

Water on Earth

A Primary Schools Water Resource





Australian Government

AusAID



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Background

The General Assembly of the United Nations adopted and signed the Millennium Declaration at its eighth plenary meeting on 8 September 2000. This declaration outlines the goals to be achieved if all peoples across the world are to have a better standard of living and freedom.

The declaration can be read and downloaded from <http://www.un.org/millennium/declaration/ares552e.htm>

The Millennium Goals

This is the historic promise that 189 world leaders made at the United Nations Millennium Summit in 2000 when they signed onto the Millennium Declaration and agreed to meet the Millennium Development Goals (MDGs). The MDGs are an eight-point road map with measurable targets and clear deadlines for improving the lives of the world's poorest people. World leaders have agreed to achieve the MDGs by 2015.

The full list of Millennium goals and, via hyperlinks, further explanations about these goals can be found at <http://www.endpoverty2015.org/>

This resource about water relates specifically to Millennium Goal 7: Ensure Environmental Sustainability which is outlined in its entirety at <http://www.un.org/millenniumgoals/envIRON.shtml>

Within this goal, target 7.C aims to *halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation*. The above link sums up the current (2011) status of the achievements of this goal.

- The world is on track to meet the drinking water target, though much remains to be done in some regions,
- Accelerated and targeted efforts are needed to bring drinking water to all rural households,
- Safe water supply remains a challenge in many parts of the world,
- With half the population of developing regions without sanitation, the 2015 target appears to be out of reach,
- Disparities in urban and rural sanitation coverage remain daunting,
- Improvements in sanitation are bypassing the poor.

The following resource provides activities for teachers of Primary School Science (F–6) with a focus on the importance of clean water and sanitation to humans and all other living things. This resource is not designed to be a stand-alone unit. It is proposed that individual activities or groups of activities are incorporated into pre-existing teaching/learning units. Each group of activities has been aligned to elements of both the Australian Curriculum – Science F–6 and Global Education Perspectives.

Chapter 1: Water for people

Activity 1.1: Water in our bodies: how much water do we take in?

Target Years: F–2

Problem: How much water do we take in every day?

Main teaching focus

Humans need a lot of water every day. Where do we get this water?

Australian Curriculum References

F-2 SU

- Living things have basic needs, including food and water
- Earth's resources, including water, are used in a variety of ways

F-2 SHE

- Science involves exploring and observing the world using the senses

F-2 SIS

- Respond to questions about familiar objects and events
- Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate.

Background Science

Food is organic material that is consumed by living organisms and consists of carbohydrates, proteins and fats. The food we eat was once living and therefore most foods contain water too.

Unless food is very dry, there will be water intake associated with eating. Most people probably get about 20% of their daily fluid needs just from the foods they eat. Fruit tend to have more water, whereas something dry like toast would have much less.

Water is also a major component of fruit juices, milk and soft foods such as yoghurt.

Part of this activity could include the differences between conditions in Australia and other countries where we are fortunate to have access to safe, clean water and more than adequate amounts of food. Some background reading about the effects of the lack of food and water can be found at http://www.hrea.org/index.php?base_id=145 and the rights of children to have access to water. This site has a number of classroom activities for water: <http://www.globaleducation.edu.au/global-issues/gi-water-and-sanitation.html> and for food: <http://www.globaleducation.edu.au/global-issues/gi-food-security.html>

Global Education Perspective

Students need to consider what needs to be done for all to live in a world where all people have sufficient food and water for a healthy and productive life.

Students' potential alternative conceptions

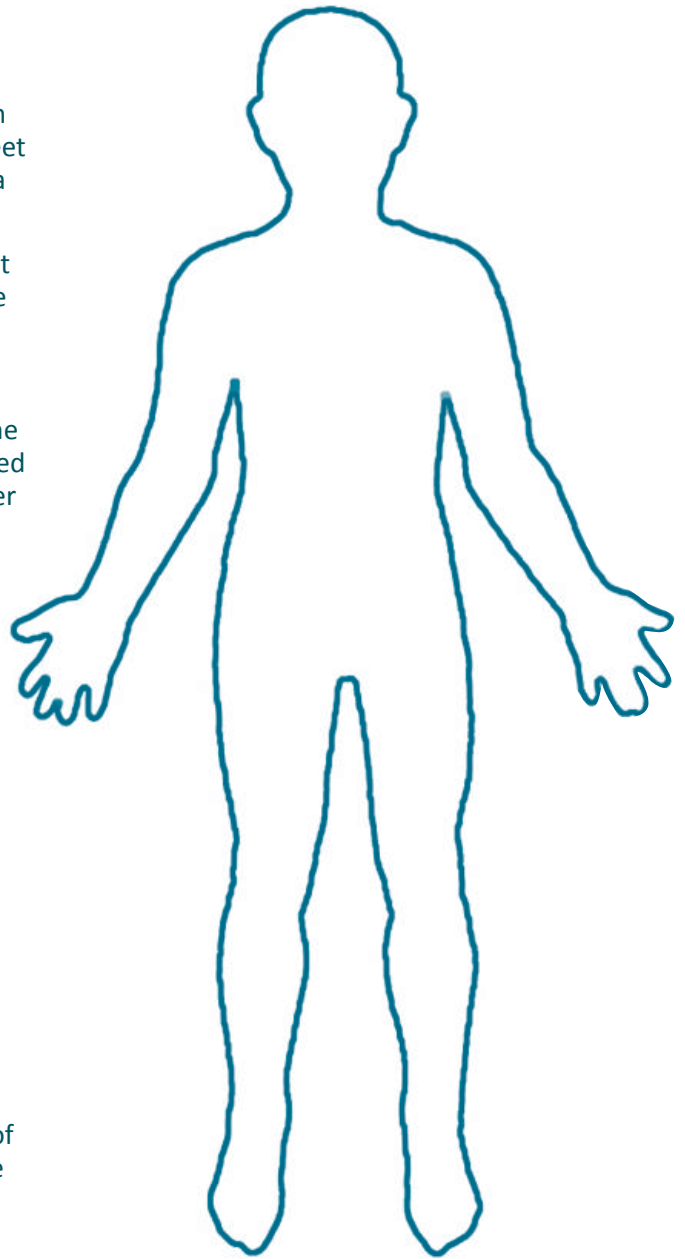
Children think that food is a solid that is different to the liquids we drink (Driver, 1994).

Children in K–6 may observe that water 'disappears' when a wet surface dries; however, they will not be able to explain evaporation in terms of change of state (the liquid water changes to water vapour gas). They will explain the loss of weight in food that dehydrates by something disappearing.

Activities

Part 1 – In the classroom

1. Using our senses to determine if a living thing needs water: Seeing (wilting plants), feeling (thirsty), hearing (a human saying they need a drink).
2. Take an apple or carrot and try to squeeze the water out of it noting that it cannot easily be squeezed out. Then place the apple and carrot separately into a liquefier and observe the apple and carrot juice being produced. Discuss the change from the solid food (fruit) to the liquid (fruit juice). Measure how much juice was found in one carrot or one apple.
3. Set up a tally chart so students can show how many times they drink each day. Write down what students do each day e.g. sport or no sport; hot day or cold day. Infer a reason for needing more water for some types of activities.
4. Colour in the body outline to show how much of the body is water (~60%).
Alternatively, to avoid any misconception that the body fills with water from the feet up (or head down), have students draw a sector graph.
5. Choose two slices of bread that are about the same weight. Toast one and compare the weights of the toasted vs untoasted bread. Is there a difference? If so, it is mostly due to lost water. How much water was lost? Infer what happens to the amount of water in food when it is roasted in the oven, boiled or steamed with water or eaten raw. Which food provides more water?
6. Take some yoghurt. Weigh it. Place it in some muslin and leave it in a strainer/ sieve overnight to drain. Weigh the curd and the liquid the following day. Is it approximately the same weight? Where did the water come from? How does it taste different?
7. Case study: Getting water for people.
http://teachunicef.org/sites/default/files/units/Water-and-Sanitation_PreKto2.pdf has some photographs on pages 66–68 that could be used to talk about the different sources of water for children in other countries such as: roof draining into a house water tank, a handpump, a river, a water truck. Observe the colour of water that people drink. Which looks the cleanest?
8. Case study: Getting food for people.



There are a number of different activities that look at poor countries around the world and how they have improved their agriculture practices at:

<http://www.globaleducation.edu.au/global-issues/gi-food-security.html>

Activity 1.2: There's water in our bodies!

How do we know?

Target Years: F–2

Problem: Can we show that there is water in our bodies?

Main teaching focus

Students are led, through guided questioning and observations, that their bodies contain a lot of water.

Australian Curriculum References

F-2 SU

- Living things have basic needs, including food and water
- Earth's resources, including water, are used in a variety of ways

F-2 SHE

- Science involves exploring and observing the world using the senses

F-2 SIS

- Respond to questions about familiar objects and events
- Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate.

Background Science

Water is important to all living things. The chemical reactions of life take place in a watery environment in cells. In complex living things such as mammals and flowering plants, there are specialised vessels to carry substances dissolved in water through the living thing. Water also helps keep plants and animals cool.

Some living things have up to 90% of their body weight as water. About 60% of the human body is water. About 83% of our blood is water which carries digested food, wastes from cells, and heat around the body.

Each day humans lose about 2.4 litres of water through perspiration and urination as well as in exhaled air. The lost water must be replaced through drinking as well as from the foods eaten. Currently there are 17% of the world's population that do not have access to fresh water (WHO, 2011).

Global Education Perspective

Water is essential for life. Water is needed to grow plants and animals for food and humans need water to survive. Students need to consider what needs to be done for all to live in a world where all people have sufficient food and water for a healthy and productive life. Currently there are 17% of the world's population that do not have access to fresh water (WHO, 2011).

