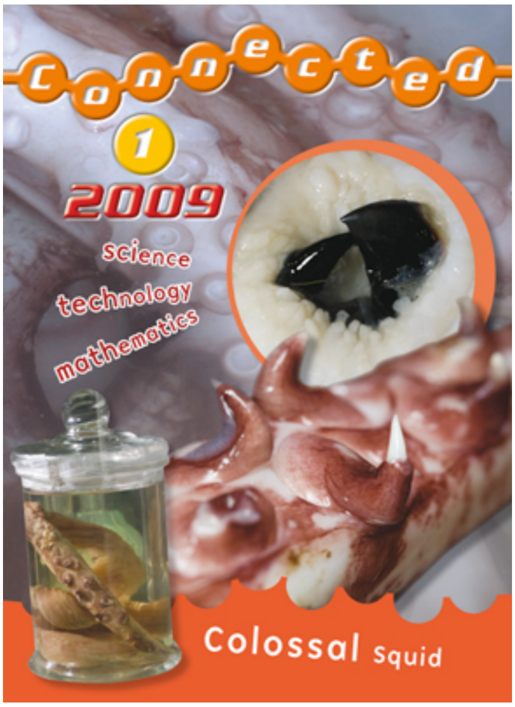
Teacher Support Materials



Connected 1 2009

Contents and curriculum links

Contents	Curriculum links	Page in students' book
Monsters of the Deep	Nature of Science; Living World	2
Te Papa's Colossal Squid	Nature of Science; Material World; Physical World; Nature of Technology; Technological Knowledge	10
What's That?	Nature of Science; Living World	26

General themes in *Connected 1 2009*

"Monsters of the Deep" and "What's That?" provide a context for exploring ideas from the Living World and Nature of Science strands. "Monsters of the Deep" identifies squid body parts; compares two different kinds (species), the giant and colossal squid; describes what squid eat or are eaten by; and compares what scientists know about squid and what they would still like to find out. "What's That?" introduces Chris Paulin – why he decided to be a scientist and the kind of work he does as a scientist at Te Papa.

"Te Papa's Colossal Squid" provides a context for exploring science ideas from the Physical World, Material World, and Nature of Science strands. This article also provides a context for exploring ideas from the technology learning area, focusing on the Nature of Technology and the technological modelling component of Technological Knowledge. You could use this story as a starter for a further activity focused around the students undertaking their own technological practice, with an emphasis on brief development and planning for practice.

"Te Papa's Colossal Squid" describes catching and storing a colossal squid in 2007, working to thaw and investigate the squid during 2008, and putting it on exhibition at Te Papa in December of that year.

Monsters of the Deep

Possible achievement objectives

Note: All achievement objectives are quoted from *The New Zealand Curriculum* (2007).

Science

Students will:

Nature of Science

Understanding about science (UaS)

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

Communicating in science (CiS)

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

Living World

Life processes (LP)

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

Ecology (Ec)

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

Evolution (Ev)

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

Key ideas

- Scientists ask questions about the world.
- To find answers, they observe carefully and record what they observe.
- One way of recording their observations of living things is by making accurate drawings and labelling the important features of the living thing.
- Scientists look for similarities and differences between living things in order to group (classify) them. The rules they have agreed on are based on observation and theory.
- Scientists and other people can share information about living things by using the specific words for living things, their parts, and the different groups they belong to.
- Scientists make reasoned guesses (inferences) based on their own and other scientists' observations. These inferences help scientists to develop theories about how the world works.

- Scientists may change their theories in the light of new discoveries and the observations and theories of other scientists.

Shared learning goals

We are learning to:

- identify some of the questions that scientists ask about the world (UaS)
- make scientific inferences about some of the colossal squid's habits (LP)
- use the specific words for the parts of the squid and for how it is grouped or classified (CiS)
- describe how squid move (LP, Ec)
- suggest what things a colossal squid might eat (LP, Ec)
- draw a simple food chain involving colossal squid (LP, Ec)
- explain the main difference between invertebrate and vertebrate animals and identify some examples of each (Ev)
- make observational drawings of living things (CiS)
- discuss how scientists have agreed to a particular way of grouping living things (Ev).

Developing the key ideas

Science learning

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

- **identify some of the questions that scientists ask about the world (UaS)**
- **make scientific inferences about some of the colossal squid's habits (LP)**
- **describe how squid move (LP, Ec)**
- **suggest what things a colossal squid might eat (LP, Ec).**

Introduce the key idea that *scientists ask questions* to explore how and why things are as they are by sending the students on a question search. How many questions can they find in "Monsters of the Deep"? They may point to the several headings that are expressed as questions and should also be able to find the list of questions about colossal squid in the section on page 6 headed "Following the clues". But several other discoveries about squid are expressed as information in the body text. These facts represent answers to questions that scientists have investigated and for which they have some reasonably certain answers.

