# Science and Numeracy

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## Introduction

The 2010 Australian Curriculum documents represent a sharp break with previous practice in Australian schools. They have resulted in mandated content from Foundation to Year 10 in all Australian jurisdictions. In the case of the Australian Curriculum Science (ACS), this content is set out in three columns as follows:

- Science Understanding (*SU*: things to be taught to learners),
- Science as a Human Endeavour (*SHE*: context to be exposed for learners) and
- Science Inquiry Skills (*SIS*: things to be done by learners).

The content descriptions are supported by introductory explanatory material, suggested elaborations, achievement standards and a set of very useful General Capabilities and Cross-curriculum Priorities (ACARA, 2015).

Learners already know things and they use the things they know to make sense of new experiences. Any new learning that links to unpredictable experience may lead to expected understandings, unexpected misunderstandings or some alternative conception representing a combination of the two. If something new does not connect at all with learner prior knowledge, it is likely to be ignored or quickly forgotten (Baviskar, Hartle, & Todd-Whitney, 2009). Our learning experiences are scaffolded by our families and the cultures and sub-cultures within which we grew up. Learner cultural knowledge and the extent to which school knowledge is connected to their lives will influence the extent to which students pay attention to the experiences teachers design to help them acquire supposedly socially important

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M. Sellars (ed.), *Numeracy in Authentic Contexts*,
https://doi.org/10.1007/978-981-10-5736-6_16

knowledge, such as science (Waldrip, Timothy, & Wilikai, 2007). 'Knowledge' that learners do not recognise as significant is discarded. Because of this, science sits ambiguously in learners' worlds. On one hand, science is school knowledge: '*teacher stuff*' at best and only of interest to '*dead privileged white males*' at worst. On the other hand, learners are immersed in the world that science claims to explain. Both things are true: science ***is*** both all around us and locked in books written by people unlike ourselves. There have long been profound concerns about the lack of impact school knowledge seems to have on learner beliefs (Caleon & Subramaniam, 2005; Pfundt & Duit, 1997) and yet science-themed media command a wide audience. This combination is odd and the very popularity of science infotainment can bring tensions between specialist and popular science to the surface (Jeffries, 2003).

Young children soak up experiences at an astounding rate and appear able to pay meaningful attention to multiple tasks, although they may make apparently unpredictable meanings. Many young children are profoundly interested in the world around them. Anybody who spends time with young children will hear many questions and often they will pile one atop the other! Many of these questions fall within that search for understanding that we call 'science' and they provide those of us who teach it with a great place to start and a wonderful opportunity for moving forward. However, something happens when these young children become young school learners and it happens much more obvious when they move between ACARA's Years 6 and 7. Children's almost insatiable curiosity about their world becomes muted and 'science' becomes something for other people. Science becomes a problem rather than an exciting opportunity. Effective teaching utilises a combination of content knowledge, learning theory and pedagogy is one version of Pedagogical Content Knowledge (Abell, 2008; Park & Oliver, 2008). The absence of any of these three components of teacher knowledge will make quality science teaching less likely. All of this is as true of the mathematical components of the now mandated science content as it is of the more recognisable science ideas.

## Science and Mathematics

The entire field of science is underpinned by mathematical concepts and procedures. In this discipline, hypotheses become questions of chance and probability and answers are frequently found in the manipulation, measurement and interpretation of data, statistics, frequencies and measurements that become the empirical data. This is the evidence collected by observations and experiments and subsequently analysed by scientists. From the very simplest observations and experiments to the most complex and sophisticated, this evidence is recorded as mathematical symbols, mathematical visual organisers and mathematical formulae. The analytical component of the work of scientists is also underpinned by the logic and reasoning that is embedded in mathematics as the processes by which patterns and relationships are identified in diverse contexts, generalised and abstracted to develop formulae.

Examples of the interdependence of mathematical competencies can be found in every strand of the sciences. As early as the Foundation year in physical science, students are asked to visualise two-dimensional shape and three-dimensional objects and the ways in which they move. This not only requires that students have substantial prior knowledge of the similarities and differences of two-dimensional shape and three-dimensional objects and of their properties but also presumes that students have had sufficient experience handling and exploring these artefacts. It is simply not possible for young students to visualise these shapes and objects and the ways in which they move if they have not previously explored then tactilely. Feeling the edges, corners, examining the faces of shapes and objects, seeking out their capacities to roll, stack and pack are critical to the students' understanding of how they may visualise the movements of each and to determining the impact of the second aspect of the scientific inquiry; generalising about the properties of these shapes and objects to establish the categories or classifications to which they each belong. To this end, students need to be able to discuss how the shapes and the properties of objects facilitate or impede certain types of movement, such as rolling, sliding, etc. Students also need have had these tactile and visual–spatial experiences so that they can also reflect on the notion of size and if it larger or smaller items of the same shape or construction move differently from each other. The entire conceptual foundations of this formal introduction to the study of understanding the physical world are underpinned by learning in the mathematics strand of space.

Similarly, the science inquiry skills of year one and year two students necessitate students to be able to measure accurately (this is without overlaps or gaps) using informal measures and later, metric measures and further recording these measurements using drawings, tables and technological software. Developing these inquiry skills requires students to have established one–one correspondence, to trust the count, to count on and to have other number related competencies. Comparing measurements for discussion with peers involves the establishment of other foundational mathematical competencies. One of these is conservation of attribute, without which meaningful comparison cannot be made as it is not likely that the students will understand the critical nature of a common, level starting point from which to measure or compare their observations with their predictions, which would be based on the language of probability. Another is the recognition that both informal and formal units of measurement are required to remain a stable quantity. For example, clothes pegs joined together to make an informal measure for length need to be of equal size and formal measures using centimetres, for example, need to be equally calibrated. Students and the mathematical language, a pivotal aspect of predicting the outcomes of everyday events is the capacity to reason logically and understand the notion of 'chance' as relative to their predictions.

The primary elements of the Australian syllabus are no less dependent on foundational mathematical knowledge. The learning tasks in the year three earth and space sciences demand an understanding of rotation as a full revolution, along with sophisticated understating of time, including night and day and how these concepts relate to each other and form a pattern of daylight and darkness depending on the position of the earth which rotates on its axis. The focus on the basic tenets of mathematical reasoning and logic is further explored as the major conceptual understanding in nature and development of science for this age group and in the planning and conducting of experiments as science skill development. This is particularly important in the measuring, recording and data displays that result from experiments, tests and observations of phenomena. At this stage, students are also required to reflect on the notion of a 'fair' test and discuss logically when a test may or not be considered as meeting these criteria. Technological representation of data includes the digital development of mathematical visuals to display data, including column graphs, maps, diagrams and tables and the capacity to 'read' these digital displays and disseminate the information they represent in terms of any visible patterns and relationships. Whilst the digital construction of graphs and tables at this stage automatically formats equal calibration, spacing and structure where appropriate, students still need to use their mathematical knowledge to enter data correctly after determining measurement scale and unit of measurement and the attributes that are being measured for comparison and analysis. Interpreting this information demonstrates the students' capacities to interpret statistical data. However, they are required also to compare their predictions with the actual evidential data and develop hypotheses which explain any differences or validate their predictions. This requires a considerable application of the reflection, decision-making, explaining and validating that comprises the mathematical construct of adaptive reasoning.

