism, light, sound, waves, and heat.

Key ideas

Nature of Science

- Scientists identify trends and patterns when exploring natural phenomena.
- Scientists use the trends and patterns to generate questions whose answers will help them create explanations.

- Scientists check their explanations by testing their evidence.
- Scientists record and share both their explanations and the processes they used to test their ideas with other scientists and with the general public, as well as using them to solve problems and needs.

Physical and Material Worlds

- Energy comes in many forms, one of which is heat energy.
- Heat energy is converted from other types of energy, including the energy that is provided by food.
- Heat energy flows from where it is warmer to where it is cooler.
- What insulating materials are made of and where they are located influence the rate at which heat energy flows.
- Scientists and technologists use their knowledge of the physical and chemical properties of materials when seeking explanations and solutions to problems caused by changes in temperature.

Developing the ideas

Learning goals (to be shared with your students)

In this activity we are learning to:

- explore and explain natural phenomena in a scientific way (CiS)
- identify and test the evidence we use to inform our explanations of what is heat energy, how it is generated, and how insulating materials can be used to control its movement (PI&PC)
- explore and investigate the insulating properties of readily available materials (C&S/PI&PC)
- make connections between the science ideas and concepts we are exploring and our everyday lives (P&C)
- explore how scientists and technologists apply their understanding of the properties of materials and heat energy to develop insulating products and processes that help people to cope with changing temperatures (P&C).

The following activities and suggestions are designed to be used as a guide. Choose from them to support students to develop scientific explanations of the phenomena involved and processes used to control the rate of flow of heat energy from warmer to cooler areas. There are two stages to this approach.

Stage one: The exploratory phase

The main purpose of the exploratory phase is to allow the students to develop an understanding of the following concepts.

- What is heat energy?
- How does heat energy flow?

- How do animals, including people, conserve or maintain their body temperature?
- How can different materials be used to control the rate that heat energy moves from one area to another?

During the exploratory phase, the students actively participate in a number of hands-on interactive activities that allow them to explore the phenomena and clarify their existing thinking. Scientist's explanations are shared with the students as they seek answers to the spontaneous questions that arise. As the students take part in the activities, encourage them to identify any trends and patterns they can see. At this stage, encourage them to generate and record tentative explanations for the phenomena. Support the students to become familiar with the scientific terms and vocabulary and to use them when communicating their thinking about the phenomena involved.

Exploratory activities for investigating and clarifying students' thinking about heat energy and insulation

What is heat energy and how does it move?

Read page 2 of "Warming Up, Cooling Down" with the whole class and lead a discussion about Freddie's experiences. Encourage the students to share similar experiences that they have had. Establish that Freddie was trying to keep warm when he curled up in a tight ball and pulled the quilt over himself. Ask: *What would have happened if Freddie did not curl up and cover himself? Where would the warmth go?*

Establishing that heat energy moves from one area to another

Give the students a glass marble each and tell them to hold it gently against their cheeks. Then tell them to place the marble on the floor beside them. Ask them to discuss what they felt. (Most students will say the marble felt cold.) Explore their thinking behind the responses. (Some will say the marble made their cheek cold.) Next, ask them to pick up the marble and rub it between their hands before again placing it against their cheeks. Again explore the ideas they express about what caused the change. *What warmed the marble? Where did the heat energy come from?* Establish with the students that when the marble appeared to be cold on their cheeks, this was caused by heat energy moving from their cheek to the marble. The heat energy moved to the marble by a process called conduction. The loss of heat energy from the surface area of the cheek made the cheek feel cold. The same phenomenon occurred when they rubbed the marble in their hands. The heat energy moved from their hands to the marble.

Repeat this activity with a variety of objects, such as metal spoons, plastic spoons, plastic pegs, wooden pencils, ice block sticks, rubber erasers, paper, and fabric. Establish that some objects allow heat to move more quickly than others and that these are better conductors. Ask the students to identify and record the properties that may affect a material's capacity to conduct heat energy.

Exploring rates of conduction of heat energy

In this activity, the students explore how different materials slow down or speed up the transfer of heat energy. They investigate the changes that occur when different materials come in contact with a heat source.

Choose a range of rigid sample materials similar to those used in the activity above. Place a small blob of butter or margarine on one end of each sample before putting the other end in a container of hot water. (The hot water should only partly cover the material.)

Ask the students to draw a chart with four columns. In the first column, ask them to record the material the sample is made of. In the second column, they should record a description of the temperature of the material. *Does it feel warm, cold, or at room temperature?* In the third column, ask the students to predict what will happen to each sample when it is put into the water. In the fourth column, ask them to record any changes that occurred and the times when the changes began.

The students can also draw or photograph any changes that happen to the butter or margarine over time. (A fuller description of this activity is found in the Building Science Concepts Book 36: *Heat on the Move*, page 13.

Talking about the results

Discuss with the students which material(s) conducted the heat most quickly and which material(s) could be used to slow down heat transfer. In groups, have the students make a list of everyday materials and identify whether they think each material will be a good conductor of heat energy or would be better as an insulator to slow down heat energy transfer.

Probing students' thinking

Tell the students this story.

"Paul and Maria were going to the diary to buy five iceblocks. Their mother told them to ask the shopkeeper to wrap the iceblocks in newspaper before they put them in their bag to take home.

On the way to the dairy, Maria thought about wrapping the iceblocks in newspaper. It worried her a little. If she started to get cold, she would put a sweater on to keep herself warm. Wouldn't the iceblocks get warmer and melt if wrapped up in newspaper and placed in a bag? Maybe she shouldn't ask the shopkeeper to wrap up the ice blocks at all. Maybe she should just take them home in their plastic wrappings."

Ask the students: *What do you think would happen to the iceblocks if they weren't wrapped? Would they stay the same or start to melt as they were carried home? What do you think are the reasons their mother asked for them to be wrapped?*

How can we be sure of who has the correct thinking? If we want to think and act like a scientist, we need evidence to support our thinking. What can we do to collect evidence that will allow us to explain to Maria why her mother wanted the iceblocks wrapped?

This story provides an authentic context for the students to plan and carry out investigations to test Maria's and her mother's thinking. The students can use newspaper and iceblocks to test what happens when the ice isn't covered with paper, and when it is.

This test can be extended to study other variables, including using different materials, increasing the number of layers of covering materials, and using chilly bins or cardboard boxes filled with other materials.

Keeping our temperature just right

The following activities explore how some animals, including humans, have life processes that enable them to monitor and control the exchange of heat energy so that they can survive when there is a change in temperature in the environment.

Controlling body temperature

Some animals, including humans, are warm blooded. That means their bodies need to stay at a similar temperature all the time.

The article "Warming Up, Cooling Down" describes how humans, huskies, and seals have natural processes or features that enable them to warm up when it gets colder or cool down when it gets warmer.