You could divide the class into groups, ask each group to take one question from the following table, and have them work out what the scientists know, how they know it, and what the scientists don't know. This provides a context for talking about *interpreting evidence*. Encourage the students to discuss their ideas with each other and debate and explore any differences in opinion.

Bring the groups back together and summarise this discussion by using an organiser on the whiteboard. One row has been filled in as an example.

Squid questions	**What do scientists know?**	**How do scientists know that?**	**What don't scientists know?**
What are the squid's body parts?			
How do squid swim?	Most squid move in a backwards direction by using their mantle to suck water in and squirt it out.	This is not directly stated – the scientists have observed some or many of the "hundreds of different species" of squid swimming in this way.	Scientists are not yet sure if the colossal squid moves in the same way because they have not been able to observe one swimming.
How do squid protect themselves?			
Where do the giant and colossal squid live?			
How big are the giant and colossal squid?			
How do colossal squid eat?			
What eats colossal squid?			

Discussing what the squid scientists know or do not know is also an opportunity to explore how scientists *make inferences*.

Focus questions

- *What guesses (inferences) would you make from the evidence of squid beaks in the whale's stomachs and squid scars on the whales' bodies?*
- *Are there other kinds of evidence that back up these guesses?*

The scars on the sperm whales' bodies suggest that they may have to fight hard to catch the squid.

The huge size of both these animals and the "sharp, rotating" hooks and suckers the colossal squid is armed with help to reinforce this guess.

You could tease out with the class the mixture of evidence and inference in the example given on page 8 of the student book.

Scientists *observe* numbers of colossal squid beaks in the sperm whale's stomachs.

⇓

They *infer* (guess) that colossal squid are an important part of the sperm whale's diet, perhaps as much as 75 percent of what they eat.

⇓

(Unstated) Scientists can *observe* sperm whales easily, and have good *evidence* for how many there are and the very large amounts of food they need to stay alive and grow.

⇓

The scientists *make a further inference*: there are likely to be very large numbers of colossal squid.

Scientists may be forced to make inferences from limited evidence because of *unknowns*. Read over the first paragraph in Following the clues on page 6.

Focus question

- *Why is it so hard to observe the colossal squid?*

(You may need to tease out the most obvious answers – that the colossal squid lives where it is too deep or too cold).

- One thousand metres is the same as 20 laps of an Olympic swimming pool or 2.5 times round an outdoor athletics track.
- It is very dark at 1000 metres. What we describe as the sunlit zone of the sea extends from the surface to 200 metres, the twilight zone from 200–1000 metres, and the midnight zone from 1000–4000 metres.
- It is freezing cold and the water pressure is very high at 1000 metres. Fully-suited divers with oxygen tanks cannot go much deeper than 100 metres.
- The ocean is a huge area for a diver or a remotely operated camera or vessel to search.

More for super science sleuths

Te Papa's colossal squid was caught on a longline that the *San Aspiring* was using to catch toothfish, at an estimated depth of 1800 metres. The line hooked a 30-kilo toothfish that the squid was feeding on and brought both to the surface.

Visit the page Underwater vehicles on the Dive and Discover website at http://www.divediscover.whoi.edu/robotics/index.html This page has sections on how deep we can go, what pressure the water places on us, and the main types of vessels that can explore the ocean depths.

See also How deep can they go? on the Smithsonian Ocean Planet website at http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_how_deep.html

On the basis of questions, observations, evidence, and reasoned guesses (inferences), scientists *develop theories* that can be used to explain how the world and living things in it operate. Sometimes scientists discover new information that challenges what they thought they knew. This is why science knowledge sometimes changes and why scientists often say, "We *think* this is what happens" or "It *probably* happens like this".

To finish the discussion of how scientists think, the class might like to explore and discuss why some earlier theories in science changed. For example, they might discuss how Earth was once thought to be flat and, until the seventeenth century, most people thought that the Sun and Moon revolved around our world.

The language of science

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

- **use the specific words for the parts of the squid and for how it is grouped or classified (CiS)**
- **discuss how scientists have agreed to a particular way of grouping living things (Ev).**

The science words for squid parts

Explain to the students that many scientific words have an agreed, precise meaning. When one scientist uses a science word, another scientist knows exactly what that word means. Find and discuss the following key words for squid parts from the text:

Gladius	
Mantle	
Funnel	
Tentacle	
Hook	
Sucker	

The science words for groups

Scientists also talk about living things by means of the different groups they belong to.

A *phylum* (page 3) is a subgroup or division of a bigger group, called a regnum or kingdom. There are at least 33 phyla (the plural of phylum) within the animal kingdom.