Identifying and explaining pattern and relationship remains a focus throughout the middle years of primary schooling in science. Investigations that include exerting force to create movement, either at close range or from a distance provides varied and complex data depending on the scope of the distance, the objects being propelled and the force expended. This data provides fertile ground for mathematical calculations, interpreting visual data displays, matching or explaining differences in predictions and conducting 'fair' tests. The science skills and enquiry processes are also consolidated at this stage with students being required to produce data displays of increasing complexity, interpret this data and analyse for patterns and relationships; including the mathematical notions of repeating patterns and growing patterns; and become increasingly skilful at determining attributes to be measured, units of metric measurement to be used and the competent use of smaller calibrations of metric measures which include decimals to one place and fractions. Many of the activities associated with exerting force on objects and the resultant impact on the object in terms of movement also engage students in the conceptual complexity of the mathematical use of rate and ratio to explain the results of activities such as kicking a ball from various distances at a witches hat and measuring any distance travelled by the witches hat or making origami jumping frogs a standard size, half the size and double the size and recoding the number of times force was exerted to make the frog travel a predetermined distance. The comparison of the results of experiments such as these provide opportunities for students to discuss what they already experience in, for example, ball games or games that involve hitting, kicking, or throwing and travelling in a vehicle at various speeds.

The senior primary years' curriculum in science continues to rely heavily on students' mathematical knowledge, thinking processes and strategic understanding. These allow students to further develop more complex science enquiry and process skills as the facilitate the predicting, reflecting reasoning, measuring, data gathering and analysis that is integral to scientific endeavour at all levels of investigation. The various, more complex development of mathematical visuals to display and describe data are increasingly important as are the skills of interpreting data, using this evidence to create possible explanations for the results whilst considering social and cultural events and conditions which may have an impact on the explanations. The entire range of mathematical competencies; fluency, understanding, strategic competence, adaptive reasoning and problem-solving skills and strategies are integral to the purpose of scientific study and investigation. This is consistently evident in the Australian curriculum for science as it is further unpacked and examined into the lower secondary (middle school years) years of schooling. These basic mathematical ways of working with evidence, recording and interpreting data, understanding statistics and developing increasingly abstract formulae in algebraic terms are heavily relied upon as the science experimenters and investigations get increasingly more come complex, subtle and sophisticated. The capacities to make predictions, understand the mathematical potential of chance, measure diverse attributes accurately and generalise arithmetic evidence to abstract an algebraic rule or function are the foundational skills of science inquiry, not only in school contexts but are evidenced in the industrial, academic, historical and cultural endeavours in all societies through the history of mankind.

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| **Differentiation** students can experiment with other root vegetables and see if they also grow in water (they should as all their nourishment is stored in the tuber or bulb). They can measure informally using paddle pops sticks and making a mark or taping thin pieces of fine cardboard to the back of the glass and making carefully. Unifix and other materials that connect can be used to measure (paper clips, clothes pegs etc.). Later, other vegetables may be grown in the school garden. | **Australian Curriculum Mathematics Outcomes**<br><br>(ACMMG006) | Numeracy Links<br><br>*Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language<br><br>*comparing objects directly, by placing one object against another to determine which is longer |
| **Australian Curriculum Subject outcomes and elaborations**<br><br>ACSSU002 Needs of living things<br><br>ACSHE013 Observation<br><br>ACSIS014 Questioning the familiar<br><br>ACSIS012 Sharing observations | **The Learning Task: Foundation- Pot Plants and Potatoes**<br><br>In this task the students are able to see what is going on at both ends of the sweet potato as it grows in the water. They are able to appreciate what happens in the growth of what they may eat for dinner. | **Including ATSI perspectives** This activity is perfect for students in this group. These students may have a strong connection to the land and may have opportunities to grow something in their gardens at home although traditional hunters and gatherers, not farmers. The class may wish to plant other things in the school garden and may choose traditional bush tucker roots as these are Australian http://www.survival.org.au/bush_tucker_diet. |
| **Strategies to include learners with a background of oracy:** Many of these students may have the background knowledge for this task and the class may wish to try this task with other root vegetables that are commonly eaten in their diet. Although traditionally many peoples from backgrounds of oracy were nomadic, in recent times this changed and they may have had a garden in their original homeland or may have one in their new homeland. The students will be able to follow the demonstration by the teacher and their peers but may need the language associated with reflecting and explaining supported by visual materials | **Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and encouraging short bursts of focussed discussion. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of group or individual plants. | **Variations for students from diverse social contexts: S**ome students may be really familiar with sweet potato, having eaten them at home as chips, baked or boiled and mashed. Many may never have seen how they grow so it may be useful to roast small cubes of sweet potato on a baking tray, sprayed lightly with oil and allow the students to taste the plant that they are growing in the glasses. Some students may want to plant these in a home garden so it is useful to be aware that only one 'eye' is required per plant and large sweet potatoes can be cut in pieces so that each one has an 'eye' |

## Foundation: Science—Pot Plants and Potatoes

**Resources**: Each group (or individual) will need one small sweet potato, four toothpicks, a drinking glass and water. The sweet potato needs to be small enough to fit into the drinking glass with one-half sticking out the top and the other just above the bottom of the glass.

**Background for teachers**

Science in the Early Years is predominantly a matter of directing children's attention to parts of their environment that they may not otherwise notice and redirecting them before their interest wanes. Unexpected connections between parts of that environment can generate and sustain considerable situational interest.

**Science Concepts**:

Plants are composed of roots, stems, leaves and some reproductive part, such as a flower or a cone. Some plants reproduce through these and others can reproduce from cuttings or tubers. Sweet potato (called '*kumera*' in some parts of the world) is a very useful plant with a starchy tuber that is very tasty when it is cooked. Sweet potato can reproduce from this tuber or from flowers that grow from their stems. Many children will only have seen a sweet potato in bins in the fruit market and they the idea that this vegetable can grow into something that is recognisable a plant can evoke considerable enthusiasm. This activity allows children to watch the vegetative reproduction of a sweet potato. If the water is topped up, the potato will grow roots from its bottom half and stems and leaves from its top. If left long enough, some potatoes may flower.

**Implementation**:

*Activity Origin:* Adapted from Hinkler 2015, Activity 65.

Each group/individual should:

- Fill the drinking glass with water.
- Stick toothpicks around the middle of the sweet potato, so that they are evenly spaced.
- Place the potato into the glass.
- Make sure that the bottom of the potato is in the water.
- Place the 'potato-in-water' equipment on a shelf where they are in the sun for part of the day.
- Check their potato every day.

**Reflection Activity**: *, **

Each day, each group should discuss what has happened to their sweet potato.

- Are different things happening to different ends of the sweet potato?
- How much time passed before something happened?
- How could the group keep a clear record of what happened when?
- What does this activity show about plants?
- How could we measure the plants?

**Differentiation:** After the initial explorations, students may be able to experiment with bottles of different sizes and then place in order of how they would like the pitch to alter and adjust the water level accordingly. They can make a video of their activities in groups and discuss the ways in which they were able to vary the sound. Some may be able to explain that the sound depends on size, shape and volume of water.