After reading the article "Warming Up, Cooling Down", discuss the following exploratory questions with your students.

What physical features do humans, huskies, and seals have that allow them to respond to changes in the environment that may affect their body temperature? What role does air play in helping animals regulate the flow of heat energy from their bodies as they respond to temperature changes?

Working in groups, the students can reread "Warming Up, Cooling Down" to check and record the answers to the above questions on a chart or table. Each group could be asked to draw a diagram of one of the heat transfer processes discussed in the article.

Probing students' thinking

Tell the students this story.

"Ethan and Hera went on a skiing holiday. They stayed in a ski lodge that had bunk beds. The weather was very cold. The lodge was heated by a large open fire which they were told would keep burning most of the night. Ethan was still cold so he decided he would go to bed early. He climbed up to the top bunk, which was just below the ceiling. He lay there quietly, feeling warm and cosy, and drifted off to sleep."

Ask the students to reread "Trapping heat energy in the home" on page 8, and then explain, using a diagram and symbols, what they think made Ethan choose to sleep in the top bunk. To cue them into the process you want them to focus on, you could ask *What knowledge about heat transfer did Ethan use?*

Exploratory activity to introduce the article "Heat Thieves"

"Heat Thieves" introduces the phenomenon of wind chill and the impact that the speed a person is travelling has on their body temperature. It goes on to explore the significant role a process like evaporation can have on our body temperature if we spend time in wet clothes. Heat energy is required for evaporation of water to take place. When the water evaporates from our clothes, the heat energy is drawn from our skin and passes through the clothes to the air outside. If a wind is blowing, the evaporation rate will increase as will the amount of heat energy drawn from our bodies.

Many sportsmen and women need to know which way the wind is blowing before starting to play a game. On a windy day, they can hold up a flag or a handkerchief and watch which way it blows. But what can they do if there is only a very gentle breeze? The experiment with wet hands and a fan described on page 30 offers a clue.

Take the students outside and ask them to wet one of their fingers by sucking it for a few moments, then to hold it upright and still, above their heads.

Ask *What do you notice?* Facilitate a discussion of what is happening.

If there is any movement of air, one side of their fingers will feel cool. It will be the side that the air is moving towards. As explained above and on page 30, the moisture is evaporating and the heat energy is passing from their fingers to the moving air. The stronger the wind, the quicker the rate of evaporation will be.

Stage two: Testing our evidence

During this stage, the students plan and carry out scientific inquiries that will allow them to test the evidence they used to inform their explanations. At levels 1 and 2, these inquiries can be carried out as whole-class activities. It is important that the processes they use and their thinking about their findings are communicated and evaluated by other members within the class and school community.

Further activities

Revisiting "Warming Up, Cooling Down"

Ask the students to suggest other ways that Freddie might have been able to keep warm. Make a list of suggestions. These may include putting on extra blankets or putting on his socks, dressing gown, or track suit. The students may suggest that he turn on the electric blanket or fill up a hot-water bottle. Investigating how a hot-water bottle works provides an authentic context for introducing how to plan and conduct the exploratory and evidence-testing stages of a science investigation.

Revisiting "Investigating Insulation"

What happens to the hot-water bottle overnight? Establish that it goes cold. The heat energy moves from the bottle and spreads out until it is at the same temperature as the surrounding material. Ask the students to suggest ways they could make the hot-water bottle stay warm longer. *What do we do if it's cold outside and we want to go out? We put on a jersey. Can we do the same to the hot-water bottle? What materials could we use to insulate our hot-water bottle? How do we know if they will work and which materials will keep the water warm the longest?*

Ask the students to think about how they could test their ideas. Have them read "Investigating Insulation" on page 23. Ask the students: *Does this article suggest ways we can go about finding out what are the best materials for insulating a hot-water bottle? Can we do a similar experiment?*

As a class, identify the stages of an investigation. You could follow the model used in the article, a model from a Building Science Concepts book or your school's inquiry model.

It's important that the students participate in the investigation in small groups. As they investigate, record what they predict might happen and what they observe did happen. At levels 1 and 2, this recording could be done by the teacher and later presented to the whole class. It can be recorded directly onto a slide presentation or as a large book.

Revisiting "Heat Thieves"

Together reread pages 30 and 31 of the article "Heat Thieves" and focus on the explanation of why a person who stays in wet clothes and lets the water evaporate will get very cold. Suggest that the students could use this idea to see if they can make their soft drink colder by using the evaporation and cooling process.

They will need some material to cover a bottle or a can of drink, a place to hang it in the shade, and time for it to evaporate.

Remind the students to think about the properties of the material they choose to use. *You need a material that will absorb water and a place where you can hang the bottle or can so that the air can circulate around it.*

When they have chosen their material, ask them to identify the properties that help it work. *Is it smooth or rough? Does it have air trapped in it?* Then let them test it, collecting all the evidence that they will need to convince a buddy that they can use evaporation to make their soft drink cold on a hot day. Remind them that they must work like a scientist. Prompt them to work systematically, make repeated measurements, record data accurately, and look for trends that might indicate changes.

Remind them to keep a record of all the materials they tried and to share what they found out with their buddy or with the other members of their group.

Ministry of Education resources

Making Better Sense of Physical World, pages 55–64. The unit titled Exploring the Energy We Can Feel provides a range of exploratory, hands-on activities that are very suitable for supporting the ideas expressed in the *Connected* articles. Informative teacher support materials describe the key ideas involved.

These Building Science Concepts books explore heat energy and insulation:

Book 14, *Making Porridge,* item number 12631

Book 36, *Heat on the Move,* item number 12653

Book 46, *Keeping Warm,* item number 12663

Book 47, *Insulation,* item number 12664

Book 48, *Fabrics,* item number 12665

Further resources

Websites

A number of practical hands-on activities that focus on insulation are available on http://digistore.tki.org.nz

Investing heat transfer by conduction on the Science Is website

http://www.tki.org.nz/r/science/science_is/activities/isact_heat_transfer_e.php

Technology in "Warming Up, Cooling Down" with links to "Making Clever Clothes"

Possible achievement objectives

Nature of technology

Characteristics of technological outcomes (CoTO)

- L1: Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature
- L2: Understand that technological outcomes are developed through technological practice and have related physical and functional natures

Characteristics of technology (CoT)

- L1: Understand that technology is purposeful intervention through design
- L2: Understand that technology both reflects and changes society and the environment and increases people's capability.

Key ideas

- Technology involves people making "things" for an identified purpose.
- Technological outcomes have physical attributes and functional attributes.
- The physical attributes are related to the functional attributes (and vice versa). For example, Freddie's clothes are light, making them easy to move in.
- Technological outcomes, such as clothing and housing, develop differently because of the environment they are designed and made for.
- Technological outcomes, such as clothing and housing, help people do things that would be difficult to do without these outcomes.

