"An Interview with a Glass of Water" and "The Water Cycle"

Possible Achievement Objectives

Science

Material World

- 2.3: Investigate and describe everyday changes to common substances.
- 3.3: Investigate and report on temporary and more permanent changes that familiar materials undergo.

Planet Earth and Beyond

- 2.1/4: Investigate easily observable physical features and patterns and consider how these are affected by people.
- 3.1: Investigate the major features, including the water cycle, that characterise Earth's water reserves.

Developing the Ideas

These two pieces are very different in style and approach but they both focus on the same topic: the water cycle. "An Interview with a Glass of Water" touches on some important key ideas in a humorous and whimsical manner. "The Water Cycle" elaborates on these ideas in a more systematic and detailed way. It is therefore suggested that the students read the interview first in order to engage with the topic and share their developing ideas. Then they can follow up with "The Water Cycle", using the article to confirm or adjust their ideas in light of more detailed information.

The Big Ideas

Used together, these two pieces can help students to develop the following big ideas.

Water exists in three physical states: solid, liquid, and gas.

During a change of state, water undergoes one of the following processes: freezing, melting, evaporation, or condensation. All these processes are reversible.

Changes in water's physical state are a key element in many weather phenomena, including increases and decreases in humidity, cloud formation, and precipitation.

The "water cycle" involves the continuous movement of water between the Earth's surface and the atmosphere.

As water moves through soil and over land surfaces, it changes the shape of the landscape.

The key processes through which the water cycle affects the shape of the land are erosion, transportation, and sedimentation (deposition of rocks and weathered material).

"An Interview with a Glass of Water" is suitable as a discussion starter because it charts the conceptual terrain without supplying detailed scientific information. The piece's dialogue format lends itself to a read-aloud approach, and so you could have your students read it together in pairs, after which, one pair could perform the dialogue for the rest of the class. (If you or the students are to read the piece aloud, you could change the introductory text slightly to reflect a talk show rather than a magazine interview by referring to "this week's episode of Celebrity Substances".)

Alternatively, you may decide that the piece would have more impact if the audience hadn't read it before. Therefore, you could begin by having most of the class carry out a simple activity that explores the properties of water, in particular, the ease with which it changes state from solid to liquid to gas. During this time, one pair of students could practise reading the dialogue and then perform it for their classmates once the activity has been completed.

An Introductory Activity

The students could carry out Activity 1: Disappearing Water, on page 26 of the Ministry of Education's *Making Better Sense of the Material World* (Learning Media, 1998, revised 2001). In this activity, they begin with an ice cube, which they observe melting into liquid water. For convenience, you could have them begin by observing the ice cube melting in a warm or sunny position and then speed up the process by transferring the ice cube and meltwater to a saucepan on a hotplate. Ask the students why the ice melts more quickly in the heated saucepan. This question should bring out the idea that the hotplate speeds up the melting process by introducing additional heat. Pure water changes from a solid to a liquid if its temperature rises above 0° Celsius. Ask the students to suggest examples of frozen water in nature, such as snow, hail, frost, glaciers, icebergs, sea ice, and frozen lakes and rivers.

Returning to the meltwater in the saucepan, ask the students what they think will happen if they continue to heat the water. Gather their ideas and have them test these out. As the water warms up, it begins to evaporate. In other words, it turns into an invisible gas that's known as water vapour. When the water reaches 100° Celsius, it will begin to boil. (Note, however, that evaporation occurs slowly at room temperature, and the hotplate simply increases the rate.) If the students allowed the process to continue, the saucepan would eventually become completely dry. Talk about this process, using the scientific terms evaporate, evaporation, and vapour. Ask the students for everyday examples of evaporation. They may mention clothes drying, puddles evaporating, aquariums and swimming pools needing to be topped up, gardens and lawns drying out in summer, and wet asphalt drying after rain. (You could use such phenomena to exemplify the fact that evaporation occurs at temperatures well below boiling point.)

(There is a common misconception that water vapour and steam are the same thing. Some students may suggest that they can see the water vapour rising above the saucepan. What they are referring to is steam, which is in fact not a gas. Rather, steam and clouds are composed of tiny droplets of liquid water that have condensed onto atmospheric dust particles. If anyone says that they can see the water vapour, tell them that's an interesting observation, but you think it needs further exploration because most gases are invisible. You could park this idea on the whiteboard and return to it later when the students are reading "The Water Cycle".)