**Australian Curriculum Mathematics Outcomes**

(ACMMG006)

**Numeracy Links**

*Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language

**comparing objects directly, by placing one object against another to determine which contains more

**Australian Curriculum Subject outcomes and elaborations**

ACSSU020 **Making & sensing sound**
ACSHE021 Questioning & describing
ACSHE022 Using science
ACSIS025 Investigating with guidance
ACSIS212 Compare observations with descriptions, through discussion

**The Learning Task: Year One – Musical Bottles**

This lesson allows students to make sound and to use water levels in bottle to vary the pitch. It can lead to many opportunities for discussion and for further exploration of sound and making sounds

**Including ATSI considerations:** These students may have experiences with traditional instruments and the class may be able to experiment with vibration and sound in the context of some of these traditional musical instruments

http://www.didjshop.com/austrAboriginalMusicInstruments.htm

**Strategies to include learners with a background of oracy:** these students would have traditionally not had many if any possessions, being nomadic, however the drum was a staple at all ceremonial and community celebrations. These students may be familiar with drums, the decorations and the different sounds that they make when varied. The class may like to investigate sound and vibration using home- made drums of different sizes or a bucket band with different sized buckets. See https://www.google.com.au/search?q=home+made+drums+for+children&espv=2&biw=1440&bih=862&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwivwL_zyM

**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and encouraging additional 'experimentation' with the instrument. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class performance on the instruments and explanation of their operation.

**Variations for students from diverse social contexts:** Music is common across all cultures, social and economic classes and castes. In some circumstances the types of music that students know and enjoy can be indicative of their background and their cultural origins. You may find that students with diverse backgrounds may want to make music in different ways and enjoy certain types of rhythm and combinations of sounds. See https://www.youtube.com/watch?v=rkHLGxG68 Be aware that the US is represented by the national anthem and the images include soldiers in full battle dress which may distress some students with refugee experiences

## Science: Year 1: Musical Bottles

**Resources**: Each group (or individual) will need five identical glass bottles, a plastic jug, access to water and a spoon or fork.

**Background for teachers**

Young children enjoy making sounds. This activity allows them to deliberately change the sound they make and exposes them to a couple of technical words ('pitch: high/low' and 'volume: loud/soft' that they can use to describe the changes that they make.

**Science Concepts**:

Things that move backward and forward (*vibrate*) quickly make sound and sounds have two fundamental qualities: *pitch* and *volume*. Pitch is the technical word used to indicate whether a sound sounds 'high' or ' low'. Volume is used to indicate whether a sound is 'loud' or 'soft'. Hitting (or plucking) something strongly produces loud sounds. Make it move backward and forward more quickly and it will produce high sounds. Slower vibrations cause lower sounds. This is as much explanation (and technical vocabulary) as should be expected from a one-year child.

Vibrating objects push and release against their surroundings and this sets up regular movement through fluids: waves. Our ears respond to these waves and we call it 'sound'. The compressed air hits our eardrum, there is a pause and then the next compression hits. We hear the size of the compression (*amplitude* of wave) as volume and the time between them (*frequency* of wave) as pitch. Thinner, or lighter, objects vibrate more quickly (*at a higher frequency*) than thicker, or heavier, ones. This explains why the thinner strings on a guitar sound higher when plucked and why the bottles holding more water sound lower in the activity that follows.

We (and elephants) can also 'hear' very low-frequency waves through our chests. You might have noticed this at pop concerts: you hear the falsetto lead vocal with your ears and the bass guitar and drums through your diaphragm!

**Lesson**:

*Activity Origin:* Adapted from Hinkler 2015, Activity 245.

*Each group should:

- Put the bottles in a line.
- Add water to the bottles: a little water in the first and then a little more in each as they move up the line.
- ***Gently*** hit each bottle in turn with the spoon (or fork).
- ***Gently*** hit the bottles in any order.

**Differentiation:**

There is no way to differentiate this activity authentically but the actual use of the paper for Mother's Day card or other personal use gives the students opportunities to make personal choices and decisions.

**Australian Curriculum Outcomes**

(ACMMG038)

**Numeracy Links**

*Compare masses of objects using balance scales

**Using activity sequence and reasoning to solve problems.

**Australian Curriculum Subject outcomes and elaborations**

ACSSU031 **Mixing on purpose**
ACSHE035 Recycling
ACSIS038 Manipulating materials

**The Learning Task: Year Two – Making paper**

This is a step by step guide to making paper with young students. It clarifies exactly what the teachers must do themselves and the steps that the students must carefully take to get an understanding of the process of recycling.

**Including ATSI perspectives:** Like the other students from oral traditions, these students historically had no use or need for paper. However, their conservation and caring for the land created an environment where there was no need for recycling. No wasted paper and no littering at random. Traditional customs differ from those used today but there are some famous examples of ATSI recycling. The class might like to see some activities. http://australianmuseum.net.au/blogpost/museullaneous/recycling-off-the-beach-aboriginal-artists-and-ghost-net-at-pormpuraaw Following explicit, linear, direct

**Strategies to include learners with a background of oracy:** These students would not have traditionally had any use for paper. However, in a print dominated world it may be interesting for these students to participate in this activity and use their own paper for some special purpose. Like the ATSI students, the introduction of narrative and action with the task can enhance student learning. All the students may like to decorate their paper with tradition symbolic design.

**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and reminding them of the use of such paper for gifting purposes. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of their recycled paper.

**Variations for students from diverse social contexts:**

Paper may have been a vital and useful commodity for some of these students and been in short supply. It may be valued for its unique characteristics as their personally created paper. However, some students may not value recycling or the notion of creating something as ordinary and everyday as paper. Despite different attitudes that may be present in the class, the processes of this lesson are valuable as demonstrating the conceptual understanding of recycling materials to make something new and usable.

**Reflection Activity:

- How could you describe the sounds that you have made?
- What changed the sounds that you made?
- Can you play a tune on your bottles?
- Can you explain how your musical instrument works?

## Science: Year 2—Papermaking

**Resources**: The class will need one bottle of liquid detergent, one bottle of household bleach, a large transparent glass mixing bowl, a square of metal fly screen (approx. 20 cm a side), access to water and a sink, a stainless steel tablespoon. Each group (or individual) will need a quarter of a sheet of old newspaper (about 30 cm by 20 cm), a pair of scissors, a metal egg ring, a square of metal fly screen (approx. 10 cm a side), a small transparent glass mixing bowl, a stainless steel teaspoon, an old newspaper to protect their table, a clean dry tea towel and a sheet of clean dry cardboard.

**Information for teachers**

Cheap, light and flexible writing material was very important in the development of civilisation and paper meets that need today. Paper was invented in China around the Second Century, filtered west through Eurasia to Baghdad by the middle of the Eighth, to Spain by the Twelfth and was in general use in Europe by the Fourteenth Century, just in time for the invention of the printing press. Paper was originally made from such things as waste cloth and straw (hence the derogatory reference to newspapers as 'filthy rags') but it has been made from pulped wood since the Nineteenth Century. This has had a rather negative impact on the world's forests. Paper is not hard to make from other paper and this led to it being one of the first materials to be widely recycled. This activity demystifies a common material for young children and helps them understand why waste for recycling is sorted before collection. This activity takes place in two phases.