Developing the ideas

Technological outcomes

Learning goals (to be shared with your students)

We are learning to:

- identify technological outcomes that people have made in the article "Warming Up, Cooling Down" (CoTO)
- describe technological outcomes in terms of their physical and functional attributes (CoTO)
- identify how particular technological outcomes have been designed and made (CoT)
- identify the environment issues that have influenced the attributes of particular technological outcomes (CoT).

Identifying and describing technological outcomes

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

- identify technological outcomes that people have made in the article "Warming Up, Cooling Down" (CoTO)
- describe technological outcomes in terms of their physical and functional attributes (CoTO).

The article "Warming Up, Cooling Down" talks about both technological outcomes and non-technological outcomes.

> *Technological outcomes are defined as fully realised products and systems, created by people for an identified purpose through technological practice. Once the technological outcome is placed in situ, no further design input is required for the outcome to function. Taking this definition into account, technological outcomes can be distinguished from natural objects (such as trees and rocks etc), and works of art, and other outcomes of human activity (such as language, knowledge, social structures, organisational systems etc.)*
>
> (http://www.techlink.org.nz/curriculum-support/indicators/nature/level2.htm)

Students should be able to distinguish technological outcomes from non-technological outcomes. Key ideas to establish are:

- people make outcomes (products or systems)
- outcomes are developed for a particular purpose through technological practice (see the following key idea).

Discuss these ideas with the students, using examples from the classroom environment. Classify these outcomes into two groups – technological outcomes and non-technological outcomes. Discuss why they belong in each group. Ask students for further examples and get them to explain why they think their example belongs in the selected group. Create a table like the one below on a whiteboard.

Things that are technological outcomes	Things that are not technological outcomes
pencil	people
muesli bar	the sun
computer	a feather
chair	trees

Read the article and ask the students to list items in the text that they think are technological outcomes. Ask them to justify their classification. Challenge them by asking: *Are Freddie's trousers a technological outcome? Why or why not? What about Aput's trousers? Why or why not? Is the polar bear's fur a technological outcome?*

After some practice in recognising technological outcomes, students can move on to describing these outcomes in terms of their physical and functional attributes (CoTO level 1). For example, a pencil tip is pointy (physical attribute) to make thin lines (functional attribute). Freddie's trousers have elastic at the ankles (physical attribute) to keep the warm air from escaping (functional attribute).

Use a graphic organiser, such as that below, to guide your students in their analyses. The first few examples could be discussed by the class, and students could then complete the chart in smaller groups or independently.

Technological outcome	Physical attribute/s	Functional attribute/s
quilt	flat rectangular shape, made of layers of fabric (fibre), multi-coloured	covers a bed, insulates body heat, recycles small pieces of fabric, looks decorative
parka	made of animal skins, no buttons or zips	
polypropylene hat		

The students can then progress their understanding by identifying and explaining the relationship between physical and functional attributes (CoTO level 2). As a class, choose two or three objects that have been described in the graphic organiser. Encourage the students to question why a technological outcome has the physical attributes it does. For example, ask: *Why does the chair seat have round edges? Why do the soles of shoes have patterns on them?*

Have the students read through the text, locate, and record information that links the physical and functional attributes of the technological outcomes described in the article (the clothes, the igloo, the LCVG, wetsuits).

Identifying why people have developed particular technological outcomes

Learning goals *(to be shared with your students)*

We are learning to:

- identify how particular technological outcomes have been designed and made (CoT)
- identify the environment issues that have influenced the attributes of particular technological outcomes (CoT).

The following two key ideas focus on the relationships between technology, society, and the environment (CoT).

To identify how technological outcomes have been made, students need to

"identify that technological practice involves knowing what you are making and why, planning what to do and what resources are needed, and making and evaluating an outcome." (http://www.techlink.org.nz/curriculum-support/indicators/nature/level1.htm).

The best way for students to develop an understanding of technological practice is through their own work. If the students have already undertaken their own technological practice, you could revisit the things they did when developing their outcome. Alternatively, the case studies on Techlink (for example, see http://www.techlink.org.nz/Case-studies/Classroom-practice/archive/hat-storage/index.htm) could be used as examples to help the students identify aspects of technological practice.

The article "Making Clever Clothes" provides another example of technological practice that could be used to develop students' understanding. After reading this text, students could consider the following questions:

- What technological outcomes has Stewart Collie made?
- Why were these outcomes made?
- What sorts of things does Stewart do at work? (Encourage answers that describe his technological practice, for example, finding solutions to a given need, designing, making things, doing experiments and making models to test ideas, making prototypes for factories to manufacture and trial)
- What skills and knowledge do you think Stewart needs to make the things he does? (Encourage answers that cover the range of skills needed to produce technological outcomes, for example, organising and planning skills, knowledge about how to do experiments, knowledge about fibres and materials, and the ability to communicate ideas to others and to work as part of a team).

Students can begin to understand the relationships between technology, society, and the environment by exploring the issues that influence the development of particular technological outcomes.

Choose a technological outcome from "Making Clever Clothes" to explore relationships between technology, society, and the environment. As a class, discuss:

- the resources available
- how the environment that the outcome is designed for will influences the design and success of the outcome
- the positive and negative changes the outcomes might make to peoples lives
- how making and using the outcome might impact on the environment.

This process could be repeated, this time with the students discussing a technological outcome from the article "Warming Up, Cooling Down" in small groups.

Further activities

Select a range of images of technological outcomes that are examples of objects developed for similar functions either in different physical environments or in different eras. Examples you could choose from include toys, clothes, animal shelters or means of transport. Ask the students to:

- describe the different environments the outcomes were developed for
- make a timeline showing when each outcome was developed and used

- describe changes made to the outcomes (over time or in different environments)
- identify social and environmental conditions that influenced how the technological outcomes were developed (influences such as the resources available in a particular location, climate, people's beliefs, or people's needs)
- identify how the technological outcomes have impacted on the people and their environment.

Select a range of technological outcomes that have different physical attributes but similar functional attributes. Examples you could choose from include things people use for writing (fountain pens, pencils, crayons, paint brushes, typewriters) or for storing water (pottery urns, glass jugs, plastic drink bottles, water membrane). Ask the students to:

- describe the physical and functional attributes of these outcomes
- identify the similar functional attributes and describe how the different physical attributes of the technological outcomes in the group allow the outcome to work.

Select a range of technological outcomes that have similar physical attributes but different functional attributes. Examples you could choose from include things people use to brush surfaces (garden brooms, house brooms, hand brooms, hair brushes, bottle brushes, paint brushes) or to cultivate the soil (shovels, spades, hoes, trowels). Ask the students to:

- describe the physical and functional attributes of these outcomes
- identify the similar physical attributes and describe how each technological outcome in the group functions differently.