Students' potential alternative conceptions

Children have little idea of where and how water is transported through animals and plants.

They think water is food for plants and that water is absorbed through the leaves.

Children think that water is for the plant to drink and that it remains unchanged. They think the water is the main component of new material as the plant grows.

Children understand the concept of living things taking in water however have trouble accepting water can be found inside solid things e.g. skin. They also do not understand that blood is made up of water; they think it is a different type of liquid. (Driver, 1994)

Activity

Part 1 – in a wet area or outside

Collect balloons (or some other stretchy fabric in a bag shape), flour, spoons and water.

1. Ask the students to gently pinch their forearm muscle (between the elbow and wrist). What does it feel like?
2. Then ask the students to spoon some flour into the balloon. Does it feel the same as their forearm?
3. Now pour some water into the balloon and shake the balloon to mix the flour and water. What does the balloon feel like now?
4. Lead a discussion to suggest that there might be water inside them.
5. Collect some grapes and compare the feel of the grape with the feel of the skin on the arm. How are they the same?
6. Collect a dried grape (sultana) and compare the feel of the grape and the feel of the sultana.
7. Lead the students to make a conclusion that water is present inside the grape. Infer that if skin did not contain water it would also dry up like the sultana.
8. Discuss with the students to help them think about other examples of dried animal or plant materials and compare to original form (e.g. dried fruit, beef jerky, herbs).

Part 2 – in the playground

Collect a see through plastic bag and some string or a large rubber band

1. Go into the playground and select a suitable small branch of a living plant and place the branch in the plastic bag, sealing it with the string or rubber band. Leave the bag on for at least an hour or, better still, overnight. What happens? Where did the water come from?
2. Pull up some weeds from the ground and lay them on top of the ground. Go back the next day and describe how they are different to the plants that were left in the ground. (They are wilted and will die without water).
3. Whilst in the playground, ask the students to do some gentle exercise. Can they see any perspiration on their skin? Where did it come from?

Part 3 – in the classroom

1. Lead a discussion to consider the following questions:
 - a. Where else does water leave their bodies? Why?
 - b. Have students breathe onto a small mirror. Ask them where the condensed water came from. Ask if they have ever been in a cold place and seen condensation (not steam) leave their mouths when they breathed out? <http://www.sciencebits.com/exhalecondense> has a photo that can be used if need be.
2. About plants and their need for water:
 - a. Snip off the last 2cm of the stem of a wilted flower such as Busy Lizzie, *Impatiens* sp., /branch/wilted celery stem with leaves and place in a jar of fresh water. Let it stand. The flower or branch will stand upright. (The plant absorbs water and its cells fill with water. The word “turgid” is used to describe a cell swollen with water.) Alternatively place a wilted lettuce or soft carrot in fresh water and observe the changes. Talk with students to draw out the idea that if there is no water, plants will die. What will happen if food plants die in countries with no rain (drought)?

- b. Compare pictures of global environments that have plenty of water e.g. rainforests, and environments that have little water (e.g. desert). Compare the features of a cactus plant to a plant from the playground. How do cactus plants store water? (In their stems).

This cactus has adaptations to survive where there is little water



Acknowledgement: M Watts

- c. People across the world eat grains such as rice, corn and wheat; these are all plants that need water. Through discussion, lead students to consider what will happen if there is not enough water for plants to grow.

If the soil is dry, plants for food will not grow



Ningxia, autonomous region of China (AusAID)

Activity 1.3: How do we use water?

Target Years: F–2

Problem: Can we list the ways in which we use water?

Main teaching focus

This activity reminds students that water is very important for staying alive but that much water is also needed for other things in our everyday lives.

Australian Curriculum References

F-2 SU

- 💧 Living things have basic needs, including food and water
- 💧 Earth's resources, including water, are used in a variety of ways

F-2 SHE

- 💧 Science involves exploring and observing the world using the senses

F-2 SIS

- 💧 Respond to questions about familiar objects and events
- 💧 Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate.

Background Science

People in developed countries such as Australia use large amounts of water in households (12%), agriculture (50%) and industry (38%).

With respect to households, water is primarily used for:

- 💧 food preparation and cooking
- 💧 sewerage systems
- 💧 washing and cleaning

Some households will also use water for:

- 💧 growing food including plants
- 💧 pets and domestic animals

<http://www.sydneywater.com.au/> has detailed information on how water is used in households in Sydney in the Education section of their website at <http://www.sydneywater.com.au/Education/PrimaryStudents/Howdoweusewater/>

Global Education Perspective

Students need to consider what needs to be done for all to live in a world where all people have sufficient food and water for a healthy and productive life. <http://www.wateraid.org/> in the “about us” section has information about individual aid workers and their work in developing countries and provides background information to tell students a story about water access in another country.

Students' potential alternative conceptions

Children (and adults) often do not realise that water is used in the production of many foodstuffs and goods nor do they realise how much water is required. See <http://www.theage.com.au/articles/2007/05/20/1179601242802.html>

Children who have always had access to safe tap water may find it difficult to comprehend the impact of only having access to unsafe water.

Activity

1. Whole class brainstorming activity: Make a list of all the ways that water is used at home by:
 - a. students
 - b. their siblings
 - c. parents
2. Draw up a table which includes the final list which will include activities such as:
 - toilet and showers
 - gardening and cleaning (cars/pets/tools etc)
 - playing (swimming)
 - cooking
 - washing machine etc (A useful list can be found at <http://www.corkcoco.ie/co/pdf/823678116.pdf> which also has additional activities described).
3. Ask each child to spend one day at home counting the number of times each activity happened. Brainstorm ways that the amount of water used could be reduced. Finalise the activity with a feedback session, which identifies the importance of water in our lives.
4. Case study: use one example such as the work in Uganda from the www.wateraid.org site to describe how water is used to compare the differences between plentiful water supply and little access. Older children might discuss the ways in which they could save water at: <http://www.environment.gov.au/water/topics/save-water-at-home.html>
5. Extension: <http://www.waterfootprint.org/?page=files/productgallery> shows how much it takes to grow some common foods. Use this with older children to emphasise the use of water in food production. Choose one item from this site and discuss how much water is needed to produce a small amount of food. Ask the children to predict whether it will be more or less water to produce other items on the list. Graph the results to show the corresponding amounts.
6. **Global Education Perspective:** Select one of the following case studies to engage students in the impact of projects that can change people's lives in developing countries.
 - a. <http://www.usaid.gov/publications/focus/june10/focus-on-africa.pdf> – page 24–25
 - b. http://www.usaid.gov/publications/focus/feb09/focus_feb09_06.pdf – page 17
 - c. http://www.wateraid.org/australia/what_we_do/where_we_work/mali/examples_of_our_work_in_mali/default.asp
 - d. http://www.wateraid.org/australia/what_we_do/where_we_work/india/examples_of_our_work_in_india/default.asp
 - e. <http://www.wateraid.org/documents/lookingback.pdf> – page 11

Activity 1.4: Why is water so important?

Target Years: 3–6

Problem: What is so special about water?

Main teaching focus

It is the unique properties of water that make it so important for life on Earth.

Australian Curriculum References

3–4 SU

- Living things, including plants and animals, depend on each other and the environment to survive
- Natural and processed materials have a range of physical properties; these properties can influence their use

3–4 SHE

- Science knowledge helps people to understand the effect of their actions

3–4 SIS

- With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge.

Background Science

Pure water is virtually colourless and has no taste or smell. It freezes at 0°C and boils at 100°C.

Water has a very high *surface tension*. It tends to clump together in drops rather than spread out in a thin film. Surface tension is responsible for capillary action, which allows water (and its dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies.

Water has a high specific heat index. This means that water can absorb a lot of heat before it begins to change temperature.

On Earth water exists in three STATES or FORMS – ice (which is the solid state), water (which is the liquid state) and water vapour (which is the gaseous state). Ice is very unusual because it FLOATS on water. With most substances the solid form is more dense than the liquid form and would sink.

Global Education Perspective

Water keeps plants and animals alive and is required by industry and agriculture worldwide. All countries and the people living there depend on water. Some countries are dry because there is very little rain but some countries are “dry” because the water is frozen as ice and, with very cold temperatures, ice does not melt to form water.

Students’ potential alternative conceptions

Since the various states of water are so common on Earth, the unusual property of ice (solid form) FLOATING on water (the liquid form) may not be identified.

Activities

Water as a fluid

1. Give students a dropper, some water and a 5-cent piece. Ask them to place one drop of water on the coin. Ask the students to describe the appearance of the water droplet and to predict:
 - a. what will happen to the drop if more water is added?
 - b. how many drops will fit on the coin?

Use their observations to introduce the idea of surface tension. The rounded spherical shape forms because water particles cling together. The surface breaks when the amount of water is too great and pushes against the force of the surface tension. Ask the children to draw the coin and water before the surface bursts.

2. Use a glass jar or clear tumbler. Place about 1cm deep water coloured with a food colouring in a glass jar or tumbler. Put a narrow strip of absorbent paper such as toilet paper or kitchen towel in the jar so that the edge of the paper strip is just below the level of the water. Watch what happens. A companion activity is to place cut celery stems (with leaves) into coloured water.

The outcome of these activities is to demonstrate that water particles will stick together and move through another substance. With the food colouring, students will see that water can carry chemicals as it moves. This property is important for the survival of plants as well as animals.

Chapter 2: Safe water

Activity 2.1: How do we get our water?

Target Years: F–2

Problem: Where does our water come from?

Main teaching focus

The idea that water is stored in dams and is transported to people's homes in underground pipes. Issues associated with the origins of this stored water.