**The activity requires that the teacher use bleach to prepare old newsprint for recycling as 'artisan paper'. The children should NOT carry out that phase of the activity for themselves. The activity MUST be trialled before use with a class. As bleach is not allowed in some school environments, the bleaching process may be done at home, preferably outside.**

**Science Concepts**:

Paper is a compressed mat of fibres that can be easily smoothed, coloured and decorated. The fibres are usually *cellulose*. The stringy stuff in celery is the most commonly encountered example of cellulose. Pressed, tangled fibres of cellulose will stick together as they dry to form paper.

**Differentiation:**

Almost any pantry ingredient can be used in this task. A range of material may include those that change dramatically during the freezing process such as fresh vegetables and fruit. The groups may all have different materials and compare their changes to the materials selected/ provided for the other groups.

**Australian Curriculum Mathematics Outcomes**

(ACMMG061)

**Numeracy Links**

*Measure, order and compare objects using familiar metric units of length, mass and capacity

**recognizing the importance of using common units of measurement

**Australian Curriculum Subject outcomes and elaborations**

ACSSU046 **Change of State**
ACSHE050 Making predictions
ACSIS053 Scientific questions
ACSIS055 Safe use of materials

**The Learning Task: Year Three-Freezing** This task requires students to investigate what happens when materials are frozen. It raises questions about what might freeze and thaw successfully and what may not. The students can be encouraged to think about the scientific concepts –particularly that relating to water content of materials as an important consideration in the freezing process.

**Including ATSI Perspectives:** in certain parts of the country materials would freeze naturally, in other parts the notion of freezing would be very foreign indeed. Australia is always thought of as hot! The class could investigate groups who inhabited the colder parts of Australian traditionally. This activity suits this group of students as the nature of the learning is congruent with 'planning and visualising explicit processes' https://intranet.ecu.edu.au/__data/assets/pdf_file/0016/510073/8-Aboriginal-ways-of-learning-

**Strategies to include learners with a background of oracy:**

Perhaps the most inclusive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning.

**Authentic Assessment strategies:**
Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and exploring their differing experiences of temperature. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of applications of food chilling.

**Variations for students from diverse social contexts:**

Many students would need no introduction to the ideas of freezers and freezing. (a number of students may live on frozen meals and fast foods). The most supportive strategies may be to ensure that the ways in which the instruction is given is explicit and is easily understood by the students and that the scientific concepts are explained in ways that the students can relate to their own experiences.

**Lesson**:

*Activity Origin:* Adapted from Brothers, Gow & Mackay 1983, p. 754.

*Each group should: (i) Weigh their newspaper on the balance scales using dienes equipment then tear or cut their piece of newsprint into pieces about 2 cm square. (ii) Pass their pieces to the teacher. The teacher should (i) Place the newsprint pieces into the glass mixing bowl (ii) Cover the pieces with household bleach (iii) Slowly stir the mixture with the table spoon for about 5 min. The mixture should form a uniform grey pulp (iv) Put the mixture in a safe place and let it stand overnight.

*Next day*, **(i) pour the contents of the bowl, through the larger metal fly screen square, into the sink (ii) Carefully, use the table spoon to scrape the pulp off the mesh and put it back into the mixing bowl (iii) Wash the pulp with water in the bowl and then pour it back through the mesh (iv) Repeat the washing three times (v) Mix a table spoon of detergent with the pulp in the mixing bowl and then wash the mixture another three times (vi) Return similar amounts of yellowish pulp to each of the groups.

Each group should: (i) Spread the newspaper over their table (ii) Use the teaspoon to place their mound of yellow pulp, in the egg ring on the metal fly mesh, over the small mixing bowl (iii) Rock the mesh gently as the water drains into the bowl (iv) Gently remove the egg ring from the wet mat of yellow pulp (v) Lay the mesh, with the wet mat on top, on the newspaper on your table (vi) Fold the tea towel in two and lay it over the mesh (vii) Reach under the tea towel and put one hand under the mesh. Place the other hand on the tea towel (viii) Turn the tea towel over, so that the tea towel is under the wet mat of yellow pulp and the mesh is above mat (ix) Carefully lift the mesh off the wet mat of yellow pulp (x) Fold the tea towel to cover the wet mat of yellow pulp (xi) Place a piece of strong, dry cardboard on the tea towel above the mat and press it as hard as possible. This should squeeze out the remaining water (xii) Take away the cardboard and lift the top flap of cloth. The mat should have become a sheet of wet yellow paper (xiii) Peel the wet paper disc carefully off the tea towel and put it on a sheet of dry paper or cardboard. You have made recycled paper!

**Reflection Activity**:

What happens to the ink from the old newspaper? Why did the teacher wash the mixture(s) so many times? Describe places where you have seen this sort of paper before. Will the paper weigh the same as it did before the process? Give reasons.

## Science: Year 3—Freezing

**Resources**: Each group (or individual) will need access to water, vinegar, tomato sauce, bread, rice, butter and other household substances; a container for each substance (small yoghurt containers or an ice tray, depending on quantity), access to a freezer. One set of kitchen scales per group.

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| **Differentiation:**<br><br>Due to the precise nature of the experiment and the safe use of materials involved, this may not be easily differentiated. However, different materials may be used after the initial experiment to further research the concepts of heat transfer using solids. Then these may be compared with the liquids in this experiment. | **Australian Curriculum Mathematics Outcomes**<br><br>(ACMMG061) | **Numeracy Links**<br><br>*Measure, order and compare objects using familiar metric units of length, mass and capacity<br><br>**recognizing the importance of using common units of measurement |
| **Australian Curriculum Subject outcomes and elaborations**<br><br>ACSSU049 **Conduction**<br>ACSHE050 Making predictions<br>ACSIS053 Scientific questions<br>ACSIS055 Safe use of materials<br>ACSIS058 Fair tests | **The Learning Task: Year Three (ii) Ouch! That Burns!**<br><br>This task involves the students investigating heat in an experiment that focusses on safe use of materials | **Including ATSI perspectives:** This is an activity based task does suit the ways of making meaning which are used by this group. However, many students in the class may find difficulty following explicit instructions in a linear manner as this does not support their ways of learning. The task itself is connected to the natural world and to country. It can be easily embedded in narrative for the class https://8ways.wikispaces.com/Aboriginal+pedagogy+research+review |
| **Strategies to include learners with a background of oracy:**<br><br>Perhaps the most inclusive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds. | **Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and engaging them in conversation about the application questions. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class design of the 'perfect cup'. | **Variations for students from diverse social contexts:**<br><br>The conceptual understandings related to this lesson are heavily embedded in specific language. To support all students this language needs to be investigated, to be defined and to be made accessible.<br><br>One way to do this is to engage the students through narrative, through the drawing and describing and through group and peer discussion. |

**Background for Teachers**

Many homes have domestic freezers and the food is either bought frozen or chilled for later use. This activity is designed to focus child attention on a common kitchen phenomenon.

**Science Concepts**:

There are three common physical states of matter, solid, liquid and gas. Materials change their state when they lose or gain energy. Most children experience this energy as heat and variations as changes in temperature. Different materials are in different states at different temperatures. The temperatures at which a material changes state are its freezing, melting and boiling points. Pure water freezes at 0 °C and boils at 100 °C. The freezing and boiling points of water will change if it is not pure.