Ministry of Education resources

Further support is available under Explanatory Papers for characteristics of technology and characteristics of technological outcomes under Curriculum at **http://www.techlink.org.nz**

Connected 1 2005 features an article about toys. This could be used as a context from which to explore both components in the Nature of Technology strand. Ideas for exploring the characteristics of technology include:

- why toys are important
- how toys differ in different parts of the world and how they have changed over the years
- how toys are designed and manufactured
- the positive and negative impacts toys have in our lives and on the environment.

Exploring the characteristics of technological outcomes, students could:

- explain why toys can be described as technological outcomes
- describe toys in terms of their physical and functional attributes

- describe the relationship between the physical and functional attributes of particular toys
- recognise that some toys or parts of toys can be described as technological systems.

Further resources

http://www.historyforkids.org/learn/clothing/
http://www.teachers.ash.org.au/jmresources/toys/children.html
http://inventors.about.com/od/tstartinventions/a/Toy_Inventions.htm

Mathematics in "Staying Warm, Keeping Cool"

Possible achievement objectives

Geometry and Measurement

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

Measurement (M)

- L1: Order and compare objects or events by length, area, volume and capacity, weight (mass), turn (angle), temperature, and time by direct comparison and/or counting whole numbers of units.
- L2: Create and use appropriate units and devices to measure length, area, volume and capacity, weight (mass), turn (angle), temperature, and time.
- L2: Partition and/or combine like measures and communicate them, using numbers and units.

Statistics

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

Statistical investigation (SI)

- L1: Conduct investigations, using the statistical enquiry cycle:
    - posing and answering questions
    - gathering, sorting and counting, and displaying category data.

Statistical Literacy (SL)

- L1: Interpret statements made by others from statistical investigations and probability activities.

- L2: Compare statements with the features of simple data displays from statistical investigations or probability activities undertaken by others.

Links to mathematics standards

Geometry and Measurement

After 3 years at school

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

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

By the end of of year 4

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

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

Statistics

After 3 years at school

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

- investigate questions by using the statistical enquiry cycle (with support):
    - gather and display category and simple whole-number data
    - interpret displays in context.

By the end of of year 4

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

- investigate questions by using the statistical enquiry cycle independently:
    - gather and display category and simple whole-number data
    - interpret displays in context.

Key ideas

- Temperature can be described and measured using comparisons or standard units and measuring devices. There are advantages to measuring temperature using a standard scale.

- Scientists and manufacturers use mathematical methods and skills to investigate variables such as insulating materials and to then determine which is the most appropriate for the situation.

- To find answers, they observe carefully, record what they observe, and organise their observations using charts and graphs.
- The temperature that we feel can be affected by many factors including the wind – wind-chill and evaporative cooling can lower our body temperature.

Developing the ideas

Learning goals (to be shared with your students)

We are learning to:

- describe temperature in words
- recognise that temperature can be described by a scale
- order temperatures from coldest to hottest
- classify, describe, or sort objects by their characteristics – these characteristics include shape, size, colour, texture, weight, and temperature
- use standard units and devices to measure temperature, thickness and time
- use measuring devices such as stop watches and thermometers to measure temperature drop and understand that the marks on a linear scale show the endpoint of units
- perform and communicate calculations involving measures of time and temperature
- describe how different factors affect the way we feel temperature
- interpret tables that show bivariate information, for example, the effect of wind chill on the temperature we feel.

Use the contexts of the articles to explore the mathematics of measurement and statistics by selecting from the following levelled activities:

Exploring the language of temperature and describe objects or places using non-standard measures

Before reading the article, get the class to consider how they stay warm or cool enough by looking at pictures of different situations. Scenes could include a windy day, a tropical island beach, a snow-covered landscape, a shady garden, a rainy day, a desert scene, and a night-time barbeque. Discuss what sort of clothes they would be wearing and why. Encourage the students to use descriptive words for temperature like “hot” and “cold”. Alternatively, show the students pictures of people dressed in different types of clothing and ask them to describe the temperature they think the person would be experiencing.

Ask the class to brainstorm all the words they know that can be used to describe temperature, for example, “boiling” and “chilly”, or get the class to reread the

"Warming Up, Cooling Down" article and list all the words that describe temperature.

Estimating the temperature (or conductivity) of different objects; compare and order them by relative temperature

Ask the students to write temperature vocabulary words on cards and place them on their desk in order from coldest to hottest. Plan carefully what words should be included to promote a good discussion as to where on the temperature "scale" a word lies, for example, is "warm" cooler than "tropical"?

Give each student a temperature word card and have them form a line in order of the relative temperature of each word. Encourage the class to discuss any placement they don't agree with as this will reinforce the difficulty with non-standard "descriptions" of temperature. Ask questions such as *Is "boiling" hotter than "scorching"?*

Use pictures and everyday objects such as clothing to make temperature words less abstract. Pair sample sets of clothing with appropriate scenes, for example, parka, t-shirt, raincoat, long sleeve shirt, or hooded sweatshirt with a tropical beach, shady garden, windy day in town, rainy day, and snow-covered landscape.

Look at pictures of different objects and order them from hottest to coldest. Students could also be asked to sort these objects into groups of similar temperature. Examples that could be included are: an electric heater, a light bulb turned on, a light bulb turned off, a cup of tea, a bowl of soup, an ice cream, milk, fruit juice, a hair dryer, a clothes dryer, an ice cube, a book, a table, a glacier, lava, a river, an ocean, an iceberg, a rotisserie, or a barbecue.

To increase the students' experience and understanding of temperature, explore the "feel" of temperature by touching objects of various temperatures. Set proper safety norms before handling hot items.

Set up a number of workstations with two or three objects of varying temperatures. While ice cubes and cold water should be part of this, include other objects such as wood, wool, or metal that has been in the shade or sun so that students can gain an understanding of the heat-holding properties of various materials. Encourage the students to guess what they think the hottest one will be before touching the objects. They could write their estimate and their actual result in a table like the one below, and/or order their data by relative temperature.

Objects	**What I thought would be the hottest**	**What was the hottest**
Glass jar, wooden spoon, metal spoon, ice cube	Glass jar	Metal spoon
Rubber plug, paper cup, scissors, polar fleece cap		

Note: A metal spoon is very conductive, so if you put it in the sun it will warm up rapidly, and in the shade it will cool down rapidly. Just because it absorbs heat easily doesn't mean it will be a good insulator in fact, it's the opposite. Similarly, a wool sweater feels cool in the sun because it takes a long time for heat to transfer to the wool through the trapped air pockets, but wearing a wool sweater on a sunny day is a bad idea!

