PrimaryConnections®

Australian Academy of Science

Fully aligned with the Australian Curriculum

Rising salt

Year 6

Biological sciences

About this unit Rising salt

Our very survival depends on a reliable source of natural resources, including food. Primary industries use their knowledge of how physical conditions of the environment affect the growth and survival of living things to ensure good yields. However they are faced with new environmental challenges, such as rising salinity and changing weather patterns, which provide a highly relevant context in which to investigate how living things are affected by such changes.

The *Rising salt* unit is an ideal way to link science with literacy in the classroom. Through hands-on investigations, students explore how physical conditions of the environment, including methods of watering and salinity, affect the growth and survival of living things. With support, they plan and conduct an open investigation and design solutions to improve agricultural sustainability.

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Contents

Foreword

Never has there been a more important time for science in Australia. More than ever, we need a scientifically-literate community to engage in debates about issues that affect us all. We also need imaginative thinkers to discover the opportunities in our exponentially expanding knowledge base. Teachers play a vital role in nurturing the minds of our future citizens and scientists.

The Australian Academy of Science has a long, proud history of supporting science education. Our primary education program, Primary**Connections:** linking science with literacy, now has over 15 years' experience in supporting teachers to facilitate quality learning experiences in their classrooms. Regular evaluations demonstrate the significant impact the program can have on both teacher confidence and student outcomes.

PrimaryConnections has been developed with the financial support of the Australian Government and endorsed by education authorities across the country. It has been guided by its Steering Committee, with members from the Australian Government and the Australian Academy of Science, and benefitted from input by its Reference Group, with representatives from all states and territories.

Key achievements of the program include engaging over 24,000 Australian teachers in professional learning workshops, producing multi award-winning curriculum resources, and developing an Indigenous perspective framework that acknowledges the diversity of perspectives in Australian classrooms.

The Primary**Connections** teaching and learning approach combines guided inquiry, using the 5Es model, with hands-on investigations. It encourages students to explore and test their own, and others', ideas and to use evidence to support their claims. It focuses on developing the literacies of science and fosters lasting conceptual change by encouraging students to represent and re-represent their developing understandings. Students are not only engaged in science, they feel that they can do science.

This is one of 40 curriculum units developed to provide practical advice on implementing the teaching and learning approach while meeting the requirements of the Australian Curriculum: Science. Trialled in classrooms across the country and revised based on teacher feedback, and with the accuracy of the teacher background information verified by Fellows of the Academy, the experience of many brings this unit to you today.

I commend Primary**Connections** to you and wish you well in your teaching.

Professor John Shine, AC Pres AA
President (2018–2022)
Australian Academy of Science

The PrimaryConnections teaching and learning approach

Primary**Connections** units embed inquiry-based learning into a modified 5Es instructional model. The relationship between the 5Es phases, investigations, literacy products and assessment is illustrated below:

Primary**Connections 5Es teaching and learning model**

Phase	Focus	Assessment focus
ENGAGE	Engage students and elicit prior knowledge	**Diagnostic assessment**
EXPLORE	Provide hands-on experience of the phenomenon	**Formative assessment**
EXPLAIN	Develop scientific explanations for observations and represent developing conceptual understanding Consider current scientific explanations	**Formative assessment**
ELABORATE	Extend understanding to a new context or make connections to additional concepts through a student-planned investigation	**Summative assessment** of the Science Inquiry Skills
EVALUATE	Students re-represent their understanding and reflect on their learning journey, and teachers collect evidence about the achievement of outcomes	**Summative assessment** of the Science Understanding

More information on Primary**Connections** 5Es teaching and learning model can be found at: www.primaryconnections.org.au

Reference: Bybee, R.W. (1997). *Achieving scientific literacy: from purposes to practical action*. Portsmouth, NH: Heinemann.

Developing students' scientific literacy

The Primary**Connections** program supports teachers in developing students' scientific literacy. Scientific literacy is considered the main purpose of school science education and has been described as an individual's:

- scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues
- understanding of the characteristic features of science as a form of human knowledge and enquiry
- awareness of how science and technology shape our material, intellectual and cultural environments
- willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

Reference: Programme for International Student Assessment & Organisation for Economic Co-operation and Development. (2009). *PISA 2009 assessment framework: key competencies in reading, mathematics and science*. Paris: OECD Publishing.

Linking science with literacy

Primary**Connections** has an explicit focus on developing students' knowledge, skills, understanding and capacities in science and literacy. Units employ a range of strategies to encourage students to think about and to represent science.

Primary**Connections** develops the literacies of science that students need to learn and to represent their understanding of science concepts, processes and skills. Representations in Primary**Connections** are multimodal and include text, tables, graphs, models, drawings and embodied forms, such as gesture and role-play. Students use their everyday literacies to learn the new literacies of science. Science provides authentic contexts and meaningful purposes for literacy learning, and also provides opportunities to develop a wider range of literacies. Teaching science with literacy improves learning outcomes in both areas.

Assessment

Assessment is ongoing and embedded in Primary**Connections** units. Assessment is linked to the development of literacy practices and products. Relevant understandings and skills are highlighted at the beginning of each lesson. Different types of assessment are emphasised in different phases:

Diagnostic assessment occurs in the *Engage* phase. This assessment is to elicit students' prior knowledge so that the teacher can take account of this when planning how the *Explore* and *Explain* lessons will be implemented.