**Lesson**:

*Activity Origin:* Adapted from Hinkler 2015, Activity #129.

Each group should:

- *Weigh the materials according to the size of the containers and the nature of the material (5 g increments. The containers should be placed on the kitchen scales and the dial reset to zero. This need to be done each time a different container is used. Food can be weighed in one container and transferred to another neatly if desired.
- **Each group needs to estimate and then decide how much of each material they are putting in their containers and add it to the description.
- Place each material in a separate container.
- Draw a picture of each and describe it.
- Put the containers in the freezer overnight.
- Check the containers next day.

**Reflection Activity**:

- Describe any changes you see?
- Why do we cool foods like this?
- Is there any difference in the changes for the materials when they are different weights?

## Science: Year 3—Ouch! That burns!

**Resources**: Each group (or individual) will need access to hot water (NOT boiling), one drinking glass, one metal mug, one pottery cup and one polystyrene cup. Measuring cups with calibrations.

**Background for teachers**

Heat flow is one of the most common experiences for growing children but they still seem to burn themselves. This activity focuses on the insulating properties of some materials.

**Differentiation:** there are a number of ways in which this task can be differentiated. The students can explore what happens when magnets get together, when they are near a variety of different metallic objects – what reacts and what doesn't- they can develop a facts sheet about magnets and how they work, what they used for in industry, how they react with various technology and so on.

**Australian Curriculum Mathematics Outcomes**

(ACMSP092)

**Numeracy Links**

*Describe possible everyday events and order their chances of occurring

****using lists of events familiar to students and ordering them from 'least likely' to 'most likely' to occur**

**Australian Curriculum Subject outcomes and elaborations**

ACSSU076 **Action at a distance**
ACSHE061 Predicting and describing relationships
ACSIS216 Compare results with conclusions

## The Learning Task: Year Four - Magnetism

This task explores the magic of earth forces, magnets and magnetisation and direction including the cardinal points

**Including ATSI perspectives:**

Students may prefer to learn by repetition of another's example but the will be able to carry on from this original experiment by examining the whole, then the parts of the experiment and deconstructing and reconstructing the steps along the way with the examination of the non-verbal cues.
https://8ways.wikispaces.com/Aboriginal+pedagogy+research+review

**Strategies to include learners with a background of oracy:**

Perhaps the most supportive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds. The class may enjoy this lesson embedded in narrative.

**Authentic Assessment strategies:**
Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and guiding the discussion of magnets. Children often already know quite a lot about magnets. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class discussion of the role and use of magnets.

**Variations for students from diverse social contexts:**

Most students will enjoy investigating this area of magnetism. Some students who have more sophisticated understandings of technology and computers may be able to explain how they work together, why credit and other cards with magnetic identifying strips and similar devices should not be stored next to magnets.

**Science Concepts**:

Heat flows through contact (*conduction*), expansion (*convection*) and flight (*radiation*). Some substances conduct heat better than others. Solids conduct heat better than liquids, liquids conduct heat better than gases and empty space will not conduct heat at all. Metals conduct heat better than glass, glass conducts heat better than pottery and pottery conducts heat better than polystyrene. Polystyrene is a solid foam of plastic with gas inside the bubbles. It slows down conducted heat (*insulates*) so well because the heat has to get around the bubbles.

**Lesson**:

*Activity Origin:* Adapted from Hinkler 2015, Activity #128.

Each group should:

- *, **Fill the four containers with the same amount of hot** water.
- Gently and carefully place your hand around each container, one at a time.

**Reflection Activity**:

- Why were you asked to touch the cups 'carefully and gently'?
- Why were you asked to use the same amount of water in each cup?
- Which container felt hottest?
- Which container felt coolest?
- Which container would you use to keep chocolate hot on a cold night?
- Which container would you use to cool down a hot cup of soup?
- What would be the perfect drinking cup?

## *Science: Year 4—Magnetism

**Resources**: Each group (or individual) will need a needle, a magnet, a pair of scissors, a small piece of cardboard, a jar, thread, a pencil and a magnetic compass.

**Background for the teacher**

Magnetism looks like magic: things move without being touched and unseen forces resist human effort. It is no wonder that children (and adults) find magnets fascinating. This activity depends on class access to magnets, which can be bought fairly cheaply from hobby or toy shops.

**Science Concepts**:

The Earth has a core with two layers that are not moving together. The relative movement between the two huge concentric balls produces a magnetic field, within which we all live. This *geomagnetic* field allows migrating animals to navigate and makes some substances behave very strangely on the earth's surface. They attract iron, attract and repel each other and indicate direction if left free to move. We call these things 'magnets'. They are not magic; they are just arranging themselves in the geomagnetic field.

**Differentiation:** There are a number of ways in which this task can be differentiated. The students can explore what happens when a variety of other substances are subjected to the sun's energy. Are they solid or liquid? Students can make predictions based on prior knowledge and experiences but the task can be made increasingly complex by heating something that is part liquid, part solid and asking for explanations and reasoning from the students.

**Australian Curriculum Mathematics Outcomes**
(ACMSP116)

**Numeracy Links**

*List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions

**Australian Curriculum Subject outcomes and elaborations**

ACSSU043 **States of matter**
ACSHE217 Benefits of fuels in different states
ACSIS093 Varieties of communication

**The Learning Task: Year Five – Solids, Liquids and Gasses**

An introduction to the particle model of matter.

**Including ATSI perspectives:** Students may prefer to learn by repetition of another's example but they will be able to carry on from this original experiment by relating it to their knowledge and understanding of the land and the impact of heat on various liquids. Using narrative in this context will support learning shttps://8ways.wikispaces.com/Aboriginal+pedagogy+research+review

**Strategies to include learners with a background of oracy:**

Perhaps the most supportive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds. The class may enjoy this lesson embedded in narrative

**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their understanding by managing whole class discussion to draw out the classroom image with which the Science Concepts section ended. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class enactment of the particulate explanation of change in state.

**Variations for students from diverse social contexts:**

The language in this lesson may need to be simplified and to be gradually defined within the conceptual understanding of the task. The students could describe/ write what happened in their own words before engaging with the vocabulary on the whiteboard. They can the substitute any words they have not used (or used correctly) from the list in their activity descriptions so that they have a draft with their own explanation and a draft with the metalanguage required for the more scientific report

**Lesson**:

*Activity Origin:* Adapted from Hinkler 2015, Activity #238.

Each group should:

- Stroke the needle with the magnet to magnetise it.
- Tie one end of the piece of string to the small piece of cardboard and the other to the pencil.
- Push the needle through the piece of cardboard. Make sure that the middle of the needle rests in the middle of the cardboard.
- Lay the pencil across the mouth of the jar to hang the piece of cardboard inside the jar. Set the length of the string so that the cardboard does not touch the bottom of the jar.
- The cardboard should turn on the string.

**Reflection Activity**:

- What is turning the cardboard?
- In which direction does the needle points?
- Explain what you see.
- Why do you think this is happening?
- *Make predictions about the chance of the same thing happening in your next experiments. **Record your predictions using the terms from 'most likely' to 'least likely'
- Repeat but without stroking the needle with the magnet- has anything changed?
- Repeat and pass the magnet through the cardboard but not through the centre- what happens—has anything changed?
- Using all these findings, develop some ideas about the reasons why the fits experiment worked but the others were not so successful
- Test the experiment again with your own ideas to see if you have come to the correct conclusions regarding why the first experiment worked and the others were not as successful.
- **Write up your findings and illustrate showing the experiments you performed.