Introducing the concept of a temperature scale and temperature measurement

Show the class a photograph or set up at a bench a cup of hot coffee and a cup of slightly less hot coffee. Without letting the students touch the coffee, ask them to tell you which one is warmer. Ask them how they would know when the coffee was cool enough for them to drink without burning themselves. Many will say that they just test it with their mouth. Ask them how they would know if the temperature was correct if it was food for their baby brother or sister.

Use focus questions to prompt the students to compare any variations in their understandings of the non-standard "descriptions' of temperature, so that they realise the need for standard units of measure. *Which measurement is the best way to tell how cold or hot an object is? What problems would arise if non-standard measures were used in weather forecasts or to set the temperature of a freezer? If everyone measured the same way, how would this be helpful?*

Help students to reach the conclusion that a scale and a system of measurement are useful. For example, it is easier to bake a cake in an oven than on a camp fire because cakes (and other foods) need to reach and maintain a certain temperature in order to cook properly. While open fires can reach this temperature, it can be very difficult to tell when they do and to ensure that temperature is maintained. Lead the discussion to include the use of thermometers as a way of determining temperature.

Students at level 1 may not have any sense of what the numbers on the Celsius scale mean. They might not know, for example, that 35 degrees is a hot day and 0 degrees is cold. If students can estimate temperatures for different scenes, you may wish to skip ahead to interpreting a temperature scale. Alternatively you may need to hold off estimating temperatures in degrees until the students have had practice measuring temperature using a thermometer.

Using a thermometer to measure temperature

Introduce the students to the thermometer and how it works. Introduce the scale on the thermometer and discuss the degree unit. It may be useful to provide background information about thermometers. You could discuss:

- where you would usually measure temperature at home, for example, in heating or cooling appliances, such as an air conditioner, oven, hot water heater, or refrigerator
- the fact that thermometers are commonly made of glass filled with coloured liquid; the liquid in the tube rises as the temperature warms and drops as it cools
- the increasing use of digital thermometers (students may have had their temperature taken with one of these as they are commonly used by health providers)
- the divisions on the scale – many thermometers are divided into units of two degrees

- the term “Celsius” (also mention of the “Fahrenheit” scale).

Use an interactive display or other easily readable model to show how to read a thermometer. Show the students how the scale works by indicating changes and getting them to read them off the large thermometer. Students could then read values from sample thermometers or colour in pictures of blank thermometers to show different temperature readings.

Practise using thermometers to measure the temperature of actual objects. This may be best done using a series of workstations with objects. Set proper rules for handling equipment, and remind the students to hold the thermometer so that their fingers do not warm the glass. Ask them why they might need to wait a minute before taking a new reading. (The liquid or sensor in the thermometer will not heat or cool instantly; it needs time to adjust to the new temperature.)

Interpreting temperature measurements

Help the students link temperature readings to the work they have already done on describing temperature. Use questions to encourage students to think about the consequences of temperature. Ask *If I needed to wear a heavy coat, gloves and a scarf, what would the temperature be showing on the thermometer?* and *What sort of clothes would you be wearing if the red liquid was high up on the thermometer?*

Encourage the students to quantify non-standard scales, for example, by writing an estimated temperature in degrees on photographs of different climates. If words have been placed in order from hottest through to coldest, the class could now discuss what the actual temperature might be. Coloured thermometers could be placed along the wall indicating the temperatures students believe words indicate. The pictures depicting different temperatures could also be placed along the wall “temperature scale”. Part of the wall scale might look like this:

Ask the students to collect pictures from magazines or the Internet that show temperature and place these on their own thermometer diagrams with lines indicating the temperature the picture is showing. You may want to include the freezing temperature of water and human temperature on this.

Introduce the idea of room temperature as this will be important during the investigation into insulating material. Get the students to estimate and then measure the temperature of different places around the school. Discuss why the air temperature in some areas of the school might be hotter (for example, a sunny room) or colder (for example, a shaded area) than others.

Recording and organising data in tables and charts

Students should be able to record and organise data in charts before attempting the statistical investigation described in “Investigating Insulation”. If your students are not familiar with recording information on charts, introduce this idea once they are comfortable taking temperature measurements.

Discuss the idea that things do not always stay the same temperature. Get students to suggest what happens when a cake is taken out of the oven, a cup of coffee is left to stand, or a cube of ice is left in the sun. Refer to the thermometer scale and get the class to decide what would be happening numerically on the scale.

Have the students record temperatures at various points around the school over time, using a chart such as the one below. The various sites could be divided amongst groups of students and the temperature taken every hour or day.

Place	Monday	Tuesday	Wednesday	Thursday	Friday
Shaded garden					
Our classroom					
The main office					
On the field					

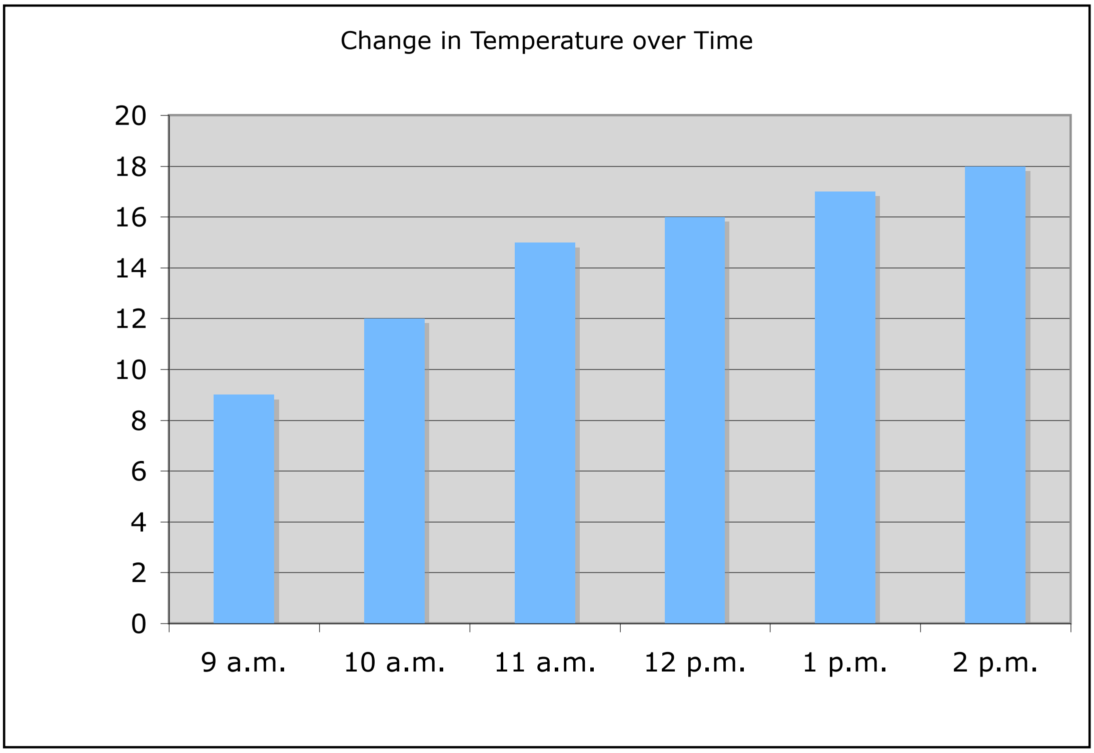
Discuss why scientists use charts and how charts help to organise data. Explore simple patterns in the chart – was one location always hotter than the others?