Australian Curriculum References

F-2 SU

- 💧 Living things have basic needs, including food and water
- 💧 Earth's resources, including water, are used in a variety of ways

F-2 SHE

- 💧 Science involves asking questions about, and describing changes in, objects and events
- 💧 People use science in their daily lives, including when caring for their environment and living things

F-2 SIS

- 💧 Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources.

Background Science

Water is one of the most essential elements for living. Without access to safe drinking water, we die. Our drinking water can come from several sources such as:

- 💧 surface water from a river, lake or artificial dam,
- 💧 groundwater that is obtained through a bore,
- 💧 ocean water where the salt is removed (desalination),
- 💧 clean recycled water that has been used by people,
- 💧 rainwater collected in a tank.

Many cities and towns in Australia are supplied with water from large storage areas such as dams outside of the residential areas. Water from these dams is both chemically and physically cleaned before being pumped, then pumped or gravity fed to homes and industries.

Global Education Perspective – Sustainable futures

Students learn to assess, care for and restore the state of our planet, creating and enjoying a better, safer, and more just world. More of the Earth's surface is covered by water than by land. However there is only a limited and finite amount of fresh water for human use and consumption. Whilst the vast majority of Australian children have access to potable water, many children in developing countries spend much of their daily lives carrying water from distant water sources such as wells and rivers.

Students' potential alternative conceptions

Many children will have no idea about the chain of events that lead to water coming out of a tap when it is turned on.

Activities

- Pose the question: If it has not rained today, how can we get water? Lead a discussion to consider storage of water in dams and water tanks. Look at the school water tanks, or visit a family who has water tanks.
- Follow the pipes from the taps and toilet cistern to see how the water is delivered. Obtain a map of the local area to identify dams and other water sources near the school.
- Pose the question: How does the water get to our home or our school from the dam? Talk about the network of pipes that carry water from its source to a water treatment plant (where it is cleaned), then straight to our homes and schools. If possible, you can see part of the pipe network connected to the water meter that measures water coming into school.
- Invite a plumber in to the classroom to show children examples of water pipes used in homes.

Further activities

Global Education Perspective 1: Water in a cold country

Use the following set of photographs as a stimulus to discuss how children in other countries live when there is no tap and no running water.

Filling water containers at a source of water in the Mongolian countryside



Acknowledgement: Amandine Boucard and William Berbon
(Histoires Recyclables)

It is often the children's role to collect the water and fill the containers.

Ask your students to:

- Estimate how long it would take to fill the container using the dish that this little boy is using.
- Predict how much of this little boy's day would be involved in collecting water.
- Discuss the impact of water collection on this boy's chances of spending each day at school.
- Compare the life of this boy to their own lives.

These people in Mongolia do not have access to a safe and clean water supply. They have to walk to a lake which is some distance from their homes. They have chipped a hole in the ice and are ladling water from a lake. The large animal in the background gives us a clue about a possible source of water pollution.

Filling water containers at a source of water is often a job for children in the Mongolian countryside



Acknowledgement: Amandine Boucard and William Berbon
(Histoires Recyclables)

Children bringing home the water in the Mongolian countryside



Acknowledgement: Amandine Boucard and William Berbon (Histoires Recyclables)

Bringing the water home. These boys have made a trolley to carry the water.

Ask your students to:

- Explain why it needs three boys to push this trolley.
- Estimate how long these two containers of water would last in a family of two parents and three boys.

Global Education Perspective 2: Water in a hot country

A girl collects water from a stand pipe in Costa del Sol near Maputo, Mozambique in April 2009. It was installed as part of the World Bank's Water and Sanitation Program, supported by Australia.



Image acknowledgement: Kate Holt, Africa Practice.

1. Collecting water often means long trips carrying heavy weights. The water container in the image holds about 20l. One litre of water weighs one kilogram.
 - a. Ask your students to decide how much water they could easily carry. Perhaps find some containers such as icecream containers or 2-litre milk containers and fill them with water so students can relate the weight of these to larger containers.
 - b. Discuss the possible impacts of carrying large weights on the health of young children.
2. Women in Africa and Asia walk an average distance of six kilometres to collect water (<http://www.wateraid.org/documents/lookingback.pdf>). Water is limited to the amount the women and girls can carry that distance. Often this means that girls cannot go to school and so miss out on an education.
 - a. Ask your students to imagine what it would be like not to go to school. Let them consider what it would be like to be unable to read and write. How would their lives be different?
 - b. The installation of water pipes to villages can change the lives of young girls and boys. Ask your students to suggest ways in which their lives might change. (consider free time for education, play, better crops leading to a healthier diet, effects of better sanitation.)

Activity 2.2: Where do we get our water?

Target Years: 3–6

Problem: Where does our water come from?

Main teaching focus

The idea that, in Australia, water is stored in dams and is transported to people's homes in underground pipes. Issues associated with the origins of this stored water. The impact of water availability on humans and other organisms.

Australian Curriculum References

3–6 SU

- 💧 Living things, including plants and animals, depend on each other and the environment to survive
- 💧 Living things have structural features and adaptations that help them to survive in their environment

3–6 SHE

- 💧 Science knowledge helps people to understand the effect of their actions

3–6 SIS

- 💧 Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports
- 💧 Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts.

Background Science

Water is one of the most essential elements for living. Without access to safe drinking water, we die. Our drinking water can come from several sources such as:

- 💧 surface water from a river, lake or artificial dam,
- 💧 groundwater that is obtained through a bore,
- 💧 ocean water where the salt is removed (desalination),
- 💧 clean recycled water that has been used by people,
- 💧 rainwater collected in a tank.

Many cities and towns in Australia are supplied with water from large storage areas such as dams outside of the residential areas. Water from these dams is both chemically and physically cleaned before being pumped, or gravity fed to homes and industries.

Safe water is also needed for maintenance of natural ecosystems as well as for agricultural purposes. Water resources need to be protected from pollution and used sustainably.

Global Education Perspective – Sustainable futures

Students learn to assess, care for and restore the state of our planet, creating and enjoying a better, safer, and more just world. More of the Earth's surface is covered by water than by land. However there is only a limited and finite amount of fresh water for human use and consumption. The Australian environment includes examples of extremes of water availability. These examples can be used to extrapolate problems for humans and their food production around the globe. For example, in some communities water is very limited and, unlike Australia, many people have to use water that has not been cleaned.

Students' potential alternative conceptions

Students are unlikely to have knowledge about the variety of ways that Australian communities (and communities in other parts of the world) obtain their water.

Activities

- Set up a rain gauge in the playground and measure the amount of rain that falls each week. Set up a chart to record rainfall each week. Ask the students to identify any patterns that they can see over the months.
- Compare the amount of rain in different states of Australia and relate the amount of rain to the type of environment in that state. Use pictures such as those below that show the effects of high rainfall and low rainfall.

The wetlands of the Northern Territory support large numbers of different kinds of birds. How would this affect humans? What would happen to the numbers of birds if the rains stopped?



Acknowledgement: M Watts

- Older students can be led through discussion to consider what would happen if rainfall was low and there was no water storage system. (More than 1 billion people in the world do not have access to safe, clean drinking water. These people have to walk long distances everyday to get water and then this water may be used for bathing, cooking and washing clothes as well as drinking and food preparation.)

The Pilbara experiences limited rainfall and its environment is very different. How will this affect humans? How will this affect wildlife?



Acknowledgement: M Watts

- **Global Education case study:** *Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. It is a pre-requisite to the realization of all other human rights.* The United Nations Committee on Economic, Cultural and Social Rights.

With little rainfall, people depend on underground water, digging deep wells by hand. This well has been dug by hand but the surrounding area has been sealed with concrete to protect the water. Women work in pairs to do the heavy work of pulling water out of the well using metal pulleys mounted on a strong frame.



Acknowledgement: World Vision

Ask your students to access one or more of the case studies available for download at <http://www.bemore.org.au/globalissues/water> As an interdisciplinary activity, ask them to prepare a presentation on one of the case studies. This presentation should include:

- a map of the world with the location of the case study identified,
 - a description of the climate conditions in that location,
 - a description of the types of living conditions, food and water availability for people in the region,
 - an explanation of the changes that need to be made to make people's lives better with an identification of the Aid organisation involved.
- Further activities that could be included in a school program on water are described at <http://www.caritas.org.au/ozspirit/2010/213b.html> and also at <http://www.globaleducation.edu.au/global-issues/gi-water-and-sanitation.html>

Activity 2.3: Can we drink it?

Target Years: F–2

Problem: When is water fit to drink? Is it safe?

Main teaching focus

Water that is stored in open spaces such as dams has to be cleaned before it can be used.

Australian Curriculum References

F-2 SU

- Living things have basic needs, including food and water
- Earth's resources, including water, are used in a variety of ways

F-2 SHE

- Science involves asking questions about, and describing changes in, objects and events
- People use science in their daily lives, including when caring for their environment and living things

F-2 SIS

- Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources.

Background Science

Physical separation procedures can be used to remove solid particles from water. The steps used at water treatment plants to remove **SEDIMENT** (which sinks to the bottom) and **SILT** (which remains suspended) may include:

- sieving through a series of increasingly fine meshes,
- filtering using a small pore size,
- sedimentation where heavier particles settle to the bottom and the surface water is decanted,
- distillation where water is heated and the water vapour captured through condensation.

In addition, drinking water is further treated to remove microorganisms that may cause disease usually by adding dissolved chlorine – in much the same way as the treatment for swimming pool water.

Consider why humans, dogs and horses are excluded from the catchment areas of town water supplies.

Global Education Perspective

Everyone needs clean water to drink. Obviously water in dams and water holes can get very dirty. Rainwater tanks help keep water cleaner for drinking but what happens if water is not cleaned properly?