## Science: Year 5—Solids, Liquids and Gases

**Resources**: Each group (or individual) will need a brick, a large block of ice, a saucepan, a heat source (like the sun on a hot day).

**Background for teachers**

The Australian Curriculum begins to move children's science towards that expected at later stages of schooling in Year 5. This activity forms part of the introduction of the particle model of matter.

**Science Concepts**:

There have been two historic views of the nature of stuff (*matter*). One has seen matter as essentially *continuous*. That is, stuff is shoved up against other stuff, with no space in between. The other view is that matter is made up of smaller bits of stuff that are eventually hanging around together but not touching (*particulate*). These views are sometimes called theories or *models* because the particles are invisible. Modern science is based on the particulate model, which leads to the conclusion that everything is pretty much nothing because the spaces between are so much bigger than the particles when we get small enough. This sounds pretty silly, and some fairly intelligent people (Ernst Mach for one) have disbelieved it, but it does allow us to explain things that the continuous model cannot. That is the definition of a successful model in science. Children often find it a bit silly, too. After all, where are the holes? The states of matter are where they get introduced to the model.

*Solids* have a definite size and shape because the particles are close together and moving just a little. *Liquids* have a definite size but not a definite shape because the particles a little closer but they are sliding around each other. *Gases* have no definite size and no definite shape because the particles are far apart and keep shooting off in all directions.

Energy is the key to this model. The particles in solids have less energy than those in liquids, so they stay in place. The particles in a gas have more energy than those in a liquid, so they break away from each other. If we take energy from a gas, it will *condense* to form a liquid, which will *freeze* to form a solid if we keep pulling out energy. Remember Activity 4?

A class of students is a common image for this: a solid during the lesson, a liquid when the lesson ends and a gas in the playground.

**Lesson**:

*Activity Origin:* Adapted from Brothers, Gow & Mackay 1980, pp. 62–68.

Write the following words on the board: *size, shape, definite, melt, boil, evaporate, solid–liquid, gas*

Each group should:

- Compare the brick and the block of ice
- What are the good criteria for comparison? Make a list
- *Predict what might happen in the experiment
- *Use a fraction to describe the chance of your experiment resulting in your prediction
- Put the ice in the saucepan and begin to heat it slowly (this can simply be done by putting them outside in the sun on a hot day)
- Describe what happens.
- *Predict—what would happen to the brick if you did the same to that?
- *Predict what may happen to a variety of other substances

**Reflection Activity**:

- How are the brick and ice similar; how are they different?
- What happens to the shape of the ice block as you heat it?
- How could you explain this?
- Write out your explanation.
- What happened to the shape of the brick?

**Differentiation:** It is rather complex to try and duplicate this experiment to illustrate how and earthquake happens but it is possible to simulate realistically with technology or with a hands on activity using marshmallows and toothpicks

https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_natdis/cub_natdis_lesson03_activity1.xml

**Australian Curriculum Mathematics Outcomes and elaborations:**

(ACMSP144)

**Numeracy Links**

*Describe probabilities using fractions, decimals and percentages

**Australian Curriculum Subject outcomes and elaborations**

ACSSU043 **States of matter**
ACSHE217 Benefits of fuels in different states
ACSIS093 Varieties of communication

**The Learning Task: Year Six – Tsunamis and Earthquakes**

An experiment that illustrates the actions of the earth plates and the resultant upheaval that causes these natural disasters

**Including ATSI perspectives:** This is an activity based learning opportunity that is linked to the land and not necessarily language based. The actions themselves are indicative of what occurs, as is the Aboriginal legend of how the earth was created, which includes some very serious understandings of earth movement and the creation of landforms. This could be used respectfully to enhance the modern scientific understanding of the forces that break through the earth's crust and the movements that create these natural phenomenon but this is controversial for some http://www.upfromaustralia.com/dreamabstoro.htmlhttps://8ways.wikispaces.com/Aboriginal+pedagogy+research+review

**Strategies to include learners with a background of oracy:** Perhaps the most supportive strategies in the lesson for this group of students is to ensure they have sufficient language support to join in the predictions and reasoning for the reflection. The introduction of narrative is always supportive as it reflects their traditional ways of learning and making meaning as do the Aboriginal pedagogies as both are from non-print backgrounds. Throughout the world, all cultures and peoples have had their own stories about the world, its natural ways moving and the subsequent earthly upheaval so it may be interesting for the class to investigate some of these. Integrating traditional stories with modern scientific explanation is controversial for some. Care is needed. Some students may have experienced these natural disasters

**Authentic Assessment strategies:** Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and enhancing the realism of the tsunami simulation by adding additional detail or asking open questions about the group response to their observations. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through class presentation of group explanations. Their predictions also show understanding of the impact of the force with which these movements occur

**Variations for students from diverse social contexts:** Some students in this group may have experienced one of these natural disasters. The language in this lesson may need to be simplified and to be gradually defined within the conceptual understanding of the task. The students could describe/ write what happened in their experiments in their own words before engaging with the formal vocabulary. They can the substitute any words they have not used (or used correctly) from the list in their activity descriptions so that they have a draft with their own explanation and a draft with the metalanguage required for the more scientific report

## Science: Year 6: Earthquakes and Tsunamis

**Resources**: Each group (or individual) will need a deep baking pan, access to waterand two blocks of wood. Optional requirement are, toothpicks, a bowl of jelly and marshmallows for each group (enough marshmallows and toothpicks for each group/pair/individual to make a basic 'house' shape.

**Background for teachers**

Disasters seem to fascinate students and Earth Science helps us to understand them as moderately predictable consequences of the way our planet is constructed, rather than the capricious whims of a vengeful nature. Care should be taken with classes which may include children with the personal experience of any of these disasters.

**Science Concepts**:

The *crust* of the Earth is made up of a number of solid *plates* which a floating on a liquid *mantle*. We live our whole lives on the top of these slowly shifting blocks. Plates are being formed where mantle material rises through cracks in the crust and destroyed where one plate plunges underneath another. Such movements explain volcanoes, earthquakes, tsunamis, landslides and other natural disasters. Plate movement can cause earthquakes, which in turn trigger underwater landslides, which in turn set up strong waves in the sea nearby. These waves may be relatively harmless in deep water. The disturbed water simply rolls in large surges above the sea bed. However, if the wave moves into shallow water, it can suck back water from harbours and then rush in as very high waves. 'Tsunami' is the Japanese word for 'harbour wave' and it gives these disasters their name.

**Lesson**:

*Activity Origin:* Adapted from Hinkler 2015, Activity #236.

Each group should:

- Fill the pan with water and take it outside to a grassy area.
- Push the two blocks of wood completely under the water in the pan.
- Hold the blocks and move them together quickly.
- Repeat this until the blocks can no longer squeeze the water.
- Watch the way that the blocks coming together below the water makes waves at the surface.