Do the students understand condensation, which is the opposite of evaporation? In order to demonstrate condensation, hold a cold saucepan lid or plate over the boiling water so that the students can observe droplets of liquid water forming on the cold surface. Talk about this process, using the scientific terms condense and condensation. Can the students think of examples of condensation in their everyday world? They may mention condensation on bathroom mirrors or windows or the droplets of water that form on a cold can or jug of drink when you take it out of the fridge.

Ask them why water vapour changes back into a liquid. If they have trouble coming up with an answer, you could give them a clue by reminding them that evaporation occurs when liquid water is heated up – so, what might cause the opposite process? The key is a decrease in temperature. Droplets of condensation form on bathroom mirrors and windows because, like the saucepan lid, these surfaces are cold. When water vapour comes into contact with these surfaces, it condenses back into a liquid. (You could demonstrate this phenomenon with different temperature differentials. For example, you could chill a metal pot lid in a freezer and hold it over a basin of hot water.)

You could summarise these ideas by writing the following schema on the whiteboard:

state: ice ——› liquid water ——› water vapour

process: melting evaporation

state: water vapour ——› liquid water ——› ice

process: condensation freezing

Now that the students have explored the processes through which water changes its physical state, they will understand some of the key concepts that underpin "An Interview with a Glass of Water". If you have chosen two students to perform the dialogue, ask one of the other students to brief them on what the rest of the class did and found out while they were rehearsing.

After the students have read or listened to the dialogue, you could focus on the water cycle aspect to consolidate the ideas gained through the preparatory activity. Widely spaced on the whiteboard, write the stages of the cycle that the glass of water has quoted: fishpond, hail, waterfall, inside a cow, dewdrop, fog. Ask the students to help you fill in the details. Through discussion, add labels that indicate the physical state of the water at each stage (solid, liquid, or gas). Then record the processes that accompany the changes of state. For example, between evaporating from the fishpond and hailing down in South America, the water went through three transformations: liquid to gas (pond to atmosphere), gas to liquid (vapour to cloud droplet), and liquid to solid (liquid droplet to solid hail). Between emerging from the cow and waking up as a dewdrop, the water would have evaporated and condensed again. Similar processes would have accompanied the ensuing transformation into fog. Note that in the formation of dew, the vapour condensed onto the solid ground, or perhaps a leaf, and in the formation of fog, the vapour condensed onto tiny specks of atmospheric dust.

Further Activities

"The Water Cycle" both consolidates the ideas presented in "An Interview with a Glass of Water" and expands the focus to include a consideration of how the water cycle affects the land through processes such as erosion, transportation, and deposition. In other words, the water cycle and parts of the rock cycle are closely intertwined. For background information about the water cycle, refer to the Ministry of Education's *Making Better Sense of Planet Earth and Beyond* (Learning Media, 1999), pages 19 to 20, 64 to 66, 68 to 71, and 85. For background information about the rock cycle, refer to pages 18 to 19, 24 to 25, and 32 to 33.

"The Water Cycle" consolidates and expands on the ideas presented in "An Interview with a Glass of Water". It is suggested that you take a shared reading approach to "The Water Cycle". In this way, you can facilitate discussion about the science concepts and information at appropriate points. You could begin by asking the students to concentrate on the photographs before reading the text. Can they tell you about the physical states of the water in the photographs and describe any of the weather phenomena and land-forming processes shown?

After the students have discussed the photographs, read the entire article as a class so that everyone has an overview of the way in which the water cycle influences the shape of the land. Ask the students for their comments and questions and then return to the text to

seek clarification. You could read the article again in chunks, this time pausing at appropriate points for discussion or practical demonstration. Depending on student queries or interest, you may wish to pay particular attention to some of the following aspects.

Water Vapour and Steam

The second and third paragraphs of the article touch on a point that may have emerged when the students read "An Interview with a Glass of Water". Make sure that the students understand the difference between water vapour, which is an invisible gas, and steam, which is liquid water in the form of a mass of tiny droplets suspended in the air. As water vapour rises, it cools and turns back into a liquid by condensing onto tiny particles of atmospheric dust. Now that the water is liquid again, we can sometimes see it. Near to the ground, we see millions of tiny droplets as mist or fog. Higher up, we see a mass of droplets as cloud. If you look very closely at a jug of boiling water, you might be able to observe the different appearances of water vapour and steam. Directly above the liquid water, you can sometimes see a clear area in which there is no steam. This area contains invisible water vapour, which has not yet cooled to the point at which it condenses into steam droplets, which you can see in the layer above.