Within each phylum, there are several classes, and within each class, several orders, and so on, down to the many, many individual species. The various groups from larger to smaller are set out in the following table.

Groups
Regnum (kingdom)
Phylum (division)
Class
Order
Family
Genus
Species

Scientific and common names

Every living thing has a two-part *scientific name*. Its first name (a bit like our surnames) tells scientists what *genus* that living thing belongs to. Its second name (a bit like our first name) identifies the organism as an example of a unique *species* within that genus.

Dinosaur lovers will probably be familiar with the name *Tyrannosaurus rex*, in which *Tyrannosaurus* is the genus or group that this dinosaur belongs to and *rex* is its specific name.

Most living things will also have a *common name*. The colossal squid was given its common (popular or everyday) name only very recently.

Focus questions

- *Do you think "colossal" is a good word for describing the colossal squid?*
- *Can you suggest some other words that might make an easily remembered or good popular name for this squid?*

More for super science sleuths

Scientific names are not easy to say. Your students may find these words easier if they can think of them as parts that tell a small story. Scientific names are usually constructed from several Greek or Latin words, each one of which helps to describe that living thing. Sometimes a scientific name will include the name of a particular person, who may have discovered that living thing or added vital information to what scientists know about it.

Tyrannosaurus rex	*Architeuthis dux*	*Mesonychoteuthis hamiltoni*
No common name	Giant squid	Colossal squid
tyranno (from the Greek for tyrant or cruel ruler)	*archi* (from the Greek for chief)	*mesos* (from the Greek for middle)
saurus (from the Greek for lizard)	*teuthis* (from the Greek for squid)	*onyx* (from the Greek for claw)
–	–	*teuthis* (from the Greek for squid)
rex (from the Latin for king	*dux* (from the Latin for leader)	*hamiltoni* (named after a person called Hamilton)

Grouping (classification/taxonomy)

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

- **discuss how scientists have agreed to a particular way of grouping living things (Ev)**
- **explain the main difference between invertebrate and vertebrate animals and identify some examples of each (Ev).**

Taxonomy is the science and practice of classifying living things. Taxonomies are arranged in hierarchical structures of nested sets, in which the highest set contains all the identifying features of the subsets, which each have some additional features or constraints. For example, vertebrates (phyllum) all have backbones, but the subsets (classes) include mammals, reptiles, birds, and fish, which each have their own distinct features. There are different taxonomic systems.

Grouping by different features

Introduce classification to your students through two principles:

- Living things can be grouped by their different features.
- These groupings range from very large ones, for example, the plant kingdom and the animal kingdom, to subgroups based on more particular features.

(The language of grouping is introduced in the preceding section.)

Begin by checking your students' *prior knowledge*. Ask them if they can think of examples of familiar things that are grouped together on the basis of similar qualities. You may need to prompt them to think of specific contexts. In a school, examples might include: students grouped into classes on the basis of how old they are; sports teams organised on the basis of different sporting codes; or books in the library grouped into fiction and non-fiction shelves. As a quick exercise, you could get the students to collect as many examples of writing tools as they can find in the classroom, then talk about features these have in common, and possible subgroups (for example, those that write on paper or those for use on whiteboards).

Meet the cat family

As a group or pair activity, ask your students to list as many members of the cat family as they can think of, then share their lists as a class. The cat family (felidae) includes the domestic cat, lions, tigers, leopards, jaguars, cheetahs, pumas, cougars, lynxes, and ocelots, among others. There are close to 40 species or members of the cat family.

Focus questions

- *Can you think of any features that most members of the cat family have?*
- *Can you think of any different features that not all members of the cat family share?*

List suggestions in two columns on the white board. *Shared features* might include:

- Cats are warm blooded (mammals).
- They give birth to and suckle litters of young.
- Cats hunt and eat smaller animals. (They are carnivores.)
- Cats have sharp teeth and claws, which help them to catch and devour their prey.
- Cats are good at stalking. They have flexible bodies and can get low to the ground or into small places to hide.
- Their fur colours and markings (stripes and spots) also help to hide them (camouflage).
- Cats are good climbers.

You could also suggest other similarities the students might not have thought of, for example, that all cats have a backbone (are vertebrates).

The students may have questions, for example, whether all cats purr. (They do, but some do it only when breathing in and some can purr when breathing in and out.)

The students may suggest that cats are fast or speedy. This is true of the cheetah, but, while capable of bursts of speed, cats are generally better at stalking. They are strong and muscular, which helps them with controlling their prey.

Differences might include:

- While most cats prefer to live by themselves, lions like to live in groups called prides.
- Cats are mainly wild, except for *Felis catus*, the domestic cat.
- Cats range in size. Scientists subgroup cats into the lesser cats and the big cats.
- Only the big cats can roar.
- Cats live in a wide variety of habitats.