**Reflection Activity**:

- What happened to the surface of the water when you moved the blocks together on the bottom of the pan?
- Describe how this might explain disasters at sea.
- Can you use this experiment to explain how earthquakes occur?
- There is a measure of the energy released from earthquakes that can be measured by seismic waves (Richter Scale)

- How would you measure the energy expended as you banged your black together under the water?
- What might happen if you have been more gentle? Less forceful?
- *Repeat the experiment several times and predict the chance of displacing all the water in the baking dish in a specific number of actions, e.g. chance of it happening in 3 strong forceful actions, 6 soft actions, etc. use decimals, fractions and % for your predictions.
- If investigating the earthquake with house models using toothpicks and marshmallows, make the same predictions about your 'house' and the bowl of jelly

## 1. Year 7: What is 'pure'?

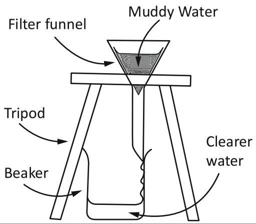
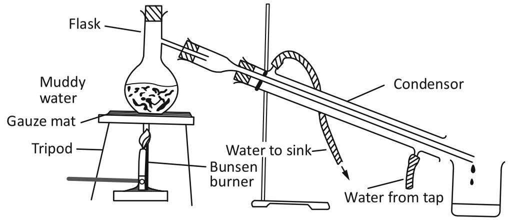
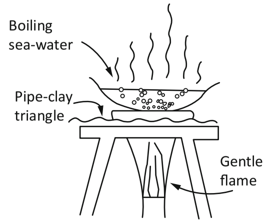
Science in secondary contexts is a separate subject, with specialist teachers and specialist spaces. This lesson is written for a double practical period of about 80 min duration.

**Science Concepts**:

Most natural materials are mixtures of different things. For example, sea water is a mixture of water, common table salt and small amounts of other salts. The different parts of a mixture have different particle sizes, boiling points, melting points, densities and solubilities. These are physical properties and we can use them to separate the different parts of a mixture. So we can dry out sea water to get the salt out of it. When we have tried all the ways of physical separation, what we have left is a pure substance. For example, if we cannot separate the salt any further, we have pure salt. This lesson applies this science to the problem of providing safe drinking water.

**Lesson**:

*Activity Origin:* Adapted from Brothers, Gow & Mackay 1977, p. 98.

|  |  |  | **Equipment**<br>***(for one set of stations)*** |
|---|---|---|---|
| Station 1<br>**Filtering**<br>1. *Put an empty beaker under the tripod*<br>2. *Wet the inside of the funnel with water*<br>3. *Put the funnel into the tripod, so that its tube is inside the lip of the beaker*<br>4. *Fold a piece of filter paper and put it into the wet funnel*<br>5. *Pour some muddy seawater into the funnel*<br>6. *Carefully describe what you see to your group members* What is in the funnel? What is in the beaker? How did this happen?<br>7. Is the water clean yet? Is it pure?<br>8. *Pass the beaker on to the next group* (Station 2), *to put the liquid into the flask* | Station 2<br>**Distilling**<br>Some broken bits of pottery have been added to the flask. The liquid in the flask is the same as that in beaker from Station 1<br>*Discuss the following questions with your group:*<br>1. What is happening in the flask?<br>2. What is going up the flask and then down the tube?<br>3. What is dropping into the beaker?<br>4. Why is the tube connected to the water tap?<br>5. How does the water in the beaker differ from the water in the flask?<br>*Use what you know about the particle model of matter to explain what is happening in the:*<br>6. Flask<br>7. Tube<br>8. Beaker | Station 3<br>**Evaporating**<br>This activity is dangerous, so be VERY careful<br>1. *Put some of the liquid from the measuring cylinder into the little white bowl*<br>2. *Light the Bunsen and turn it down so there is a gentle flame*<br>3. *Add more liquid to the bowl as the liquid level drops*<br>The liquid will sometimes 'froth'. When that happens, move the Bunsen burner, let the 'frothing' die down and then put the burner back under the bowl<br>The first two groups on this Station will move on before the action is over<br>4. *Keep adding liquid until it begins to 'spit'*. When this happens, turn off the gas to the Bunsen burner and let the bowl cool<br>5. *Compare the liquid in the measuring cylinder with the liquid in the funnel and beaker on Station 1 and the flask and beaker in Station 2*<br>6. What do you see in the bowl?<br>7. *Discuss what you think is happening* | • 250 mL beaker of mixed dirt and sand<br>• 3 large drinking glasses: 300–500 mL in capacity<br>• 2 × 1 litre bottles of sea water (60 g of table salt added to 1 L of water)<br>• 1 triple beam balance<br>• 5 clean beakers (250 mL)<br>• 3 tripods<br>• 1 wire gauze<br>• 1 pipe-clay triangle<br>• 2 Bunsen burners<br>• 1 ceramic evaporating dish<br>• 1 filter funnel<br>• 6 filter papers<br>• 1 distillation apparatus: round bottom flask, Liebig condenser, associated fittings and access to water tap and sink<br>• 1 measuring cylinder of seawater (100 mL)<br>• Small pieces of broken pottery |

**Reflection Activity**:

- Imagine that you are washed up on a small tropical island with three of your classmates.
- Discuss with them how you might use what you have learnt through the activities in this lesson to produce safe drinking water.
- Design the equipment that you think that you might use from the things that might have been washed up with you.

## Australian Curriculum Subject Outcomes and Descriptors

ACSSU113 **Separating mixtures**

*Elaboration*:

- Investigating and using a range of physical separation techniques such as filtration, decantation, evaporation, crystallisation, chromatography and distillation

ACSHE119 Scientific knowledge changes
ACSHE223 Science changes through collaboration

*Elaboration:*

- considering how water use and management relies on knowledge from different areas of science and involves the application of technology

- recognising that traditional and Western scientific knowledge can be used in combination to care for Country and Place

ACSIS125 Plan and conduct investigations

*Elaboration:*

- working collaboratively to decide how to approach an investigation, learning and applying specific skills and rules relating to the safe use of scientific equipment
- identifying whether the use of their own observations and experiments or the use of other research materials is appropriate for their investigation

**Authentic Assessment**

Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. The teacher could monitor the quality of their discussions by moving between groups and enhancing the realism of the 'castaway' scenario by adding additional detail or asking open questions about the group response to their imagined situation. This formative assessment of outcome satisfaction could support the summative evaluation of group and individual work through the class presentation of group plans.

**Differentiation:** This experiment can be duplicated with tank water, creek water, stagnant water, water from water holes and even tap water in order to try and gauge what pure water really is.

Investigate how people may purify water when travelling long distances without new supplies, when camping away from water supplies, in rural areas in times of drought etc. What equipment could they use to do this and what did the first settlers use to purify water?

**Australian Curriculum Mathematics Outcomes and elaborations:**

(ACMSP116)

(ACMSP117)

**Numeracy Links**

*List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions

**Recognise that probabilities range from 0 to 1

**Australian Curriculum Subject outcomes and elaborations Separating mixtures** ACSSU113*Elaboration*: Investigating and using a range of physical separation techniques such as filtration, decantation, evaporation, crystallisation, chromatography and distillation **ACSHE119** Scientific knowledge changes **ACSHE223** Science changes through collaboration *Elaboration:* considering how water use and management relies on knowledge from different areas of science, and involves the application of technology, recognising that traditional and Western scientific knowledge can be used in combination to care for Country and Place **ACSIS125** Plan and conduct investigations. *Elaboration:* working collaboratively to decide how to approach an investigation, learning and applying specific skills and rules relating to the safe use of scientific equipment

**The Learning Task: Year Seven- What is pure?**

A laboratory based investigation of muddy sea water involving filtering, distilling and evaporating.