Students' potential alternative conceptions

Many people believe that running water is clean and that clear (transparent) water is clean. This is often not the case. There is often 'invisible pollution' in water – substances may be dissolved in water and we are unaware of their existence.

Activity – Does a bit of dirt hurt?

1. Lead a discussion about safe drinking water. What precautions should children take to make sure the water that they drink is not going to make them sick?

For urban children, include questions such as:

Is the drinking container clean? Are your hands clean? Is the water straight from the tap?

For rural children, include questions as above and expand them to include questions such as:

How do you know that the tank water is clean? Does a bit of dirt hurt?

2. Do we always know when there are things in water? Collect some clear plastic cups, some table salt and some sugar. Give each group of students a teaspoon and ask them to put first a teaspoon of salt, then a teaspoon of sugar into a cup of water and stir. The salt and sugar will disappear (dissolve). Use this to alert students to the possibility that clear water might have other “stuff” in it. For children with access to the oceans, they will be able to recall the taste of sea water.
3. The photograph below is of the Fortescue River in Western Australia. It is a beautiful, deep river which is used by huge flocks of corellas for water; they hang over the river banks on trees so it is to be expected that their droppings and the odd feather hit the water. Use this scenario to lead a discussion on “when is water safe to drink?” Can we always assume that clear water is clean water?

The Fortescue River looks clean. Is its water safe to drink?



Acknowledgement: M Watt

Activity 2.4: How is our drinking water made safe?

Target Years: 3–6

Problem: The water is too dirty to drink. How can we make it clean?

Main teaching focus

This activity focuses on processes used to remove contaminants from water.

Australian Curriculum References

3–4 SU

- Living things, including plants and animals, depend on each other and the environment to survive

3–4 SHE

- Science involves making predictions and describing patterns and relationships
- Science knowledge helps people to understand the effect of their actions

5–6 SHE

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives

3–4 SIS

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports.

Background Science

In 2006, 1.1 billion people did not have access to an adequate supply of drinking water. (WHO/UNICEF). In many cases, where water was available, it needed treatment before it was safe to drink.

Physical separation procedures can be used to remove solid particles from water. The steps used at water treatment plants to remove SEDIMENT (which sinks to the bottom) and SILT (which remains suspended) may include:

- sieving through a series of increasingly fine meshes,
- filtering using a small pore size,
- sedimentation where heavier particles settle to the bottom and the surface water is decanted,
- distillation where water is heated and the water vapour captured through condensation.

Consider why humans, dogs and horses are excluded from the catchment areas of town water supplies.

In addition, drinking water is further treated to remove microorganisms that may cause disease usually by adding dissolved chlorine – in much the same way as the treatment for swimming pool water.

Water may contain dissolved chemicals that are dangerous. Chemical testing is used to identify such substances as is the presence or absence of certain aquatic animals in waterways.

Global Education Perspective – Interdependence and globalisation

Interdependence describes the relationships of mutual dependence between all elements and life forms (including humans) within and across cultures, environments and social systems. It means that decisions taken in one place will affect what happens elsewhere. Where countries share the same water source such as the Nile, the Amazon or the Ganges, decisions made about water usage and treatment upstream can impact on water users downstream.

Students' potential alternative conceptions

Many people believe that running water is clean and that clear (transparent) water is clean. This is often not the case. There is often 'invisible pollution' in water – substances may be dissolved in water and we are unaware of their existence.

Activities

Using dam water

Inspecting the water hole

Use this photo or a similar one and guided questions to discuss the following:

1. Would you drink straight from this water hole? Explain your answer. (Do we know what's living in the water? Do we know where the water came from that's in this water hole? What did the water run over to get to this water hole? Chemicals; manure; decaying insects/animals.)
2. What evidence would you gather to make decisions before drinking this water?

A typical country dam



Acknowledgement: M Watts

Evidence of visitors

1. Close inspection of the mud around the water hole reveals animal footprints. Can we assume that animals drink this water? If so, does that mean that the water is safe for humans to drink? (Animals may carry disease in their faeces and urine. If they wash or cool off in the water, will germs come off their bodies?)

Wallaby footprints



Acknowledgement: M Watts

Extension: How do we clean this water?

A bucket of dam water



Acknowledgement: M Watts

The photo shows a bucket of water from the water hole. Would you drink this water?

Lead the students through a series of guided question to design a procedure to clean this water.

The procedure can include:

- sieving to get rid of the large solid bits,
- letting the water stand so sediments can settle and pouring the water off the top (decantation).
- filtering with a kitchen towel or coffee filter to get rid of smaller solid bits,
- boiling to kill any tiny animals or germs in the water.

Ask your students to predict what this water might taste like. Would they drink it?

Global Education Perspective: *Diseases from unsafe water and lack of basic sanitation kill more people every year than all forms of violence, including war. The UN predicts that one tenth of the global disease burden can be prevented simply by improving water supply and sanitation.* Extract from <http://www.charitywater.org/whywater/> This site is a good place to start on a web research project for good readers on “Water diseases world-wide and their prevention”.

Ask students to select one of the diseases mentioned and prepare a presentation which summarises the following:

- name of disease and its cause,
- the effect of the disease,
- how the disease may be treated,
- how the disease may be prevented,
- the role of science and technology in reducing the incidence of the disease.

Activity 2.5: Water as a solvent

Target Years: 3–6

Problem: Why does water need to be cleaned?

Main teaching focus

This activity focuses on the types of substances that can be dissolved in water and relates these to the impact on living things.

Australian Curriculum References

3-4 SU

- Living things, including plants and animals, depend on each other and the environment to survive

3-4 SHE

- Science involves making predictions and describing patterns and relationships
- Science knowledge helps people to understand the effect of their actions

5-6 SHE

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives

3-4 SIS

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports.

Background Science

Water is called the “*universal solvent*” because more substances are able to dissolve in it than any other liquid. This means that wherever water travels through the ground or through our bodies, it carries dissolved chemicals such as oxygen, carbon dioxide, minerals, and nutrients.

When heating water, small bubbles will be produced and these contain dissolved gases in the water. Note that the large bubbles present when water is boiling are due to bubbles of water vapour – not dissolved gases which emerge early in the heating process.

Global Education Perspective

More of the Earth's surface is covered by water than by land. However there is only a limited and finite amount of fresh water for human use and consumption as much water contains dissolved chemicals that can be harmful to humans.

Students' potential alternative conceptions

Children often refer to ‘pure water’ and ‘pure air’ thinking of ‘lack of harmful substances’ rather than a single substance.

Children may think of water as a single substance because they cannot see what it contains.

Children often fail to recognise that gases can be dissolved in water.

The notion of air is regarded as ‘good’ because it is for breathing and living however the notion of gases is regarded as ‘bad’ and dangerous.

Activities

Water as a solvent

1. If a substance disappears completely when it is mixed thoroughly with water, it is said to be **soluble** in water. An **insoluble** substance may mix with water but it can still be seen as present in the water. Provide students with a selection of common household chemicals such as salt, flour, sugar, carb soda, baking powder, cornflour, cooking oil, and citric acid. Ask them to measure equal quantities of each substance (say a half teaspoon of each) and mix each substance separately and thoroughly in half a cup of water. Separate into two groups – the soluble substances and the insoluble substances.

The outcome of this activity is to impress on children that water may seem clear but may have substances dissolved in it that are harmful to living things including humans.

2. How do we know that there are gases in water? Get an unopened bottle of gassed mineral water and an unopened bottle of mineral water without gas. Cool them both. Lead a discussion about what is in each bottle and ask the students to predict what will happen when the bottles are opened. (Opening the gassed bottle releases pressure and then any gas, which was dissolved in the water, will be released. There will probably be no bubbles released from the ungassed water.) Discuss the importance of gases dissolved in water for plants (carbon dioxide) and animals (oxygen) that live in water.

Activity 2.6: The importance of sanitation

Target Years: 3–6

Problem: Is water safe to drink?

Main teaching focus

This activity focuses on microscopic parasites in water. The concepts include the existence of microorganisms as a cause of disease and strategies used to ensure the specific named microorganisms are absent from drinking water.

Australian Curriculum References

3-4 SU

- Living things, including plants and animals, depend on each other and the environment to survive

3-4 SHE

- Science involves making predictions and describing patterns and relationships
- Science knowledge helps people to understand the effect of their actions

5-6 SHE

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives

3-4 SIS

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports.

Background Science

Parasites are living things that rely on other living things for shelter, nutrients and waste disposal. In so doing, parasites may harm their hosts, causing disease and sometimes causing death.

Many parasites are microscopic and are so small that they can only be detected using electron microscopes (as opposed to using light microscopes). Microscopic parasites of humans include some bacteria, viruses and single celled animals.

Giardia is an example of a single celled animal parasite that can cause a non-fatal form of diarrhoea. If 100 Giardia parasites were lined up side by side they would only measure 1mm (fit onto the top of a pin).

E. coli bacteria live in animal intestines and pollute water when faeces enter the water supply. If 500 of these bacteria were lined up end to end they would measure 1mm in length.

Many viruses are found in water. One of these, Rotavirus is the most common cause of severe diarrhoea in infants and young children. About 20,000 of these viruses would fit onto the head of a pin.

Global Education Perspective – Sustainable futures

Students learn to assess, care for and restore the state of our planet, creating and enjoying a better, safer, and more just world. Throughout the world, increased treatment of drinking water and increased efforts to ensure that human and animal wastes do not pollute drinking water has reduced the incidence of water-borne diseases in the developed world and in developing countries.