Alternatively, give students simple examples of unsorted data and ask them to organise the data in a chart. Compare and contrast the usefulness of the disorganised and organised data, for example, 1 p.m. 17°, 9 a.m. 9°, 11 a.m. 15°, 10 a.m. 12°, 2 p.m. 18°, 12 p.m. 16° compared with:

Time	Temperature (degrees C)
9 a.m.	9°
10 a.m.	12°
11 a.m.	15°
12 p.m.	16°
1 p.m.	17°
2 p.m.	18°

You could build students’ awareness of temperature change and how to display it by having them graph their results on a chart with time along the bottom.

Note: The graph below is not a simple data display. It is appropriate for students working at level 2.



Conducting an investigation of insulation using the statistical enquiry cycle

Students could perform the investigation described in the article "Investigating Insulation". Students working at level 2 of the curriculum should be able to work with categorical and discrete data but the investigation will challenge students working at level 1. Group your students appropriately and provide scaffolds as needed, for example, pre-formatted record sheets.

Activate prior knowledge by asking the students about ways they know or have used to slow down the cooling or heating up of water. They may talk about using a chilly bin or thermos flask. Encourage them to talk about the use of warm clothing to stay warm in winter and relate it to the term "insulation". This will lead to discussions about what materials are better at keeping them warm or cool. Does the bulk or thickness of the material being worn affect how well insulated an object (in this case them) is? The class could then read the "Investigating Insulation" article and carry out the investigation.

This data-gathering activity can be used to introduce or reinforce the statistical enquiry cycle. Show the class the main features of the PPDAC (statistical investigation) cycle (available at www.censusarschool.org.nz) and either in groups or individually, relate the different things they do in the investigation to different aspects of the investigation. This could include:

Define a **problem**:	What question/s do you think this investigation could answer?

Plan an investigation:	What information (temperature and time) will we collect to answer our question? How can we ensure that we keep the data as accurate as possible?
Gather the **data**:	How will we collect the data?
Analysis:	How will we sort the data? What types of tables or graphs will clearly display the information we collect? How can we show the information for all insulation materials on the one page to allow comparison? How can we show the patterns in our data? (Reinforce the idea that the tables and graphs help us to detect relationships as well as provide evidence for our conclusions.)
Conclusion:	How can we present the results of our investigation to the class.

Emphasise that while most results are (probably) about the same, experiments need to be done several times to ensure as accurate an investigation as possible. Discuss the importance of clear instructions (so that the experiment can be repeated by someone else). If there are some results that greatly differ from the others, discuss what would happen if those were the only results ever obtained. (Wrong conclusions would be reached).

Once the students have analysed their data and come to a conclusion as to which material they think is the best insulator, encourage them to move on to making comparisons. This could be done in several ways:

- Compare different sets of results. The students may well have somewhat different readings, reinforcing the need for experiments to be performed several times before conclusions can be drawn. If some students' results differ from those of others, it could be a good starting point to get them to think of ways that they could design a further experiment to test between the two or three better materials.
- Compare different materials within the same investigation. How much faster did the water insulated by material A cool down compared to the water insulated by material B? This concept of looking for patterns in the results is developed further in the article "Heat Thieves".

Remind the class that an investigation will end with more questions being asked. Brainstorm further questions to explore and look into avenues for further investigation. Students should be encouraged to make some predictions based on the results they have collected. Ask students to describe what they think would happen if double the amount of water had been used? What might happen if twice the thickness of insulating material had been placed around the bottle or if the bottle had been placed in a hotter or cooler place, such as a refrigerator?

As an extension, if students have access to a graphing programme, get them to try several types of graphs in order to see that in different situations, some graph types are more effective at showing information than others. Encourage them to use time-series graphs with the different materials represented by different colours or symbols. After completing the experiment, these graphs could be displayed on the wall under each of the different insulation types.

Interpreting bivariate data in tables

Reading and interpreting information from tables is part of the analysis phase of the PPDAC (statistical investigation) cycle. At level 2, students should be able to read and interpret simple tables with two variables. In “Investigating Insulation”, students look at temperature and time. In “Heat Thieves”, students look at perceived temperature and wind speed.

Practice reading and interpreting simple two-variable (bivariate) tables. For example, using the table below, ask the students which student will get wet (Tim) or who is wearing too much clothing (Gerry).

Clothing / Weather	T-shirt	Umbrella	Raincoat
Sunny	Hawera	Tu Phan	Gerry
Rainy	Tim	Susan	Meri

Further examples of other objects with two features could be displayed in this way or students could make up their own. Multiplication tables are often set out in a similar way.

After the class has read the “Heat Thieves” article, review the meaning of wind chill as discussed in the book. Explore the wind chill table as a class, reading some of the measurements together to practise reading the table. Identify features of the table, such as the fact that on a day where the air temperature is 16 degrees Celsius, the biker will feel a temperature of 14 degrees when they are traveling between 30 and 50 kilometres an hour. Ask the class to find other parts of the table where this is the case.

Further activities

The concepts explored in *Connected* 1 have large scope for extension:

While the mathematics of finding a relationship between two variables (such as time and water temperature) is beyond levels 1 and 2 of the curriculum, you can use the investigation and contexts in the book to introduce the concept of relationships between variables and how two variables can be displayed.

The class could extend their measurement skills to include recording several weather measurements and maintaining a weather chart in the classroom. For example, the class can measure and record air temperature, rain levels , and wind direction using simple instruments and compare their readings with published data.

Temperature data often includes negative values. Discuss the idea that numbers can be below zero and the relative coldness of negative temperatures. Ask the class: *Which is colder, -1 or -10 degrees?*

Ministry of Education resources

A wide variety of classroom activities and digital learning objects can be found on the *NZMaths* website http://www.nzmaths.co.nz/ .

Activities and examples at level 1 and 2 of the curriculum can also be found on *NZMaths at* http://www2.nzmaths.co.nz/frames/curriculum/index.aspx;

http://www2.nzmaths.co.nz/frames/Curriculum/files/Level1GeometryandMeasurementMeasurement.pdf;

Reference to suitable Figure It Out activities can be found on the *TKI* website at

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

The Figure It Out book *Measurement Levels 2 – 3* includes a number of activities relating to the measurement of time, such as Clock it Up, Me he Karaka, and Cut Off and measuring water temperature in Cool It.