Focus question

- *How might grouping living things help scientists?*

Three main reasons are listed below.

- Grouping allows scientists to express the relationship between living things, for example, a pet cat and a panther.
- Scientists also use classification to help to trace how different groups of living things have evolved.
- Putting things in groups helps scientists to guess how a newly discovered specimen from that group might behave.

Larger and smaller groups

"Monsters of the Deep" names some members of the *Mollusca phylum* on page 3. The students have already thought about how similar features link members of the cat family. A phylum groups organisms on the basis of their body plan and how it is organised internally. You could use the further activity (below) to illustrate this point.

Vertebrates and invertebrates

Remind the class that some animals have backbones (vertebrates) and some do not (invertebrates). As a group or pair activity, ask the students to list as many other vertebrates and invertebrates as they can think of, then share the findings as a class.

Finally, to round up discussing grouping or classification, you and your students could turn to page 29 in the article "What's That?" and read how Chris Paulin uses his knowledge of "what different animals and plants are made of, where they live, and how they live", together with close observation of sample animals and plants, to help him to classify them. If he is working with a previously undiscovered specimen, he may even be the person who gives it a name for the first time.

Recording observations

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

- **make observational drawings of living things (CiS).**

In order to group (classify) animals and plants, making and recording accurate observations about how living things look and behave is important.

Focus questions

- *In what ways can scientists record what they are observing?*
- *What kinds of things would an observational drawing or diagram be good at showing?*
- *Can you think of some things a drawing or a diagram could show better that a photograph?*
- *What kinds of things does an observational drawing or a diagram usually include to help you understand it?*

You can use the two diagrams on pages 4 and 5 to introduce drawing/diagram conventions, such as:

- a heading that tells readers what the diagram is about
- labels (in this case, offset to one side) that tell readers what the main features of the diagram are.

You may need to show additional examples of observational drawings or diagrams, including some that use arrows to connect the labels to specific parts of the drawing.

Students can reinforce these understandings by making and labelling their own observational drawings.

- Encourage your students to attempt observational drawings of living things, beginning with static examples such as common weeds or garden plants, different flowers, or a variety of fruits. This is an opportunity to reinforce that observational drawings must be based on looking closely at a real thing, not done from memory.
- Alternatively, or as well, the students could draw from a photograph. This would be a good opportunity to discuss the pros and cons of drawing from photographs or real specimens.
- You could discuss the names for important parts of what the students are drawing and talk about how scientists use labels and arrows to help people understand these important parts. The students may enjoy adding labels to their observational drawings.
- Depending on what the students are drawing, you could ask them to think about observing and drawing other views than from the outside. For example, they might cut a fruit open to observe what is inside it or lift a plant from the ground to observe its roots. Scientists investigate every aspect of plants and animals, including looking inside and preparing slides of plant and animal tissues to look at under a microscope. The students may like to discuss why making these different observations is important and what other things scientists need to consider (such as handling specimens safely and humanely).

Observing and recording behaviour

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

- **suggest what things a colossal squid might eat (LP, Ec)**
- **draw a simple food chain involving colossal squid (LP, Ec).**

To introduce observation of behaviour, reread page 8 of the student book together. Tell the students that scientists call a list of what eats what a “food chain”. It will help the students if you have some examples of food chain diagrams to show them. You will need to scaffold their understanding by introducing the idea of using arrows to show what is eaten by what. (What these arrows show more broadly is the flow of energy from the eaten to the eater.)

Focus questions

- *What are the links in the food chain described on page 8?*
- *The toothfish grows to quite a large size. What do you think it might eat?*
- *What kind of diagram do you think we should use for the colossal squid food chain?*

Sperm whales (and possibly other large whales) eat the colossal squid.

⇓

The colossal squid eats other squid, large toothfish (up to 2 metres long), and possibly other large fish.

⇓

Toothfish eat smaller fish, crabs, and prawns on the sea floor and smaller fish and squid nearer to the surface.

Check out the description of what colossal squid eat and how they hunt on the Te Papa colossal squid site at http://squid.tepapa.govt.nz/anatomy/article/how-the-colossal-squid-feeds

Three other aspects of squid behaviour are described on pages 4 and 5: how they swim, change colour, and squirt ink.

Focus question

- *Do you think being able to change colour or squirt ink would be useful for a colossal squid?*

Further activity

Observing molluscs

1. Provide access to pictures of slugs, snails, oysters, and clams (or other molluscs of your choice) from library books and the Internet.
2. Divide the class into four groups and give each group one of the four molluscs.
3. Ask each group to focus on the mollusc's body in the relevant pictures and to discuss its features.
4. Suggest that they write down at least two features to share with the class.
5. Summarise the groups' findings on the whiteboard. You may need to tease out observations about the soft bodies of the molluscs and link it to the technical term, invertebrate (lacking a backbone). Some of the more obvious features are listed below. Students may also comment on habitat (land or water, fresh or sea water).