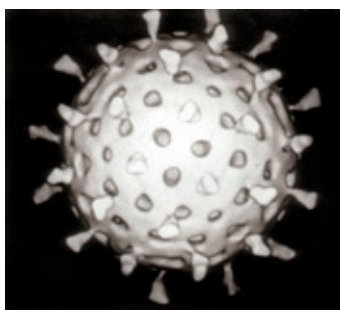
Students' potential alternative conceptions

Most children will have heard the word "germ" to describe something that makes us ill. However, it is unlikely that they will have transferred the characteristics of a living thing across to something that is as small as bacteria and viruses which cannot be seen with the human eye.

Activity – Web search

1. Review the characteristics and needs of living things (i.e. Their ability to grow and reproduce, nutritional requirements, shelter and the removal of waste).
2. Introduce the concept of microbes as tiny living things with the same needs as larger living things such as humans.
3. Introduce the concept of a parasite as a microbe that depends on another living thing for its food, water and shelter.
4. Sort the class into four groups for the following web-based research; differentiate the task by giving the more able students the fourth set of questions to research as these are more open-ended.
5. Ask the groups with the same set of questions to work together to develop a poster presentation on their topic.

Viral disease caused by Rotavirus



<http://www.health.nsw.gov.au/factsheets/infectious/rotavirus.html>

1. What are the symptoms of Rotavirus disease?
2. How long will you be sick if you have this disease?
3. How can you catch the disease?

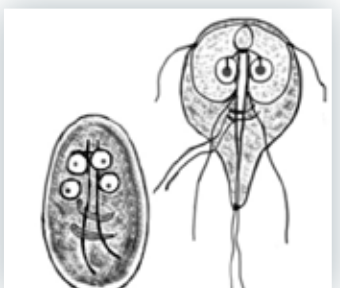
Bacterial disease caused by E.coli



<http://www.freedrinkingwater.com/water-contamination/ecoli-bacteria-removal-water.htm>

1. Where does *E. coli* come from?
2. How does *E. coli* get into water?
3. How harmful is *E. coli*?
4. How can *E. coli* be removed from water?

Disease caused by a single celled animal – Giardia



<http://www.all-about-water-filters.com/giardia.html>

1. How does Giardia get into water?
2. How can we kill Giardia in water?

A water-based disease in the world today

Water borne diseases are more prevalent in areas with poor sanitary conditions.

1. What does this statement mean?
2. Select one example of a water borne disease and describe its effect on humans.
3. AusAID is an Australian government overseas aid program, which helps in developing countries where better drinking water is needed. Use the internet to find an example of AusAID's work in preventing water borne diseases. Start at www.ausaid.gov.au

Activity 2.7: What happens when water is polluted?

Target Years: 3–6

Problem: What causes water to become polluted?

Main teaching focus

When water is not clean, plants and animals that live in the water and plants and animals that live on land and depend on the water will be affected. Some of the things that affect water quality will be investigated and discussed.

Australian Curriculum References

3-4 SU

- Living things, including plants and animals, depend on each other and the environment to survive

3-4 SHE

- Science involves making predictions and describing patterns and relationships
- Science knowledge helps people to understand the effect of their actions

5-6 SHE

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives

3-4 SIS

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports.

Background Science

Water quality is determined by the physical, chemical and biological characteristics of water. It is a measure of the condition of the water relative to the requirements of the living things that depend on it for survival.

Contamination of water can be caused by:

- micro-organisms such as viruses and bacteria from sources including sewage disposal;
- inorganic chemicals such as salts and metals;
- organic chemicals from industrial processes and road transport;
- pesticides and herbicides from agricultural use; and
- radioactive chemicals.

Water quality is also influenced by the form of the local land (hills and valleys) as well as the type of rocks and soil. Water bodies such as lakes, ponds and billabongs act as a heat sink, raising the temperature of the water which lowers the amount of oxygen available for aquatic animals.

Water overuse may lower the water level resulting in build up of sediments and dissolved substances to toxic levels.

Global Education Perspective – Sustainable futures

Education for sustainable development is about learning to be caring citizens who exercise their rights and responsibilities locally, nationally and globally.

Students' potential alternative conceptions

Students will benefit from a series of questions to check their prior understandings about both the sources of water pollution and the importance of checking for "invisible" water pollution.

Activity

Sudden fish kills are often the first indication that there is a water pollution problem and, in these situations, environmental scientists have a central role in isolating cause(s) of disasters. Comprehensive background notes, including data on fish kills in NSW is available at http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/402790/Fish-Kills-FAQ-August-2011.pdf

Internet research activity

Divide students into four or five groups and allocate each group a question with the identified series of key search terms to use. Ask each group to prepare a brief report, either as a poster presentation or a PowerPoint presentation, on their question. Differentiate the activity by selecting the challenge level of the research question – with Group 1 being the easiest level.

Group 1 – What natural events can result in a fish kill? Search terms – “flood”, “sediment disturbance”	Group 2 – How do fish get oxygen? Search words – “gills, fish, freshwater, oxygen”
Group 3 – What events can lower oxygen levels in water? Search terms – “black water”, “excessive algal growth”, “high biochemical oxygen demand”	Group 4 – Can humans reduce the number of fish kills in local rivers? Search terms – “Causes water pollution”, “run-off”, “agricultural chemicals”, “industrial water pollutants”
Group 5 – Do we have evidence of the impact of water pollution on humans? For a more able group, ask that they prepare a presentation on pollution along a food chain and its effect on humans. Search words include Minamata Disease in Japan, people eating poisoned seafood.	

Activity 2.8: Cleaning up polluted water

Target Years: 3–6

Problem: Why is polluted water a problem?

Main teaching focus

It is possible to clean polluted water, though it is not easy.

Australian Curriculum References

3–4 SU

- Living things, including plants and animals, depend on each other and the environment to survive

3–4 SHE

- Science involves making predictions and describing patterns and relationships
- Science knowledge helps people to understand the effect of their actions

5–6 SHE

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives

3–4 SIS

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports.

Background Science

Water may be polluted through:

- BIOLOGICAL (microorganisms),
- CHEMICAL (dissolved substances, oil spills etc or
- PHYSICAL (soil particles, sediment, silt, temperature) means.

It is therefore necessary to be able to recognise, avoid and/or treat the polluted water.

Substances that are mixed or dissolved in water are often able to be retrieved, creating clean water that may be used by living things.

If water is not tested and treated accordingly, the outcome for living things, including humans, can be catastrophic.

Global Education Perspective – Sustainable futures

Students consider what needs to be done for all to live in a world where all people have sufficient food and water for a healthy and productive life; sometimes, unexpected problems arise when water supplies are found for people. All water supplies should to be checked thoroughly for hidden pollutants that can damage people and their food supplies.

Students' potential alternative conceptions

Invisible water pollution is not easily recognised. Dissolved substances are thought to have disappeared.

Activity

1. Provide the class with a bucket of polluted water – containing small pieces of litter, mud, stones, dissolved salt, leaves etc.

Class brainstorm suggestions for ways to clean the water. Ideas may include: hand picking the large leaves and stones, using sieves of different meshes to remove smaller objects, filtering through paper towel/fine cotton to remove silt and sediment, evaporating and condensing the remaining water using a Solar Still. Reference: see the activity on pages 30–31 of *Streams Alive: The Water Cycle, Solar Still Demonstration*
http://www.streamwatch.org.au/cms/resources/school_pdfs/Streams_Alive.pdf

2. Make one litre of saturated salt solution by dissolving salt in hot water until no more will dissolve. Allow the solution to cool. Ask students how the salt can be retrieved. Suggestions may involve: filtering, evaporating etc. Allow students to try their ideas. For those students who do manage to obtain salt crystals ask where the water has gone. This could lead into other investigations related to retrieving water vapour from the air.

3. **Global Education Perspective:** Case study

Quote from http://news.nationalgeographic.com/news/2003/06/0605_030605_arsenicwater.html *Three decades ago health and development experts, and small local contractors, dug millions of deep tube wells throughout Bangladesh. The experts encouraged the whole nation to drink water from wells because it was deemed to be safe, free from the bacteria that causes water-borne diseases such as diarrhoea and other intestinal maladies that have long plagued this tropical country.*

In switching from rivers and other surface sources of water, the people of Bangladesh may have exchanged water-borne diseases for slow poisoning by arsenic. In the 1970's public health specialists and government policy-makers were unaware of the problem. It was only in 1993 that a previously identified "clean" well water was discovered to contain dangerous quantities of the poison.

This catastrophe is well documented on the internet. Ask your students to research and summarise the following:

- origins of arsenic in the drinking water from wells,
- the effect of arsenic on humans, and
- current scientific and technological attempts to overcome the problem.

Start the research at www.USAID.gov.au

4. **Global Education Perspective:** For older students

Case study:

For thousands of years, people living in the tiny Pacific Island countries (PICs) have lived in close harmony with their environment. Their lifestyle is organised around the warm temperatures and high rainfalls that provide their food and livelihoods.

European settlement connected the islands with the larger world, bringing many improvements but also introducing chemicals such as Dieldrin and Dichloro-Diphenyl-Trichloroethane (DDT) to fight diseases and pests. Additionally, capacitors and electrical transformers that contain polychlorinated biphenyls (PCBs) were brought to the islands to generate electricity for lighting, communication and industry. Many of these introduced chemicals are now known to be extremely toxic, and are referred to as persistent organic pollutants (POPs).

Ask students to use the information on this page to:

- summarise information and present a power point presentation to describe the project called **Lifting a toxic load: removing POPs from PICs**
- develop a written explanation about the origins of persistent organic pollutants and why they were used.

Chapter 3: Water for all living things

Activity 3.1: Life in water

Target Years: F–2

Problem: What lives in water?

Main teaching focus

This activity provides an opportunity for students to learn about the variety of living things found in freshwater and the marine environment. For older students, the differences between the marine and freshwater ecosystems can be explored.