**Including ATSI perspectives:** These students belong to a cultural group who knew exactly how and where to find clean water in this dry land. The following shows how white are helped to find water by those who know all the traditional means http://www.rswa.org.au/publications/Journal/82(1)/82(1)bayly.pdf how to distil it without scientific equipment https://www.youtube.com/watch?v=s5G9nQTLB0U

**Strategies to include learners with a background of oracy:** many of these students are from cultures that were originally nomadic and who travelled to water in the dry seasons before the 1980s when the United Nations erected hand pumps. Not all settlements had these nearby so there was still some travel to collect water and may still have to be purified to the best standards possible. These student may know some of these methods

http://www.thealternative.in/lifestyle/traditional-water-purification-methods/

**Authentic Assessment strategies:**
Students demonstrate that they have met the outcomes of this lesson by the quality of their work at the 'Reflection Activity' stage. Questions may be:
Imagine that you are washed up on a small tropical island with three of your classmates.
Discuss with them how you might use what you have learnt through the activities in this lesson to produce safe drinking water.
Design the equipment that you think that you might use from the things that might have been washed up with you.
Do you think the volume of the water was the same in millilitres as when you started?
How probable do you think that your explanation for the events in Station 3 were on a scale of 0-1?

**Variations for students from diverse social contexts:** There are numerous reasons why students may not have consistent access to clean drinking water, although in Australian towns and cities the tap water supply is relatively safe to drink. http://www.cleverwater.com.au/blog/is-australia-s-tap-water-safe-for-drinking/4 In rural communities there may be concerns about the water supply so it is best to check your local area for information http://www.abc.net.au/news/2015-11-09/rural-children-at-risk-of-parasite-thriving-in-fresh-water/6922432http://www.health.nsw.gov.au/environment/water/Pages/drinking-water-database.aspx

## Year 7: What is 'pure'?

250 mL beaker of mixed dirt and sand, three large drinking glasses: 300–500 mL in capacity, 2 × 1 litre bottles of sea water (60 g of table salt added to 1 L of water) one triple beam balance, five clean beakers (250 mL), three tripods, one wire gauze, one pipe-clay triangle, two Bunsen burners, one ceramic evaporating dish, one filter funnel, six filter papers, one distillation apparatus: round bottom flask, Liebig condenser, associated fittings and access to water tap and sink, one measuring cylinder of seawater (100 mL) and Small pieces of broken pottery.

**Science Concepts**:

Most natural materials are mixtures of different things. For example, sea water is a mixture of water, common table salt and small amounts of other salts. The different parts of a mixture have different particle sizes, boiling points, melting points, densities and solubilities. These are physical properties and we can use them to separate the different parts of a mixture. So we can dry out sea water to get the salt out of it. When we have tried all the ways of physical separation, what we have left is a pure substance. For example, if we cannot separate the salt any further, we have pure salt. This lesson applies this science to the problem of providing safe drinking water.

**Lesson**:

*Activity Origin:* Adapted from Brothers, Gow & Mackay 1977, p. 98.

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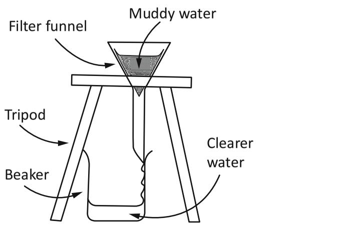
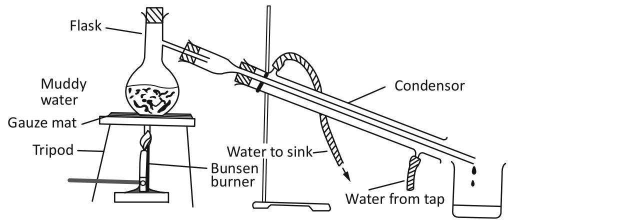
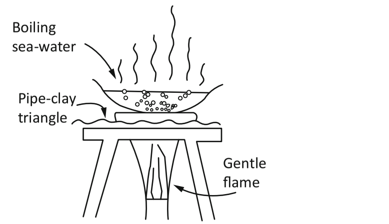
<td></td>
<td></td>
<td></td>
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<td>Station 1 Filtering<br>1. Put an empty beaker under the tripod<br>2. Wet the inside of the funnel with water.<br>3. Put the funnel into the tripod, so that its tube is inside the lip of the beaker<br>4. Fold a piece of filter paper and put it into the wet funnel<br>Pour some muddy seawater into the funnel<br>*,**Predict what may happen using fractions on a probability line 0–1<br>5. Carefully describe what you see to your group members. What is in the funnel? What is in the beaker? How did this happen?<br>6. Is the water clean yet? Is it pure?<br>7. Pass the beaker on to the next group (Station 2), to put the liquid into the flask</td>
<td>Station 2 Distilling<br>Some broken bits of pottery have been added to the flask. The liquid in the flask is the same as that in beaker from Station 1<br>Discuss the following questions with your group:<br>1. What is happening in the flask?<br>2. What is going up the flask and then down the tube?<br>3. What is dropping into the beaker?<br>4. Why is the tube connected to the water tap?<br>5. How does the water in the beaker differ from the water in the flask?<br>Use what you know about the particle model of matter to *,**predict on a probability line 0–1 what is happening in the:<br>6. Flask<br>7. Tube<br>8. Beaker</td>
<td>Station 3 Evaporating<br>This activity is dangerous, so be VERY careful<br>1. Put some of the liquid from the measuring cylinder into the little white bowl<br>2. Light the Bunsen and turn it down so there is a gentle flame<br>3. Add more liquid to the bowl as the liquid level drops<br>The liquid will sometimes 'froth'. When that happens, move the Bunsen burner, let the 'frothing' die down and then put the burner back under the bowl<br>The first two groups on this Station will move on before the action is over. *.<br>**Predict, using a probability line 0–1 what may happen as you add more liquid<br>4. Keep adding liquid until it begins to 'spit'. When this happens, turn off the gas to the Bunsen burner and let the bowl cool. Compare the liquid in the measuring cylinder with the liquid in the funnel and beaker on Station 1 and the flask and beaker in Station 2<br>5. What do you see in the bowl?<br>6. What do you think is happening?</td>
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### Author Biographies

**Mitch O' Toole** Associate Professor Mitch O' Toole has worked in science education at all levels since 1978. Mitch's major research interest is communication in science contexts, it has arisen directly from his diverse background in teaching and learning and it continues to inform his practice.

**Dr. Maura Sellars** graduated from the Froebel Institute in London (now part of the University of Roehampton) She has almost thirty years experience as a classroom teacher in primary school settings. She currently teaches mathematics, numeracy and pedagogy at the University of Newcastle, NSW. She is particularly interested in developing an equity pedagogy, belonging and inclusion, critical and creative thinking and literacy and numeracy as social practice.