(You could mention that we continually exhale water vapour from our lungs as we breathe. Ask the students to exhale and try to see this vapour. They will not be able to. On frosty mornings, however, you can see exhaled water as puffs of cold steam, which has condensed onto dust particles immediately because the air is chilled.)

Some clouds form over the land, but most form over seas and oceans and are then blown onto the land by sea breezes. As a mixture of cloud and vapour rises, it becomes cooler. As this happens, more and more vapour condenses into liquid droplets. Because there are more droplets and the droplets are bigger because they've coalesced (joined together to form larger droplets), a rain cloud often covers a large area and becomes dark before a downpour.

On page 82 of *Making Better Sense of Planet Earth and Beyond*, there is a simple activity for making a cloud by pouring hot water into a jar, screwing on the lid, and putting ice on top. Make the point that each individual water droplet is far too small to be seen with the naked eye. However, we can see large numbers of droplets en masse. A simple analogy might help to clarify this point. We wouldn't be able to see an individual grain of sand from 15 metres away, but we would easily be able to see a sandcastle at this distance.

The Rain Shadow of the Southern Alps

The text mentions that the McKenzie Basin receives a tiny amount of rainfall compared with neighbouring Fiordland. The same could be said of drought-prone Canterbury and Marlborough compared with the West Coast. This phenomenon is known as the rain shadow effect. In New Zealand, prevailing westerly winds bring warm, moist air in from the Tasman Sea. When this air reaches the Southern Alps, it is forced rapidly upwards, cooling as it rises. As the air cools, most of its water vapour condenses into rain and snow clouds, which unleash large amounts of precipitation on the western side of the ranges. Because the air has lost so much moisture, it is very dry indeed by the time it makes its way over the ranges and into Central Otago, Canterbury, and Marlborough. This is why these easterly regions record low annual rainfall.

Erosion

You will find useful background information on erosion on pages 32 to 33 of *Making Better Sense of Planet Earth and Beyond*. After the second reading of "The Water Cycle", the students could carry out Activity 10: Three-dimensional Models of Landforms, on page 35, and Activity 12: Water Erosion, on page 36.

Transport and Deposition/Sedimentation

Eroded material is transported by moving water and eventually settles to the bottom of lakes, river beds, or other bodies of water. The distance that eroded material travels depends on the size of particles and the speed of the flowing water. In general, larger rock fragments and stones settle out more quickly than soil and small rock particles because they are heavier and therefore sink, even in quite fast-flowing water. However, these river stones don't stay in the same place. They tend to gradually roll along on the bottom of rivers and streams, whereas smaller fragments and particles are carried along in suspension.

In lakes and very sluggish rivers and streams, even soil particles will settle out and form mud deposits. Floodplains owe their fertility to similar, repeated processes. A large river at peak flow carries a huge amount of solid load. If such a river breaks its banks and spreads over the surrounding land, it starts to slow down and deposit alluvial (river-borne) silts, sands, fragmentary rock, and organic material. When the river finally recedes back within its banks, the silt-clogged landscape may appear devastated, but eventually the alluvial deposits will greatly enrich the soil. (Note, however, that flood water can also carry off topsoil. So the gains may be long term rather than immediate.)

To demonstrate alluvial sedimentation, you could line a basin with calico or a handkerchief. Collect some very muddy water and pour it into the basin. If you allow it to stand for a short while and then gently drain off the water, much of the silty mud will remain on the cloth.

Links to the Building Science Concepts Series

You will probably find it very useful to refer to the Ministry of Education's *Waterways: How Rivers and Streams Work*, book 1 in the BSC series (Learning Media, 2000). This teachers' resource includes background information about the water cycle and river systems. It also suggests detailed classroom activities through which you can both assess and develop your students' ideas about rivers, erosion, and sedimentation.

Cross-curricular Links

The Arts: creating diagrams and posters that illustrate and explain the water cycle or aspects thereof – experimenting with different materials, such as felt or cotton wool for clouds and tinfoil or blue cellophane for liquid water, and paying particular attention to composition and layout in order to visually communicate information and ideas

English: writing skits that explore aspects of the rock or water cycle, for example, An Interview with a Mountain Boulder, An Interview with a Clod of Earth, or An Interview with the Rakaia River

Social Studies: discussing people's social and economic use of rivers and the ways in which these uses have changed over time, for example, in earlier times, rivers were a very important means of transport and communication, whereas these days, they are often more economically significant in terms of electricity generation and socially significant in terms of recreation; exploring the cultural and spiritual significance of water and waterways for Māori and considering the ways in which these philosophies affect the economic and social use of waterways by Māori