Australian Curriculum References

F-2 SU

- Living things live in different places where their needs are met

F-2 SHE

- People use science in their daily lives, including when caring for their environment and living things

F-2 SIS

- Respond to and pose questions, and make predictions about familiar objects and events.

Background Science

Living things in water have the same requirements as living things on land. They need food, air and water as well as shelter.

How do they get these needs? Gas is dissolved in the water around them. Provided the water does not get too warm, and has sufficient contact with the air above, plants and animals in water can absorb enough gas from the water around them. Larger animals have gills to assist this process.

Global Education Perspective – Sustainable futures

Students learn to assess, care for and restore the state of our planet, creating and enjoying a better, safer, and more just world. This activity can be used to reinforce the importance of maintaining healthy bodies of water for animals and plants as the health of humans can depend on healthy food to eat.

Students' potential alternative conceptions

Many children (and adults) do not think that fish and other marine creatures are animals. In addition, they do not view algae (sea weed) and algal "slime" as plants.

Activities

1. <http://www.oceanlifeeducation.com.au/> The resource hyperlink leads to a section with some downloadable worksheets and cut-outs that are suitable for younger students. They can be used to develop murals about the variety of plants and animals found in the oceans. There are also some simple fact sheets (some with coloured photos) that could be used in the lower primary classroom.
2. <http://australianmuseum.net.au/image/Freshwater-Habitats> has a great image to use as an aid to discuss freshwater habitats.
3. Use <http://www.discover.tased.edu.au/openit/eco-panels/freshWater8.swf> as a demonstration of the types of animals found in freshwater. Click on each diagram. The photo and information provided could be used to explain to students how living things rely on each other, for example, as food.
4. <http://www.brainpopjr.com/science/habitats/freshwaterhabitats/grownups.weml> has detailed information about freshwater habitats. The site includes activities that can be readily adapted to the Australian context.

Activity 3.2: Life in water

Target Years: 3–6

Problem: What lives in water ALL the time?
What lives in water SOME of the time?

Main teaching focus

This activity will focus on common marine and fresh water Australian animals

Australian Curriculum References

3-6 SU

- 💧 Living things have life cycles
- 💧 Living things, including plants and animals, depend on each other and the environment to survive
- 💧 Living things have structural features and adaptations that help them to survive in their environment
- 💧 Natural and processed materials have a range of physical properties; These properties can influence their use

3-6 SHE

- 💧 Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives
- 💧 Scientific knowledge is used to inform personal and community decisions

3-6 SIS

- 💧 With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be.

Background Science

Floating or sinking in water is determined by the density of the object and buoyancy of water – both are difficult concepts but are easily demonstrated in practice.

Water contains dissolved gases including oxygen which is necessary for aquatic animals to survive. Aquatic animals absorb oxygen from water as it passes over their gills.

Australia's marine environment is home to 4000 fish species, 1700 coral species, 50 types of marine mammal and a wide range of seabirds. Most marine species found in southern Australian waters occur nowhere else.

On land, a different strategy is needed to obtain oxygen, hence the breathing systems of land animals which force air in and out of the body. The surface of lung tissue is moist to assist in dissolving oxygen which then passes into the blood.

Freshwater habitats include lakes, rivers, billabongs, wetlands and ponds. Many animals and plants rely on them to provide food, water and shelter.

Polluting substances can alter the balance of life in water. For example, algal blooms caused by excessive nutrients in water can reduce oxygen levels that result in the death of aquatic animals and also poison water that humans and other animals might need to use and drink.

Global Education Perspective – Sustainable futures

Students learn to assess, care for and restore the state of our planet, creating and enjoying a better, safer, and more just world.

Students' potential alternative conceptions

Identify student's prior understanding of sinking and floating with simple demonstrations of various objects in water. Clarify how animals breathe on land compared to in water. How are seawater and freshwater different?

Activity

1. Refer to activity 1.4: Why is water so important? Compare the solid and liquid forms of common substances as follows and note whether the solid form sinks or floats: Fill three clear identical glasses with one of (a) melted butter/margarine, (b) sugar or salt solution, (c) water. Into (a) place a piece of solid butter/margarine, (b) sprinkle half a teaspoon of salt or sugar crystals, (c) place an ice cube. Observe and discuss.
2. Refer to activity 2.5: Water as a solvent:
 - a. Gills – <http://video.nationalgeographic.com/video/player/kids/animals-pets-kids/fish-kids/fish-camouflage-kids.html> has a series of very short but excellent video clips of fish. Ask your students to watch the gill area (behind the head/eyes) of the fish being filmed. They will be able to see how the gill plates are constantly moving as water is pumped over the gills so oxygen can be extracted.
 - b. Lungs – http://www.biology4kids.com/files/systems_respiratory.html has some simple information on the human breathing system.
Whales are mammals and need to breath and exhale air. The National Geographic site above has short clips that include whales in action, coming to the surface to breathe.
3. For a detailed study of a local stream or pond, download and adapt the activities in the *Streamwatch* booklet available at http://www.streamwatch.org.au/cms/resources/school_pdfs/Streams_Alive.pdf as this not only assists in identifying freshwater animals but also leads to consideration of the health of the water body.
4. Set up a small pond or water tank for students and watch tadpoles develop. Ensure that you follow animal welfare protocols which, in NSW, includes: no more than 20 tadpoles from one source, daily monitoring, returning tadpoles/froglets to the source once two tadpoles metamorphose or after 6 months (whichever comes first).
5. Ask students to create two lists – animals that always live in water and animals that always live on land. Then identify and discuss animals that usually live on land and sometimes visit the water e.g. humans to swim, ducks to swim, find food and keep safe. Ask if there are any animals that spend part of their life cycle in water and part on land – help them identify tadpoles/frogs and dragon-fly nymph/adult dragon-fly (see http://www.brisbaneinsects.com/brisbane_dragons/AustraliaEmerald.htm for adult and <http://www.ausemade.com.au/nt/destination/s/simpsons-gap/simpsons-gap-images-df1.htm> for photos of the nymph stage of a different dragon fly.) Discuss potential difficulties faced by animals that rely on water for part of their life cycle.
6. <http://www.discover.tased.edu.au/openit/eco-panels/freshWater8.swf> has images of many freshwater animals and has the potential for building of food chains from the information provided.
7. Why do some animals stay on top of the water and some under the water – relate this to floating/sinking and to how they breathe. Which water animals are in the sea and which are in freshwater?
8. Use activities 4–7 (above) as a springboard for students to draw examples of the identified animals and to research, then produce, a poster of a frog or dragon-fly life cycle. This could be a collage/multi-media/digital-generated work. Be sure to represent the water and the land at the correct life-cycle stages.
9. Taste test for freshwater and some water prepared with salt dissolved in it. Label them as A and B then get students to identify which is which. A further investigation could include reducing salt concentrations to determine the dilution at which the salt can no longer be identified?
10. The Australian Government has produced a primary school classroom education kit about wetlands for Years 3–6. This resource has a broad range of activities that demonstrate the interface between the terrestrial and aquatic environments. Go to <http://www.environment.gov.au/water/publications/environmental/wetlands/classroom-kit.html>

11. **Global Education Perspective:** <http://environment.nationalgeographic.com/freshwater/photos/> has some excellent images which could be used to predict and discuss the impact of pollution on the health of rivers. Select the “freshwater conflict” option for a series of photos about water availability across the globe. Each photo has a brief description which will assist in guiding discussion. For example: select the photo about Pollution in China to predict and discuss the impact of such water on aquatic life.

Further references

Animated life cycle online:

http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks1/science/hamshall/life_cycles/index.htm

Frog life cycle wheel:

<http://www.kidcyber.com.au/topics/lifecyclefrogactiv.htm>

For print-out sheets of the animals and information:

<http://www.kidcyber.com.au/topics/lifecyclefrog.htm>

<http://www.kidssoup.com/Frog-pond-activities/frog-pond-crafts.html#freefrogs>

<http://www.enchantedlearning.com/subjects/amphibians/Frogprintout.shtml>

<http://www.enchantedlearning.com/subjects/amphibians/books/froglifecycle>

<http://www.enchantedlearning.com/subjects/insects/dragonfly/bigprintout.shtml>

Activity 3.3: Life on land

Target Years: F–2

Problem: Living things on land need water too

Main teaching focus

This activity can develop a better understanding that humans are animals too and have the same needs as other animals i.e. food, water and shelter.

Australian Curriculum References

F-2 SU

- Living things live in different places where their needs are met

F-2 SHE

- People use science in their daily lives, including when caring for their environment and living things

F-2 SIS

- Respond to and pose questions, and make predictions about familiar objects and events.

Background Science

All animals and plants have the same fundamental needs to sustain life: food, water and shelter. Plants make the compounds that they need through photosynthesis; animals gain their compounds by eating food.

All animals and plants have specialised characteristics (adaptations) which allow them to live in the range of environments on Earth. For example, whilst all mammals have fur, the distribution and density of the fur will vary with their environment. Some animals and plants are highly adapted to living in dry environments and have various ways of conserving water, or of not requiring much water.

Students' potential alternative conceptions

Children often have specific notions of which living things are 'animals' such as being large and furry (mammal) and either a pet, farm animal or zoo animal. Humans are not regarded as animals. Small insects and spiders are often not regarded as animals.

Activity

Watch the following YouTube videos:

<http://www.youtube.com/watch?v=ZUsARF-CBcl> – desert animals

<http://www.youtube.com/watch?v=Er-OnJCn1gg> – ants in the mangroves

- Lead a discussion about the adaptations of each animal.
- Compare the different features, such as ears and skins, of different animals from different climates.
- Assess how each animal is suited to live in its environment.
- Find out where each animal lives in Australia.
- Make a chart to help compare the features.
- Group the animals together by environments and see if you can make some generalisations.

