What Makes the Weather?

by Erick Brenstrum

CONNECTED
SCIENCE • TECHNOLOGY • MATHEMATICS
2012 LEVEL 3

Overview

This article describes the physical processes that drive weather: the water cycle and changes in air pressure and temperature. The text then explains how these processes work together to cause a variety of weather conditions.

Curriculum context

SCIENCE

NATURE OF SCIENCE

Investigating in science

Achievement objective(s)

L3 and 4: Students will ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.

Communicating in science

Achievement objective(s)

L3 and 4: Students will begin to use a range of scientific symbols, conventions, and vocabulary.

PHYSICAL WORLD

Physical inquiry and physics concepts

Achievement objective(s)

L3 and 4: Students will explore, describe, and represent patterns and trends for everyday examples of physical phenomena, such as movement, forces, ... and heat.

PLANET EARTH AND BEYOND

Interacting systems

Achievement objective(s)

L3 and 4: Students will investigate the water cycle and its effect on climate, landforms, and life.

MATERIAL WORLD

The structure of matter

Achievement objective(s)

L 4: Students will begin to develop an understanding of the particle nature of matter and use this to explain observed changes.

Key ideas

- The Earth's atmosphere consists of air.
- Air is a mixture of gases.
- Gases are made of particles that can move from place to place, much as liquids do.
- Water can exist in air as a liquid (rain, clouds, mist, and fog), as a solid (snow and hail), and as a gas (water vapour).
- Changes in the lower atmosphere that we experience as weather are related to temperature and pressure differences in adjacent air masses.
- In general, air particles move from areas of high pressure to areas of low pressure as wind.
- Weather maps are a way of communicating complex ideas to a broad audience.

ENGLISH

READING

Ideas

Achievement objective(s)

L3: Students will show a developing understanding of ideas within, across, and beyond texts.

Indicators

- Uses their personal experience and world and literacy knowledge confidently to make meaning from texts.
- Makes meaning of increasingly complex texts by identifying main and subsidiary ideas in them.
- Starts to make connections by thinking about underlying ideas in and between texts.
- Makes and supports inferences from texts with increasing independence.

The Literacy Learning Progressions

The literacy knowledge, skills, and attitudes that students need to draw on by the end of year 6 are described in *The Literacy Learning Progressions.*

Meeting the literacy challenges

The following strategies will support students as they engage with the information and ideas in the text. Once they understand what the article is about ("the story"), they will be able to explore the key science ideas outlined in the following pages.

The *Connected* series includes a range of texts that provide opportunities for students to locate, evaluate, integrate, and synthesise information and ideas.

It is expected that students will read across the range of texts in this *Connected* to develop their literacy skills and their understanding of the topic.

Text characteristics

- Abstract ideas accompanied by concrete examples in the text that help support students' understanding
- A significant amount of subject-specific vocabulary
- Diagrams that clarify the text and require interpretation.

1. DEALING WITH ABSTRACT IDEAS

This is the leading article in a book about the complex subject of weather. Students need to grasp a range of abstract ideas to understand the text. Take time to read and to do the condensation and air pressure experiments (together with the experiments that follow under Exploring the Science) to enhance students' understanding of the abstract concepts of air pressure and density, lows and highs, fronts, and water vapour as a gas.

ASK QUESTIONS to help the students to engage with the text and to assess and support their understanding.

The higher you go, the less air there is, so there's less air pressure. That means the gases can expand. What does that do to the weather? Has anyone gone high enough to notice this?

MAKE CONNECTIONS between the information in the text and the weather students are familiar with.

Read the section about wild weather and discuss with your partner what might have caused the last bout of bad weather we experienced.

Look at where we live on the map and then read the section on page X (as appropriate) to find out why this is such a windy/wet/humid area.

PROMPT the students to explain the concepts in their own words in think, pair, share or group settings.

I'm finding this explanation a bit hard to follow. Read it with your partner and then paraphrase each sentence to work out what you think it means. It may help to draw a simple flow chart or diagram to clarify your thinking.

Students can then **RECORD** and **REFINE** their shared explanations and discuss whether the explanations have helped them to understand the text. This activity allows students to synthesise information and to make it their own.

2. DEALING WITH SUBJECT-SPECIFIC VOCABULARY

MAKE CONNECTIONS between the vocabulary in the text and its place in students' everyday lives. As an introduction to this article, record one or two radio or television weather reports. Have the students listen to these, recording words and phrases that they identify as specific to the topic of weather. After the reading, they can highlight recorded words that appeared in the text.

Before the reading, **IDENTIFY** and **LIST** the subject-specific vocabulary on pages 2–11.