Mollusc	Feature 1	Feature 2	Feature 3	Feature 4
Slugs	No backbone (inverterbrate)	No shell	Soft body without a separate head, arms, and legs	A strong single "foot" for creeping along
Snails	No backbone (inverterbrate)	Have a single shell	Soft body without a separate head, arms, and legs	A strong single "foot" for creeping along
Oysters	No backbone (inverterbrate)	Have a top and bottom shell (bivalves)	Soft body without a separate head, arms, and legs	A strong muscle to hold the shells closed
Clams	No backbone (inverterbrate)	Have a top and bottom shell (bivalves)	Soft body without a separate head, arms, and legs	A strong muscle to hold the shells closed

Ministry of Education resources

In *Making Better Sense of the Living World*, the section Science Focus: Classification (page 22) provides information about the systems scientists use to classify living things. It explains how categories such as vertebrate and invertebrate, phylum, family, and species fit into such systems.

Check out some of the books from the Building Science Concepts (BSC) series. Books 3, 5, 21, 25, and 45 discuss the relationships between structure and function in living organisms. Book 21 introduces the concept of habitat. Books 39, 45, and 55 look at classification in the animal kingdom.

- Book 3: *Birds: Structure, Function, and Adaptation*
- Book 5: *Fur, Feathers, and Bark: Animal and Plant Coverings*
- Book 21: *Life between the Tides: Sandy Shores, Mudflats, and Rocky Shores*
- Book 25: *Flowers, Fruits, and Seeds: Plants and Their Reproductive Parts*
- Book 39: *Is This an Animal? Introducing the Animal Kingdom*
- Book 45: *Slugs and Snails: Investigating Small Animals*
- Book 55: *Mammals: Investigating a Group of Animals.*

Visit Science IS. In particular, see the NoS theme All science knowledge is, in principle, subject to change at http://www.tki.org.nz/r/science/science_is/nos/theme_19_change_e.php

Check out the following activities:

- Grouping rocky shore animals at http://www.tki.org.nz/r/science/science_is/activities/isact_grouping_animals_e.php

- Constructing diagrams of food chains at http://www.tki.org.nz/r/science/science_is/activities/isact_food_chains_e.php
- Which ones are spiders? at http://www.tki.org.nz/r/science/science_is/activities/isact_which_are_spiders_e.php

Read "The Shell Collector" in *Connected 1 2005* and discuss Rebecca's scientific investigation. What did she observe, what did she infer, how did she investigate, and what did she discover?

Further resources

NZCER's Assessment Resource Banks (ARBs) include material that supports students' learning about classification. New Zealand teachers have access to these resources. If you do not already have a password, you can register at: arb.nzcer.org.nz/nzcer3/nzcer.htm

Select Science from the left-hand menu. Specific tasks can be looked up by selecting the appropriate classification fields and key words. Alternatively, you can use the free-text search and enter a word or phrase, for example, "food chain". If you know the number of a resource you want to access, use the free-text field. Your search will give you a list of resources, each of which can be accessed by clicking on the number on the left-hand side.

Scientists classify living things and group them together according to their shared features. Some features are readily observed, whereas others can only be observed by using scientific equipment such as a microscope. At levels 1 and 2, it's appropriate to focus on the readily observable features. ARB tasks LW0060, LW0063, LW0067, LW0068, and LW0069 all focus on classifying living things according to their readily observable features.

Task LW0637 describes a way of identifying the parts of an animal that help it to survive.

By downloading and saving tasks LW0637 and LW0067 as Word documents (click on MSWord at the top of the resource), you can personalise a task to meet your students' learning needs. Use an image from the cards for task LW0067 to customise task LW0637.

The website Windows to the Universe offers levels of suitability for each topic (beginner/intermediate/advanced) and covers large topics, such as Diversity and Classification of Living Things at http://www.windows.ucar.edu/tour/link=/earth/Life/life.html

Te Papa's Colossal Squid

Possible achievement objectives

Note: All achievement objectives are quoted from *The New Zealand Curriculum* (2007).

Science

Students will:

Nature of Science

Understanding about science (UaS)

- L1/2: Appreciate that scientists ask questions about our world that lead to investigations and that open-mindedness is important because there may be more than one explanation.
- L3/4: Identify ways in which scientists work together and provide evidence to support their ideas.

Material World

Properties and changes of matter (P&CoM)

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

Physical World

Physical inquiry and physics concepts (PI&PC)

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

Technology

Students will:

Nature of Technology

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.