Extension: Identify some different animals from outside Australia

- Find out how they are adapted to their environment,
- Compare their adaptations to Australian animal adaptations.

Activity 3.4: Water availability impacts on food production

Target Years: 3–6

Problem: Why do humans need water for their land as well as their homes?

Main teaching focus

Food production may focus on either the rearing of animals or the growing of crops or both. However, water is needed for any food production.

Australian Curriculum References

3-4 SU

- Living things, including plants and animals, depend on each other and the environment to survive

5-6 SU

- The growth and survival of living things are affected by the physical conditions of their environment

3-4 SHE

- Science knowledge helps people to understand the effect of their actions

5-6 SHE

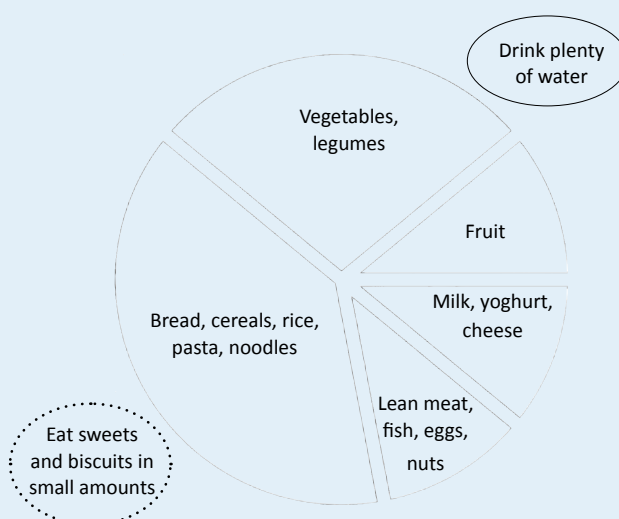
- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives
- Scientific knowledge is used to inform personal and community decisions

3-4 SIS

- Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts.

Background Science

Minimum food requirements for a healthy life for people can be summarised in a healthy diet pie chart.



The “food pie” shows the relative amounts of various food types that are needed for a balanced healthy diet. The need for water as an additional ingredient is emphasised. The Australian Government has produced an illustrated “Healthy Eating” poster which can be downloaded from [http://www.health.gov.au/internet/main/publishing.nsf/Content/E384CFA588B74377CA256F190004059B/\\$File/fd-cons-poster-2.pdf](http://www.health.gov.au/internet/main/publishing.nsf/Content/E384CFA588B74377CA256F190004059B/$File/fd-cons-poster-2.pdf)

Global Education Perspective – Sustainable futures

Students consider what needs to be done for all to live in a world where people have sufficient food for a healthy and productive life. Where there is a water shortage, there will be an inability to produce sufficient food and so people will go hungry in many developing countries.

Students’ potential alternative conceptions

Students need to be reminded that growing food means that all of the requirements for living things are needed for agricultural crops and animal husbandry. They may not have considered the costs involved in transporting foods from one place to another. In developing countries, it is much cheaper to have people grow their own food.

Activities

1. Food for a week:
 - a. Ask students to keep a diary listing all the foods that they eat and the approximate amount of each food in a week. At the end of the week, ask them to summarise their findings in a table and compare the amounts to those on the food pyramid. Are they eating healthily?
 - b. Use the information at <http://www.waterfootprint.org/?page=files/home> (there is a water footprint calculator available) to estimate of the amount of water that was needed to grow the food that each student ate in a week. Make a summary for the whole class so that they appreciate the importance of water for agriculture.
2. Walking for Water in Tanzania – Lucia’s story at http://www.youtube.com/watch?v=LPPA_rz6UXA&feature=related Many people living in poverty around the world have to walk many kilometres each day to fetch water and to meet their other basic needs to survive. Caritas Australia’s community development projects help people to lift themselves out of poverty. The video clip runs for 6.49mins – ask students to draw up a before and after chart to show the effects of a permanent water supply on a child’s life.
3. Project Compassion began in 1966 and is now the largest humanitarian fundraising campaign in Australia. This project help people all over the world tackle entrenched injustice, and build better lives for themselves, their families and their broader communities. Perhaps your students could select a project and fundraise to achieve a specific goal. http://www.caritas.org.au/project_compassion_11/Schools/index.html has a number of achievable examples worth investigating.
4. **Global Education Perspective:** <http://environment.nationalgeographic.com/freshwater/photos/> has some excellent images which could be used to predict and discuss the impact of pollution on the health of rivers. Select the “freshwater conflict” option for a series of photos about water availability across the globe. Each photo has a brief description which will assist in guiding discussion. For example: Compare the photo of Water refugees in the Sudan with that of Agriculture Irrigation in Australia to discuss the difference that water availability makes to people as they try to grow food.

Chapter 4: Origins of water

Activity 4.1: Weather Watching

Target Years: F–2

Problem: How often does our weather change?

Main teaching focus

The purpose of this activity is to encourage students to observe and classify changes in their surroundings that can be classified as weather.

Australian Curriculum References

F-2 SU

- 💧 Daily and seasonal changes in our environment, including the weather, affect everyday life
- 💧 Everyday materials can be physically changed in a variety of ways

F-2 SHE

- 💧 Science involves asking questions about, and describing changes in, objects and events

F-2 SIS

- 💧 Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play.

Background Science

Weather is the present state of the atmosphere with respect to features such as wind, temperature, cloudiness, moisture, and pressure. The weather is caused by the circulation of the gases making up the atmosphere. This circulation is caused by the unequal heating of the earth's surface by the sun causing convection currents.

Global Education Perspective

Weather patterns vary around the world.

Students' potential alternative conceptions

Students are often unaware of how rapidly weather may change through the day – often because they only make one weather observation per day.

Activity – Charting weather

1. Discussion: What day is it today? What date is it today? What is the weather like today? (Go for a walk and observe the sky – note: do not look directly into the sun if it is a sunny day)
2. Ask the students, if we wanted to remember what the weather was like today, how could we do this? Invite suggestions to the symbol you may use for this.
3. Students record the day, date and symbol in their science journals.
4. Draw up a poster chart with five columns and twenty rows.
5. As a class, decide on a legend of pictures to depict weather events such as: wind, rain, sun, clouds, hot day, cold day
6. Make up a chart of words describing weather.
7. At the end of each day, decide what picture or series of pictures should be used to describe the weather for that day. Discuss any patterns that may be occurring.
8. At the end of four weeks, describe any patterns that appear in the weather chart.
9. Ask students: Do we have a lot of rain? Why do we need rain? What if it doesn't rain? Is rain important? Why? Have we had a lot of rain this month? Is this good or bad? Tell me why!
10. This activity can be extended over several months to find seasonal as well as monthly weather patterns.

Extension

1. Talk about how the weather affects jobs: construction workers, farmers, grocery sales, clothing stores, safety workers, and transport.
2. Discuss times when the weather has caused a change of plan – sports carnival, picnic, beach trip. What are some ways that weather can be anticipated (use forecasts) or addressed (bring waterproof/warm clothing).

Weather monitoring equipment, Mt Stromlo ACT



Acknowledgement: J Sillar

Activity 4.2: Weather Watching

Target Years: 3–6

Problem: What causes the weather?

Main teaching focus

This activity builds on 4.1 to identify local, continental and oceanic influences on weather.

Australian Curriculum References

3–6 SU

- Daily and seasonal changes in our environment, including the weather, affect everyday life
- Everyday materials can be physically changed in a variety of ways

3–6 SHE

- Science involves asking questions about, and describing changes in, objects and events

3–6 SIS

- Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play.

Background Science

Weather patterns are determined by air currents above oceans; changes in ocean temperatures will alter air currents. Weather patterns are also determined by landforms; moist air moving over high mountains will lead to rain.

Climate can be described as the sum or description of all the weather recorded over a long period of time. It tells us the average or most common conditions, or extremes.

Drought Unlike other forms of severe weather or natural disasters, droughts often develop slowly. Atmospheric conditions such as ocean temperatures, changes in the jet stream, and changes in the local landscape are all causes of droughts.

Climate Change Weather patterns are changing and maintaining these changes, so that scientists concur that climate change is occurring.

For a full explanation of causes of weather, go to <http://www.bom.gov.au/lam/> where a full range of explanations on climate and weather are provided.

Global Education Perspective

Weather patterns vary around the world so that some countries get very little rain and people do not have enough water to drink or grow food.

Students' potential alternative conceptions

Students believe the weather is the same, no matter where you are. So, for example, it is sunny in Sydney, it is sunny in Mumbai.

Activity

1. Ask your students to design a table, and collect data on a daily basis of temperature, rainfall, cloud cover and wind strength for a given period such as a week/month. Use the internet to research the daily weather of the students' cultures of origin or a selected country. Alternatively, chart the daily weather in a different part of Australia. (The weather button on an iPhone is very handy for daily checking.)
2. Once the data is collected, discuss possible ways of presenting and analysing this data with the students, and ask them to organise their results so that any patterns can be identified. Discuss similarities and differences between that weather and the weather at home in Australia.
3. Invite suggestions as to why these places are experiencing different weather to where the students are. Make some class generalisations. Discuss where the countries are on the Earth and encourage students to find out why these weather patterns are different.
4. Talk about what happens to people if there is too much rain or not enough rain both in Australia as well as international events such as the Pakistani floods (<http://www.aid.gov.au/countries/southasia/pakistan/Pages/pakistan-flood-funding.aspx>) and the droughts in Africa.
5. **Global Education Perspective:** In July 2011, UNICEF posted the following on its website: *The crisis unfolding for millions of children and their families in East Africa is the result of years of drought, impact of climate change, the high price of food and fuel and compounded by exclusion and poverty.* From <http://www.unicef.org.au/Donate/One-off-Donation/east-africa-drought-emergency-appeal-famine.aspx> The impact of this food shortage and possible ways of helping out is vividly brought home in a video clip at <http://www.actionaid.org/what-we-do/food-rights> Use these two sites to alert your students to the problems caused by water shortage and to encourage discussion about solutions to these problems.