After the reading, students can work in groups to complete a glossary of this vocabulary, almost all of which is explained within the text.

3. INTERPRETING THE DIAGRAMS TO CLARIFY THE TEXT

EXPLAIN to the students that the numerous diagrams in this text will help clarify their understanding.

MODEL how to read and interpret these diagrams by thinking aloud about the information in a diagram as the students study it.

Let's read this diagram on page 4. It's called a water cycle, and the arrows show this by indicating movement around the circle in the middle. Because it's a cycle, we can start to read the information at any place on the diagram. I'm starting in the bottom right corner, where water vapour rises from the sea into the air. From there …

PROMPT the students to interpret the diagrams aloud in a shared reading context so that any misconceptions about the visual information can be corrected.

ASK QUESTIONS to guide the students' reading.

What do the dots stand for in this air-pressure diagram? Why are they shown in different patterns at each stage of the cycle?

Exploring the science

The following activities and suggestions are designed as a guide for supporting students to develop scientific understanding as they explore the physical processes that drive the weather.

Key ideas

- The Earth's atmosphere consists of air.
- Air is a mixture of gases.
- Gases are made of particles that can move from place to place, much as liquids do.
- Water can exist in air as a liquid (rain, clouds, mist, and fog), as a solid (snow and hail), and as a gas (water vapour).
- Changes in the lower atmosphere that we experience as weather are related to temperature and pressure differences in adjacent air masses.
- In general, air particles move from areas of high pressure to areas of low pressure as wind.
- Weather maps are a way of communicating complex ideas to a broad audience.

Activity 1: *Exploring the water cycle*

a. Ask the students to picture an aspect of the water cycle in their heads. Then ask them to quickly make a sketch of this picture and note what is changing.

Ask if any of the students has drawn a foggy mirror in the bathroom, water drops forming on a cold can, or a person blowing what looks like fog on a cold winter's morning. Ask the students who have drawn pictures that include mountains, seas, clouds, sky, and Sun to put their hands up. Depending on their experiences, most students and adults will identify the water cycle with a diagram that has sea, clouds, mountains, and rivers.

b. As a class, compile a model of the water cycle that records examples of the three states of water and the physical contexts and processes that cause water to change its state.

c. Read and discuss the article "An Interview with a Glass of Water" by Jeffy James in *Connected* 2 2002. This gives an amusing personal account of water changing through its cycle.

Depending on the students' previous experiences and their responses to the steps above, either explore all stages of the water cycle using ice (See *Making Better Sense of the Material World*, pages 25–29) or concentrate on exploring water vapour. Make sure they understand the relationship between the state of the water (solid, liquid, or gas) and the spacing and relative movement of the particles. Drawing simple diagrams of each can help them to understand and remember these relationships. (Solid = closely packed vibrating particles. Liquid = particles with a little more space between them, moving slowly past each other. Gas = widely spaced, fast moving particles)

Activity 2: *Exploring water vapour*

Materials: small mirrors, short lengths of drinking straws, very cold can of liquid, balloons, plastic cup, paper towel, container of water

1. Establishing that air exists

Have the students blow gently through straws onto the back of their hands. Ask them to describe what they can feel. Establish the idea that they can feel little bits of air hitting their skin and that scientists call these little bits "particles". All material things are made up of particles.

Have one student blow the balloon up part way. Ask another student to push against the balloon. Have the students explain what they felt and saw. The air inside the balloon will push back. Establish that air is made up of gases that take up space and that air can be contained. These gases are made up of many very small particles that are constantly moving.

To test that there are particles of air present, place the open end of the blown-up balloon under water and observe the bubbles of air that rise to the surface. To further test this idea, have the students explore what happens when a plastic cup with a squashed paper towel in it is immersed upside down and upright into a tank of water. The paper towel should remain dry. Ask the students to investigate and explain why this happened, using annotated diagrams.

2. Identifying water vapour

Have the students blow gently onto small mirrors and record and discuss what they see. Establish that the air they breathe onto the mirror is warm and moist and then introduce the term "condensation".

Ask the students to touch the mirror and record whether it felt cold or warm. Have them repeat the test when the mirror is cool and warm to investigate the role that temperature plays in condensation. (The mirror surface can be warmed by continuous blowing or rubbing with hands.)

Bring out the cold can and ask the students to think about what might happen to the surface of the can over the next few minutes and share their ideas. Have them observe closely and discuss what happens. Establish the idea that some of the water vapour particles in the air are condensing into water droplets on contact with the cold surface. Be aware that some students may think that the water in the glass in the page 4 experiment has moved through the glass or spilt over the edge. The can should help them understand, but you could also use colouring in the water and ice mixture of the experiment to emphasise that the water on the outside surface is different.