Characteristics of technological outcomes (CoTO)

- L2: Understand that technological outcomes are developed through technological practice and have related physical and functional natures.

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.

Key ideas

Science

- Scientists explore the world by asking questions and planning investigations. Their investigations help them observe new things and help them explain how they think the world "is".
- Scientists share their ideas with other scientists as a way to test if their ideas seem correct.
- Melting, freezing, and dissolving are physical changes that can be reversed.
- Melting and freezing are changes in state brought about by heating or cooling.
- Dissolving is a kind of mixing.
- The properties of water change when it is combined with other substances.
- People have developed technologies that slow down or alter the natural process of decomposition.
- When we put a solid object into water, it pushes the water out of the way. (We call this "displacement".)
- A solid object floats in water when its displacement (the downward force of the object) is the same as the upward force of the water. The solid object floats when it has displaced just enough water to equal its own original weight.
- Making an object into a flatter shape rather than a tight ball increases the object's ability to float. (Students can probably visualise this from their own experience in the swimming pool.)

Technology

- Technology is how people intervene in the world for a specific purpose, and one common purpose of technological developments is to help people do things.
- Technological outcomes can increase people's capability to observe the world and can therefore provide science with powerful tools to increase their knowledge of the natural world.
- Technological practice undertaken to develop technological outcomes involves:
    - knowing what you are making and why
    - planning what to do and what resources are needed
    - producing and evaluating the outcome
- A technological outcome can be described in terms of what it looks like (physical nature) and what it does (functional nature).
- Physical attributes are linked to functional attributes in a technological outcome.

- Functional modelling is used to test design ideas before the technological outcome is created. Such modelling can take many forms (for example, talking about ideas, drawing, producing physical mock-ups, using computer simulations).
- Prototyping is used to test the technological outcome once it has been developed.

Shared learning goals

Shared learning goals are listed below in a table to illustrate the possibility of a context supporting learning in more than one learning area. This table does not mean that each goal must be covered in a unit of work. Teachers should select learning goals appropriate to students' learning needs and the context of study.

We are learning to:

<table>
<tr><th>Science</th><th>Technology</th></tr>
<tr>
<td>
Nature of Science
Understanding about science (UaS)

identify what the scientists discovered about the colossal squid
discuss how the scientists worked together to find the answers to their questions about the colossal squid.

Material World
Properties and changes of matter (P&CoM)

describe the differences between water as a solid and as a liquid
discuss why ice melts and water freezes
describe what happens when salt dissolves in water
observe how adding salt to water changes the temperature at which the solution freezes
discuss how the scientists preserved the colossal squid.

Physical World
Physical inquiry and physics concepts (PI&PC)

explain why objects float or sink.

</td>
<td>
Nature of Technology
Characteristics of technology (CoT)

describe how people went about designing and making the two tanks: one for the purpose of thawing the squid and one for the purpose of displaying the squid.
identify how technology allowed the scientists to learn more about the squid.

Characteristics of technological outcomes (CoTO)
(The concepts of physical and functional nature are rephrased more simply for students at this level.)

describe how the squid's display tank (or another display item) is constructed and how it works
identify the links between how the tank (or another item) is constructed and how it functions to meet the purpose of displaying the colossal squid.

Technological Knowledge
Technological modelling (TM)

identify how the scientists used a functional model to work out how to thaw the squid.
explain why the model was used and what evidence it provided for the scientists.

</td>
</tr>
</table>

Developing the ideas

How scientists work

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

- **identify what the scientists discovered about the colossal squid (UaS)**
- **discuss how the scientists worked together to find the answers to their questions about the colossal squid (UaS).**

This article allows students to develop an understanding of how scientists work. It is important that students realise that there are still many things scientists do not know. People find or experience new things that encourage scientists to ask questions.

Scientists plan and do investigations so they can observe the world closely to find answers to their questions. They use these answers to *explain* our world.

Scientists *share* their observations and ideas with other scientists so that they can help one another answer their questions. It is helpful when different types of scientists work together to investigate things. They sometimes argue because they see or understand things differently. This is a very good process – this *debate* helps them to test, improve, and compare ideas.

Scientists have to provide *evidence* to support their ideas.

These ideas about science should be reinforced for students when:

- students read articles (in newspapers and magazines) or view TV programmes about investigations in science
- students do their own investigations and learning in science.