Further resources

Statistics

Activities and information about statistical investigations can be found on the *CensusAtSchool* website http://www.censusatschool.org.nz/. Activities tend to focus on objectives at level 3 of the curriculum and higher, but these can be modified for younger students.

Measuring temperature and interactive thermometers

Presentations showing how to measure temperature using thermometers can be found online, for example on:
http://www.metoffice.gov.uk/education/teachers/downloads/metofficeeducation_ks2_keeping_warm_using_a_thermometer_slides.pdf

An example of an interactive thermometer can be found at:
http://www.echalk.co.uk/maths/dfes_numeracy/Assets/thermometer_flash.swf

Another site that steps students through measuring temperature and provides a number of worksheets and activities can be found at:
http://www.metoffice.gov.uk/education/teachers/lessonplan_ks2_keeping_warm.html

Students can further relate temperature and ways of keeping warm through playing the Weather Game (students match a picture of weather to a thermometer reading and the clothing they might wear.)
http://netrover.com/~jjrose/weather/weather.html

Weather

The *Metservice Learning Centre* site contains a large range of weather related activities and articles that can be used within a classroom.

http://metservice.com/national/?alias=learningcentre

An interactive website for students on temperature is available at the website *Time for Teachers.* It has some simple weather activities for students including ways to record weather observations on simple charts.

http://www.timeforkids.com/TFK/teachers/teachingresources/bp/search/0,28116,Weather%20worksheets,00.html?searchstring=Weather&searchtype=theme&searchcase=worksheets&startindex=1&endindex=20

The *WeatherWizKids* website explores a number of aspects about temperature, including wind chill. It has an interactive wind chill chart than can be used to calculate the wind chill factor (using both Fahrenheit and Celsius scales.)

http://www.weatherwizkids.com/weather-temperature.htm

Measuring wind speed

Students can measure wind using a simple wind measurement device. One such example using a protractor and ping pong ball, along with a table to convert to speed can be found at the following website:

http://www.bom.gov.au/lam/Students_Teachers/Worksheet16.shtml

The following site describes a series of lessons on measuring wind speed using an anemometer made from cups:

http://www.arcticclimatemodeling.org/lessons/acmp/acmp_k4_Wind_Measuring WindSpeed.pdf

"Making Clever Clothes"

While *Connected* 1 2010: *Staying Warm, Keeping Cool* includes five articles, they are well integrated and flow well in sequence. The teacher support materials have been developed to relate to specific science, technology, and mathematics strands. Within each learning area, much of the material has been written as a set of common activities that link all the texts in a holistic way. Focus on one learning area or integrate them to meet the needs of your students. Teacher support materials for each learning area includes a discussion of the key ideas, suggested achievement objectives, activities you can use with your students to explore those ideas, and useful resources.

Technology in "Making Clever Clothes"

Possible achievement objectives

Technological Knowledge

Technological modelling (TM)

- L1: Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes.
- L2: Understand that functional models are used to explore, test, and evaluate design concepts for potential outcomes and that prototyping is used to test a technological outcome for fitness of purpose.

Key ideas

- Stewart Collie is a technologist who invents fabrics and clothes. Inventing involves designing and making technological outcomes.
- When technologists design and make technological outcomes, they make and use technological models to help them with their designs.
- Models help technologists find out how to make an outcome work and what it might look like. Functional models test design ideas.
- A prototype is the finished outcome that is tested to find out how well it functions in the situation that it was made for.
- Prototyping is important because the information it provides is used to "iron out" any problems that the technologist did not foresee when designing the outcome.

Developing the ideas

Functional Modelling

Learning goals (to be shared with your students)

We are learning to:

- describe what a functional model is and identify why technologists use functional modelling when they design outcomes
- explain ways that functional modelling can be used in technology
- identify what is being tested (in particular functional models) (TM).

In "Making Clever Clothes", Stewart Collie gives examples of the functional modelling he uses as he designs fabric and clothes. Some examples of the modelling he does are more obvious than others. You will need to guide your students to recognise the modelling he does by suggesting other models he could use to support the examples in the article.

Functional modelling is any testing that is done to explore and test design ideas. (For further support, see Teacher Guidance for technological modelling at level 1 http://www.techlink.org.nz/curriculum-support/indicators/knowledge/level1.htm and at level 2 at http://www.techlink.org.nz/curriculum-support/indicators/knowledge/level2.htm

The examples Stewart Collie discusses in "Making Clever Clothes" are:

- taking photos with infra-red cameras to test heat loss from different fabrics
- testing fabrics by stabbing them and exposing them to a flame.

Discuss with the students why it is important to do this testing. Ask *How might the testing be related to the clothes Stewart is designing?*

Stewart makes other comments that you can pick up on and discuss with the students. He says, "I work out ways to put threads into fabrics" and "this is my laboratory … this is where we solve problems …" and "lots of experiments don't work. They say you learn more from your failures." These comments indicate that trialling and experimenting are a big part of his practice.

Ask the students to think about what Stewart might have done to work out how to make the electric socks. Emphasise that any work that tests design ideas is considered to be functional modelling. For example, Stewart may have:

- discussed ideas with his colleagues (Can we do this? Is it a good idea?)
- drawn sketches of the socks, labelling how they might work
- drawn a circuit diagram
- experimented with weaving different types and numbers of wires into different materials

- tried making the socks with metal material (Would they still be stretchy?)
- tried different-sized batteries (Did it provide enough energy to make the socks warm?)
- washed the socks to see if they still conducted electricity
- tried putting the battery in different places in the shoes (Where was it most comfortable? Did it show?)

All of these steps are examples of functional modelling. Encourage the students to think about what was being tested with each model.

Prototypes

Learning goals (to be shared with your students)

We are learning to:

- describe what a prototype is and why prototyping is important
- identify the specifications used to evaluate particular prototypes.

Stewart refers to prototyping when he states, "When we've found a solution that works, we show real factories how to manufacture our products on a big scale." Using the socks as a context, discuss with the students what further testing or evaluations would be needed once they had the socks working in the laboratory. *What is a laboratory?*

Guide the students to understand that the socks would then be tested by people wearing them. Perhaps they were designed for people who work in cold places or for mountains climbers or for old or sick people who get cold feet because they can't move to keep warm. Ask: *What questions might Stewart have asked the people wearing the socks? Can you think of any measurements Stewart would want to take when people were wearing them?*

Explain that these final measurements and questions might lead to small changes to the design of the socks before the factory manufactured lots of them. It would cost a lot of money to make thousands of these socks only to find that they didn't work properly or people didn't like them and they didn't sell. This final testing of the actual finished outcome is called prototyping. Stewart would need to gather specific information to be able to evaluate if the prototype socks met the specifications that they were designed for.