Activity 4.3: Change of state

Target Years: 3–6

Problem: Where does the water go?

Main teaching focus

This activity focuses on the three states of matter – solid, liquid and gas – using water as the exemplar compound.

Australian Curriculum References

3-4 SU

- A change of state between solid and liquid can be caused by adding or removing heat

5-6 SU

- Solids, liquids and gases have different observable properties and behave in different ways

3-4 SHE

- Science involves making predictions and describing patterns and relationships

3-4 SIS

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports.

Background Science

Substances change from one state to another as a result of the change in energy of the particles making up the substance. If the average energy of the particles decreases, the substance cools, its particles slow down and the substance may change state from gas to liquid (condensation) or from liquid to solid (freezing and solidification). Conversely, as a substance absorbs heat energy, its temperature increases, its particles move more quickly and the substance may change state from solid to liquid (melting) or from liquid to gas (boiling and evaporation).

At sea level, water freezes at 0°C and boils at 100°C.

Pure water is colourless, odourless and tasteless.

Water as a gas is invisible.

The volume of a substance may change as it cools down or heats up. Water is unusual in that, in its solid form as ice, it takes up more space than as a liquid making it less dense and so it floats.

Students' potential alternative conceptions

Steam is not water as a gas – rather it is water as tiny liquid droplets. Clouds contain water as tiny liquid droplets and the atmosphere is also full of water as a gas. If you can SEE it then it is water droplets. Water vapour, which is invisible, is almost always present in the air.

Activity

Water as a gas

1. Get two dry, clean drinking glasses. Place each in a ziploc bag and place one in a freezer for 10–15 minutes. Remove both glasses from their bags and place on a table. The cold glass will become covered in a thin film of condensation and it can only have come from the air. Alternatively, place COLOURED water in the glasses. Have one with room temperature blue water, one with cold blue water. Wipe the outside of the glass with a white tissue – the condensed water is clear. (Water droplets will form on the outside of the glass as water vapour in the air condenses on the cold glass surface.)
2. Ask students to take a deep breath and then exhale onto the face of a mirror. They will see the mirror fog up. Where did the water come from? (Exhaled breath contains water as a gas which will cool to a liquid when it hits a cold surface.)

Water as a liquid

1. Add some food colouring to some water in a jar. Use an eye-dropper to place bubbles of coloured water on a plastic sheet either in the sun or near a heater. Leave to stand. (The water will evaporate and leave the food colouring [different chemical] behind.) This investigation could be extended into a discussion of:
 - a. where did the water go?
 - b. how might the evaporated water be collected?
 - c. how this could be used to clean water?
 - d. what this tells us about water evaporating from the oceans. (It is not salty, the salt gets 'left behind'.)

Water as a solid

1. Collect a plastic fruit juice bottle and lid. Fill the bottle with water, fit the lid and place it in the freezer until the water in the bottle is completely frozen. What happens? (The lid of the bottle will lift off as the water expands when it freezes.)

Extensions

1. What is a cloud? How do we know that the air above us contains water as a gas? How do we know that the air above us is moving?
2. Water can change state and remain the same substance. A 'solar still' can be built as in the picture below. Water in the air (gas) can condense (into liquid) and drip into the cup. Students can taste the water to see that it is fresh water.

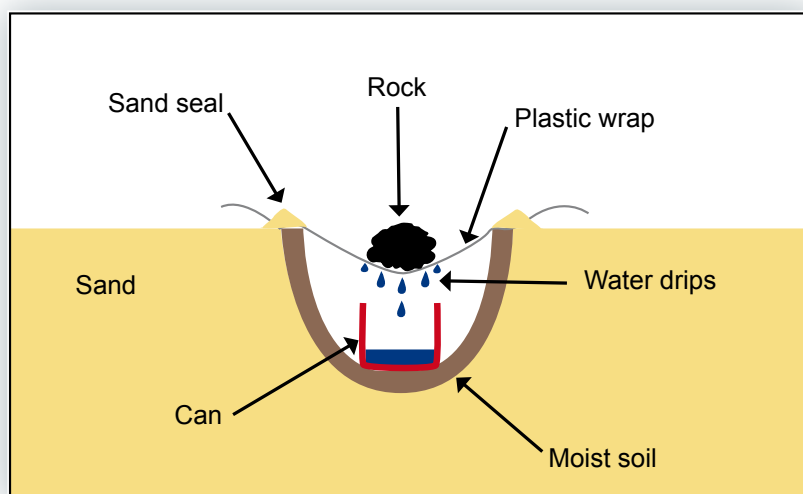


Image source: http://www.wikihow.com/Image:Stranded-in-desert1_598.gif

Another reference: pages 31–32 in Streams Alive: The Water Cycle, Solar Still
http://www.streamwatch.org.au/cms/resources/school_pdfs/Streams_Alive.pdf

Activity 4.4: Modelling the water cycle

Target Years: 3–6

Problem: Why does it rain?

Main teaching focus

Water changing state from liquid to gas and from gas to liquid is responsible for the water cycle in Australia. (Freezing can be included for those schools in snow country!)

Australian Curriculum References

3-4 SU

- A change of state between solid and liquid can be caused by adding or removing heat

5-6 SU

- Solids, liquids and gases have different observable properties and behave in different ways

3-4 SHE

- Science involves making predictions and describing patterns and relationships

3-4 SIS

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports.

Background Science

The water cycle is based on water changing from one state to another and on water cycling through the living and non-living worlds. Plants take in (absorb) water through their roots and lose water through their leaves (transpiration). Animals take in water in the food and drink they consume and lose water through perspiration, exhalation and urination. Water can be stored in natural systems such as rivers, lakes, and oceans as well as in built storage facilities such as dams and tanks.

The water cycle is variable in its consistency in different parts of Australia due to different climates and weather patterns.

Global Education Perspective – Sustainable futures

Weather patterns vary around the world so that some countries get very little rain and people do not have enough water to drink or grow food. Students consider what needs to be done for all to live in a world where all people have sufficient food for a healthy and productive life.

Students' potential alternative conceptions

Students often misunderstand how the water cycle works. Clouds may be thought to be made of smoke or cotton wool or are bags of water that tear to release the rainwater. Clouds go into the sea to collect water then move somewhere else and give rain. (Driver, 1994).

Activity

1. Get a clear jar and lid. Pour about 3cm of hot tap water into the jar. Place the lid upside down on the jar opening and fill it with some ice cubes. What happens? (Water droplets will form on the underside of the lid. Some of the hot water in the jar evaporates. The water vapour molecules hit the cold lid and cool, lose energy and change to a liquid. If the water starts dripping off the lid, use the word “precipitation” to describe the falling ‘rain’.)
2. Collect two see-through plastic bags, vaseline and some string or a large rubber band. Select a suitable small branch of a living plant and place one part of the branch in the plastic bag, sealing it with the string or rubber band. Smear the leaves of the other part of the branch with Vaseline and then place that part in another plastic bag, also sealing it with a string or a rubber band. Leave the bags on for at least an hour or, better still, overnight. What happens? (The untouched leaves will give out water in a process called transpiration.) Reference: Pages 29–30 of Streams Alive: The Water Cycle, Plant Transpiration Demonstration http://www.streamwatch.org.au/cms/resources/school_pdfs/Streams_Alive.pdf
3. Brainstorm with the students to create a word bank of terms that could be used to identify ways in which water can enter or leave the atmosphere. The word bank should include: evaporation, condensation, perspiration, urination, transpiration, and precipitation.
4. For each key term, discuss with students where the process might occur on Earth. For example, evaporation can occur from any open body of water such as oceans, creeks, dams and rivers.
5. Ask the students to design, draw and label a picture to summarise the water cycle where they live.
6. If possible, access the online book at <http://www.drippytheraindrop.com/DrippysWorldTrialStories/ToMountainsAndBack/Entry.htm> Ask the students to discuss the concepts being explained in the book. Write a scientific version of the book.

Extension

1. How does the water cycle operate in other parts of the world? <http://www.wateraid.org/australia/> has news stories about both floods and droughts in other parts of the world. More able and older students should be encouraged to find out how the climate and weather patterns in selected countries differ from that in Australia.
2. Ask students to work in groups to prepare short presentations to answer the following question (or part thereof). How can aid programs help people who suffer excessively from floods and droughts in other parts of the world?

List of references

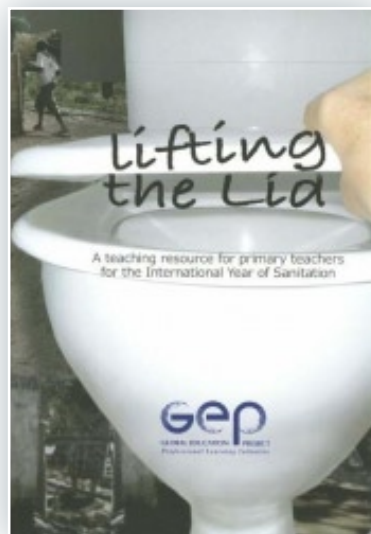
Driver, R., Squires A., Rushworth P., & Wood-Robinson V. (1994). *Making Sense of Secondary Science. Support materials for teachers*. London & New York: Routledge.

World Health Organisation. (2011).

AusAID. (2011) Global Education.

Resources available at http://www.ptc.nsw.edu.au/content_common/pg-globaled-resources.seo

Publications



Wall posters



Taking a five-minute shower uses more water than a typical person in a developing country slum uses in a whole day.

(1) 2006 United Nations Human Development Report.