Ask the students to share other examples of everyday condensation from their experience. Ask them to identify the source of the temperature changes that caused the condensation to occur.

Return to the article and ask the students to explain what is happening in the diagram of the water cycle on page 4.

Activity 3: *Exploring air pressure*

Materials: balloons

The article identifies that changes in air pressure can cause changes in weather conditions.

Establish what air pressure is by asking the students to fill three similar-sized balloons with different amounts of air. Ask the students to identify the balloons with the greatest and least pressure inside. Students then explain, using diagrams, what made them reach this conclusion.

With input from the class, make a poster that records the students' thinking.

Activity 4: *Exploring the effects of temperature on air*

1. Expanding balloons

Materials: large container of hot water, balloons, two 1.5 L plastic bottles

Establish with the students that the air inside the open plastic bottles has the same temperature and air pressure as the air outside the bottles.

Place a balloon over the mouth of each bottle.

Ask the students to predict what will happen if one of the plastic bottles is placed upright in a container of hot water. Ask the students to explain the cause of any changes they think may happen.

Compare the two bottles and balloons. (The bottle that was not placed in the hot water is the control.) Ask the students to make annotated drawings to explain what happened. Establish that the heat energy is being transferred from the hot water to the air inside the bottle. These particles of air are moving much faster, so are

creating greater pressure and taking up more space, which causes the balloon to expand. Note that a property of the balloon allows it to stretch and change shape. Have the students role-play the way the air particles react to the change of temperature.

If ice is available, the same activity could be repeated by cooling the air inside the bottle to reduce the air particles' movement and lessen the pressure on the balloon. Again, ask the students to predict what might happen.

Alternatively, tip a small amount of hot water into the bottle, shake it about, and then place a balloon over the opening. Then place the bottle in ice to cool the remaining air inside the bottle. Observe what happens to the balloon over time.

As indicated in the article, high- and low-pressure areas are identified on weather maps as they strongly influence the type of weather that will occur. To further explore weather phenomena, refer to pages 63–90 of *Making Better Sense of Planet Earth and Beyond*.

2. Exploding eggs or water bombs

Materials: boiled eggs with shells removed or filled water bombs, glass bottles (like old milk bottles or juice bottles), matches, paper tapers (12 cm x 3 cm, folded once lengthways)

The article talks about wild weather; this activity models the destructive forces an unbalanced weather system can generate when there is a sudden change in air pressure.

Traditionally this activity is done with eggs, but water bombs are just as effective, cost less, and make a lot less mess.

The activity is best done in pairs. The first person lights a paper taper and drops it into a bottle. The second places the egg or water bomb on the bottle opening. They may need to steady it as it may wobble a little. Once the flame goes out, there will be a slight pause before the egg or balloon explodes into the bottle.

Have the students carefully observe several of these and then ask them, as a group, to construct an annotated picture sequence that explains the changes they observed. The air in the bottle is heated and expands, causing some of the air to escape. This escaping air makes the egg or water bomb wobble on the rim. When the taper goes out, there is less energy to heat the air particles inside and they start to cool and slow down. The air pressure inside the bottle is now less than that outside, so the outside air will push the egg or water bomb into the jar quite violently.

MINISTRY OF EDUCATION RESOURCES

- *Making Better Sense of the Material World,* Water, pages 23–33
- *Making Better Sense of Planet Earth and Beyond,* Weather, pages 63–90
- Building Science Concepts (BSC series): Book 58: *Ice: Melting and Freezing;* Book 15: *Where's the Water?;* Book 31: *Water and Weather;* Book 30: *The Air around Us*
- *Connected* 2 2002, "An Interview with a Glass of Water", pages 2–5
- *Connected* 2 2004, "Thunder and Lightning", pages 14–17
- *Connected* 2 2004, "Hard Ice, Soft Ice", pages 18–21
- See the Assessment Resource Bank site and linking documents to the Making Better Sense books and the BSC series for appropriate tasks:
  - http://arb.nzcer.org.nz/resources/science/bsc.php
  - http://arb.nzcer.org.nz/resources/science/bettersense/

FURTHER RESOURCES

See also resource lists in BSC and Making Better Sense books.

- www.metservice.com/learning/how-to-read-maps
- www.niwa.co.nz/education-and-training/schools/students
- www.windows2universe.org/earth/Atmosphere/weather.html
- www.weatherquestions.com
- Websites for students:
  - www.kidsgeo.com/geography-for-kids
  - www.eo.ucar.edu/kids

ISBN: 978 0 7903 4140 8 (ONLINE)