Further activity

It would be helpful to reinforce the ideas about technological modelling by exploring other examples of technological practice. "Rooms 5's Amazing Meeting Seating" in *Connected* 2 2005 has some excellent examples of both functional modelling and prototyping. Emphasise that there are many types of modelling. Encourage the students to identify the design idea the students in the article were testing with each type of model they used. *Can you identify the prototype? What information did the students in the article find out from the prototype?* Ask the students to think about who and what the seating was designed for. *What questions would you ask the students of this school to find out how well the seating served its purpose?*

Ministry of Education resources

An example of how one teacher planned a unit to increase her students' knowledge of technological modelling is available at http://www.techlink.org.nz/curriculum-support/unit-planning/matariki/index.htm

Explanatory papers for technological modelling are available at **http://www.techlink.org.nz/curriculum-support/papers/knowledge/tech-model/index.htm**

“Keeping Houses Warm or Cool” with links to “Investigating Insulation”

While *Connected* 1 2010: *Staying Warm, Keeping Cool* includes five articles, they are well integrated and flow well in sequence. The teacher support materials have been developed to relate to specific science, technology, and mathematics strands. Within each learning area, much of the material has been written as a set of common activities that link all the texts in a holistic way. Focus on one learning area or integrate them to meet the needs of your students. Teacher support materials for each learning area includes a discussion of the key ideas, suggested achievement objectives, activities you can use with your students to explore those ideas, and useful resources.

Technology in “Keeping Houses Warm or Cool” with links to “Investigating Insulation”

Possible achievement objectives

Technological Knowledge

Technological products (TProd)

- L1: Understand that technological products are made from materials that have performance properties.
- L2: Understand that there is a relationship between a material used and its performance properties in a technological product.

Technological modelling (TM)

- L1: Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes.
- L2: Understand that functional models are used to explore, test, and evaluate design concepts for potential outcomes and that prototyping is used to test a technological outcome for fitness of purpose.

Nature of Technology

Characteristics of technological outcomes (CoTO)

- L1: Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature.
- L2: Understand that technological outcomes are developed through technological practice and have related physical and functional natures.

Key ideas

- Technological outcomes are made from materials that have performance properties.

- Materials are chosen for technological outcomes because of their specific performance properties.
- We can investigate the performance properties of materials. Investigating materials to use in products is part of testing design ideas – functional modeling.
- Technological outcomes are made by people for a purpose through technological practice.
- Technological outcomes can be described by their related physical and functional attributes.

Developing the ideas

Understanding Materials

Learning goals (to be shared with your students)

We are learning to:

- identify the materials that selected technological outcomes are made from (TProd)
- identify the performance properties of materials and how the materials have been manipulated (shaped, joined, finished) to make the product (TProd)
- suggest why specific materials were used in some technological products (TProd).

The article "Keeping Houses Warm or Cool" provides a context for students to discuss and explore materials that technological products are made from. At this point, it is useful to clearly distinguish the difference between two components of the curriculum – technological products (TProd) and characteristics of technological outcomes (CoTO).

Developing understandings in the component **characteristics of technological outcomes (**Nature of Technology strand) will allow students to analyse a technological outcome. Technological outcomes can be classified as either technological products or technological systems. Both products and systems have related physical and functional attributes that describe the nature of the outcome.

Learning in the component **technological products** (Technological Knowledge strand) will allow students to develop an understanding of the materials used to make technological products.

When reading "Keeping Houses Warm or Cool", identify when the article is talking about the materials used in technological products and when it is talking about a technological outcome. Rule up two columns on a whiteboard. Ask the students to identify the materials that are discussed in the article (for example, raupō, wood, mud, fibreglass) and record these in the first column. Then ask the students to record the products made from these materials (for example, houses, batts) alongside them in the second column.

Provide examples of insulating materials for the students to explore. Examples could include carded wool, newspaper, polystyrene, straw, aluminium foil, sheepskin, mud, and leaves. Choose one or two of these materials to describe as a class activity. For example, cardboard could be described as brown, flexible, 2mm thick, difficult to fold, solid (no air gaps – important when thinking about insulating properties). In groups the students can then describe the other materials.

Testing materials is an example of functional modelling

Learning goals (to be shared with your students)

We are learning to:

- identify testing materials as one type of modelling used to test design ideas about what materials to use in a technological outcome (TM).

After describing the materials that might be good insulating materials, carry out the test described in the article "Investigating Insulation". Give the students a brief that entails them having to make a technological product that insulates in some way. For example, they could design an insulating cover to keep a drink warm or cold or a lunchbox cool in summer. Ask them to choose materials and test them to find out what would be a good material to use.

You will need to make it explicit that when they are testing what material would be best for their design of an insulating cover, they are gathering data from functional modelling.

If the students are going to actually make a prototype, other aspects of the design will also impact on the materials they choose. They will need to consider, for example, if the material is able to be shaped and/or joined as required or whether it can be reused. These questions will require further functional modelling.

Describing technological outcomes

Learning goals (to be shared with your students)

We are learning to:

- identify technological outcomes (CoTO)
- describe technological outcomes in terms of their related physical and functional attributes (CoTO).

In this component, the focus is on the nature of the product rather than the properties of the materials that the product is made of.

Provide the students with a range of products that insulate in some way (for example, a variety of chilly bins, take-away coffee cups, thermos flasks). Identify all these products as technological outcomes and ask the students to explain why they are technological outcomes.

As a class, explore and describe the physical and functional attributes of one of these products. For example, a take-away coffee cup could be described as "round to make it easy to hold, with a lip to hold the lid on, made of two layers of cardboard with air in between to insulate the drink, with a stiff, flat bottom to make the cup solid and able to sit flat on a surface".

Encourage the students to identify the relationship between the physical and functional attributes of the product. The students can then work in groups to explore and describe the physical and functional attributes of the other products. (See indicators of progression for levels 1 and 2 at *http://www.techlink.org.nz/curriculum-support/indicators/nature/level1.htm* and *http://www.techlink.org.nz/curriculum-support/indicators/nature/level2.htm*)

Further activities

Students need many opportunities to explore materials and experiment with how they can be manipulated to make outcomes. These opportunities can be provided in the context of their own technological practice or as part of a unit that focuses on the exploration of a range of materials.

They also need the opportunity to explore technological outcomes through play and through dismantling and reassembling objects. Learning how things work and do what they do is important if students are to effectively "read" or analyse technological outcomes.

Ministry of Education resources

Explanatory papers for technological modelling, technological products and characteristics of technological outcomes are available under Curriculum on http://www.techlink.org.nz

These Building Science Concepts books explore the properties of materials:

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

Book 23, *Fresh Food* item number 12640

Book 32, *Introducing Metals* item number 12649

Book 46, *Keeping Warm* item number 12663

Book 48, *Fabrics* item number 12665