Ideas of science

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

- **describe the differences between water as a solid and as a liquid (PCoM)**
- **discuss why ice melts and water freezes (PCoM)**
- **describe what happens when salt dissolves in water (PCoM)**
- **observe how adding salt to water changes the temperature at which the solution freezes (PCoM)**
- **discuss how the scientists preserved the colossal squid (PCoM)**
- **explain why objects float or sink (PI&PC).**

"Te Papa's Colossal Squid" contains references to ideas of science that can be explored in more detail. Ministry of Education publications that support the development of science units to develop students' learning about states of matter, physical and chemical change, preservation, and floating and sinking are listed below.

States of matter and physical and chemical change

Making Better Sense of the Material World provides the big ideas and activities to develop understanding about solids, liquids, changes in state, and dissolving.uses, Water and Drinks, are nicely sequenced to progress student understanding. These two focuses can be supported with reference to BSC Book 58, *Ice: Melting and Freezing*, and Book 16, *Sand, Salt, and Jelly Crystals: Mixing and Melting Materials*.

Preservation

The article describes how the colossal squid was preserved. Preservation of materials is an interesting context for developing ideas about physical and chemical changes in matter.

BSC Book 23, *Fresh Food: How Food Keeps and Loses Its Freshness*, and Book 24, *Preserving Food: Processes in Food Storage*, provide the big ideas and activities to explore how foods decompose and how they can be preserved. If these books are used in conjunction with *Making Better Sense of the Material World* to support the ideas around physical and chemical change, an interesting and robust science and technology unit could be undertaken. (For reference to the link with technology, see the suggestions under further activity below about how technological outcomes that preserve foods could provide a context to learn about technological systems.)

Floating and sinking

Teaching about floating and sinking is supported by the big ideas and activities in BSC Book 37, *Floating and Sinking: How Objects Behave in Water*, and Book 38, *Understanding Buoyancy: Why Objects Float or Sink*. Page 4 of Book 37 clearly explains the factors that affect whether an object sinks or floats.

As well as providing a variety of objects that either sink or float, as in the second activity of Book 37 (page 8), you could also provide objects that float at different levels, for example, two bits of wood of the same size and shape, one a light wood, such as cork, and the other a heavy wood, such as heart rimu. *In this case, weight is the variable.*

You could give the students a clay ball and get them to divide it into two equally sized balls. Roll one ball out flat and leave the other ball spherical. Then put both into a bowl or sink full of water and see what happens. *In this case, shape is the variable.*

You could further demonstrate that objects float at different levels by placing a fresh egg in a bowl of water and adding salt to the water very slowly. The egg will rise in the water as the water becomes more dense. *In this case, the density of the water is the variable.*

ARB task PW3546 explores the density of two liquids, oil and water. The teacher notes suggest some further activities for exploring density. (See the notes on accessing the ARBs in the section Other resources in “Monsters of the Deep”.)

These examples can challenge the students’ thinking further and can stimulate debate and reasoning about what “floating” and “sinking” might mean.

There are some additional notes and activities in *Making Better Sense of the Physical World* (pages 120–122).

Achieving technological outcomes

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

- **describe how people went about designing and making the two tanks: one for the purpose of thawing the squid and one for the purpose of displaying the squid (CoT)**
- **identify how technology allowed the scientists to learn more about the squid (CoT)**
- **describe how the squid's display tank (or another display item) is constructed and how it works (CoTO)**
- **identify the links between how the tank (or another item) is constructed and how it functions to meet the purpose of displaying the colossal squid (CoTO).**

It is important for students to realise that technological outcomes are frequently designed to help people achieve things that they could not do, or could not do as well, if they were relying on their own bodies.

"Te Papa's Colossal Squid" refers to a number of technological outcomes designed to increase people's capability in this way, for example, cranes, hoists, fishing nets, plastic bags, callipers, underwater cameras, the Internet, newspapers, webcams, syringes, forklifts.

These technological outcomes could be discussed in terms of how they assist people. Students could suggest other technological outcomes and discuss how they increase people's ability to do things.

The students could discuss the thawing and display tanks and explain why these are technological outcomes. They could also be supported to describe the thawing and display tanks and the other display items in terms of their physical and functional natures. This would allow students to begin to explore the relationship between the physical and functional nature of particular technological outcomes.

To gain insight into how people design and create technological outcomes, the students, with your help, could write a brief for the development of the display tank. You could then guide the students to write a brief for one of the other display items mentioned in the article.

Other examples could be used to repeat the activity above. "Room 5's Amazing Meeting Seating" (*Connected 2 2005*) and "How to Drink a Rose" (*Connected 1 2006*) could be used. The key idea is helping students to understand the parts and function of a brief.

"Te Papa's Colossal Squid" and the two *Connected* articles mentioned above could also be used to discuss and identify the key stages and resources needed by the scientists and students (in the 2005 and 2006 articles) when developing the technological outcomes.

Students should be encouraged to think about how the final display tank was tested to ensure it was fit for the purpose of both displaying and preserving the squid.

Technological modelling

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

- **identify how the scientists used a functional model to work out how to thaw the squid (TM)**
- **explain why the model was used and what evidence it provided for the scientists (TM).**

Technologists use modelling to test and explore ideas when developing an outcome. Although not a key focus of "Te Papa's Colossal Squid", the article does refer to the block of ice used to simulate the weight and to help the scientists calculate the thaw time of the squid. The article talks about the block of ice as a replica. If a replica is developed for the purpose of testing a design idea, it is a form of functional modelling.

Encourage your students to discuss why the monster iceblock was used. Guide them to understand the importance of, and reasons for, testing and exploring ideas before developing an actual outcome. Support students to suggest other ways in which ideas can be tested.

Use examples of modelling to help students realise that each model provides different information. Often, the information is about the physical nature of the potential outcome or how it might function. For example, talking and brainstorming provide lots of ideas and/or solutions, a 2-D cardboard mock-up shows how big an outcome will be, and a 3-D mock-up shows how the object shades other objects or how the outcome fits together or operates.

The students could also be encouraged to think about the limitations of functional modelling and why it is important to test the completed technological outcome itself.

Further activity

Science and technology

As a related study, students could develop ways of exhibiting objects of interest in the classroom. Living organisms will require learning specific to the organisms' needs, and dead organisms will require preservation.

Technological outcomes that preserve foods could provide a context for learning about technological systems. Items such as dehydrators, smokers, and ovens are examples of technological systems. The students need to be able to identify the components of the system, the inputs and outputs, and the purpose of the system.

You could provide a brief requiring the students to develop a technological outcome that specifically increases the capability of a person or group of people. The students could identify a specific purpose for such an outcome and refine the brief to describe the key attributes it should have. They could undertake functional modelling to produce a conceptual design of an outcome that has the potential to be fit for the specific purpose outlined in the brief. They could then develop an outline for the key stages and resources that would be needed to produce and test the outcome.

Further resources

Visit the official Te Papa website at http://blog.tepapa.govt.nz/category/colossal-squid for more on the colossal squid exhibition, including: squid anatomy; the squid files (on the squid's journey from capture to display); and other options.

What's That?

Possible achievement objectives

Note: All achievement objectives are quoted from *The New Zealand Curriculum* (2007).

Science

Nature of Science

Understanding about science (UaS)

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

Communicating in science (CiS)

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

Living World

Evolution (Ev)

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

Key ideas

- Scientists often have a deep curiosity about the nature of things and how they work.
- Investigation of the living world involves careful observation and recording of the evidence gathered.
- Scientists preserve living things carefully as a record of their investigations and for future reference.

Shared learning goals

We are learning to:

- discuss why it's important to make observations when trying to identify and classify living things (UaS, CiS, Ev)
- discuss why it's important to collect specimens and preserve them in a way that conserves their physical features (UaS, CiS)
- share our experiences of discovering living things that we did not know about before (CiS).

Developing the ideas

The University of Canterbury's page about physics asks, "What type of student should consider a Physics degree? Someone with an experimental and/or mechanical bent?" It goes on to say: "Certainly these help. The needed motivation is an enquiring mind and a fascination with natural phenomena. Rutherford was intrigued in childhood by seeing a stick apparently bend when dipped into a farm bucket of water; Einstein asked how his face would appear in a hand-held mirror if he ran at some significant fraction of the speed of light (answer: the image would not change). A budding physicist will share this fascination with and curiosity about the natural world." Go to http://www.canterbury.ac.nz/subjects/phys

You could encourage your students to discuss their ideas about who scientists are and what they do. What qualities would make someone a good scientist?

To develop student appreciation of Chris's journey through science, you could:

- Put the key events of Chris's science learning on a timeline.
- Read "The Shell Collector" in *Connected 1 2005*. Might Rebecca's fascination with the living world continue? What might she study at university? What work might she do when she grows up?
- Alternatively, or in conjunction with "The Shell Collector", read "Buried Treasure" in *Connected 1* and *2 2008*. The unnamed girl in this story collects fossil shells and looks forward keenly to her next fossil hunt. If her excitement about fossils continues, what kinds of science might she want to study when she is older?

Ministry of Education resources

Connected 2 2009 features some other kinds of scientists. "The Magic of Science" features a virologist, "DNA Talks Every Time" discusses forensic scientists, and "Dead Pigs with Maggots Please!" features a molecular microbial ecologist.

Further resources

The American Museum of Natural History's Ology website explains some of the different branches of science. After your students have read "What's That?" (or "Buried Treasure" in *Connected 1* and *2 2008*), you could asked them if they can think of any other kinds of scientists or areas of science. They could then visit the Ology website and explore further at http://www.amnh.org/ology