Formative assessment occurs in the *Explore* and *Explain* phases. This enables the teacher to monitor students' developing understanding and provide feedback that can extend and deepen students' learning.

Summative assessment of the students' achievement developed throughout the unit occurs in the *Elaborate* phase for the Science Inquiry Skills, and in the *Evaluate* phase for the Science Understanding.

Rubrics to help you make judgments against the relevant achievement standards of the Australian Curriculum are available on our website:
www.primaryconnections.org.au

Safety

SAFETY

Learning to use materials and equipment safely is central to working scientifically. It is important, however, for teachers to review each lesson before teaching to identify and manage safety issues specific to a group of students. A safety icon SAFETY is included in lessons where there is a need to pay particular attention to potential safety hazards. The following guidelines will help minimise risks:

- Be aware of the school's policy on safety in the classroom and for excursions.
- Check students' health records for allergies or other health issues.
- Be aware of potential dangers by trying out activities before students do them.
- Caution students about potential dangers before they begin an activity.
- Clean up spills immediately as slippery floors are dangerous.
- Instruct students never to smell, taste or eat anything unless they are given permission.
- Discuss and display a list of safe practices for science activities.

Teaching to the Australian Curriculum: Science

The Australian Curriculum: Science has three interrelated strands—Science Understanding, Science as a Human Endeavour and Science Inquiry Skills—that together 'provide students with understanding, knowledge and skills through which they can develop a scientific view of the world' (ACARA 2020).

The content of these strands is described by the Australian Curriculum as:

Science Understanding	
Biological sciences	Understanding living things
Chemical sciences	Understanding the composition and behaviour of substances
Earth and space sciences	Understanding Earth's dynamic structure and its place in the cosmos
Physical sciences	Understanding the nature of forces and motion, and matter and energy
Science as a Human Endeavour	
Nature and development of science	An appreciation of the unique nature of science and scientific knowledge, including how current knowledge has developed over time through the actions of many people
Use and influence of science	How science knowledge and applications affect people's lives, including their work, and how science is influenced by society and can be used to inform decisions and actions
Science Inquiry Skills	
Questioning and predicting	Identifying and constructing questions, proposing hypotheses and suggesting possible outcomes
Planning and conducting	Making decisions about how to investigate or solve a problem and carrying out an investigation, including the collection of data
Processing and analysing data and information	Representing data in meaningful and useful ways, identifying trends, patterns and relationships in data, and using evidence to justify conclusions
Evaluating	Considering the quality of available evidence and the merit or significance of a claim, proposition or conclusion with reference to that evidence
Communicating	Conveying information or ideas to others through appropriate representations, text types and modes

Primary**Connections** has units to support teachers to teach each Science Understanding detailed in the Australian Curriculum: Science from Foundation to Year 6. Units also develop students' skills and knowledge of the Science as a Human Endeavour and Science Inquiry Skills sub-strands, as well as specific sub-strands within the Australian Curriculum: English and Mathematics. Detailed information about its alignment with the Australian Curriculum is provided in each unit.

Unit at a glance — *Rising salt*

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Living sustainably	To capture students' interest and find out what they think they know about how the growth and survival of living things are affected by the physical conditions of their environment. To elicit students' questions about living sustainably.
EXPLORE	**Lesson 2** Water worries	To provide students with shared experiences of how different methods of watering affect plant growth and health.
	Lesson 3 Salt solutions ***Session 1*** Make it salty ***Session 2*** Sorting out the solution	To provide students with hands-on, shared experiences of how different concentrations of salt water affect living things.
EXPLAIN	**Lesson 4** Sustainable systems	To support students to represent and explain their understanding of how the growth and survival of living things are affected by the physical conditions of their environment. To introduce current scientific views about the causes of salinity and how to address it.
ELABORATE	**Lesson 5** Design challenges	To support students to plan and design an irrigation system or water trough to decrease water consumption.
	Lesson 6 Testing improvements *(Optional)* ***Session 1*** Further investigation ***Session 2*** Sharing results	To support students to plan and conduct an open investigation into variables that might affect a plant's tolerance to salinity.
EVALUATE	**Lesson 7** Sustainable solutions	To provide opportunities for students to represent what they know about how the growth and survival of living things are affected by the physical conditions of their environment, and to reflect on their learning during the unit.

A unit overview can be found in Appendix 11, page 72.

Rising salt—Alignment with the Australian Curriculum

Rising salt is written to align to the Year 6 level of the Australian Curriculum Science. The interrelationship between the three strands—Science Understanding, Science Inquiry Skills and Science as a Human Endeavour strands are interrelated and embedded throughout the unit (see page xi for further details. This unit focuses on the Biological sciences sub-strand.

Year 5 Science Understanding for the Biological Sciences:	The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094)
Incorporation in *Rising salt*:	Students generate inquiry questions about how different types of watering and different levels of salinity affect the growth of plants. They discuss and formulate plans of actions to answer these questions and conducting scientific investigations. They generate new claims based on evidence to answer their original questions.

AC All the material in the first row of this table is sourced from the Australian Curriculum.

Year 6 Achievement Standard

The Australian Curriculum: Science Year 6 achievement standard indicates the quality of learning that students should demonstrate by the end of Year 6.

By the end of Year 6, students compare and classify different types of observable changes to materials. They analyse requirements for the transfer of electricity and describe how energy can be transformed from one form to another when generating electricity. They explain how natural events cause rapid change to Earth's surface. **They describe and predict the effect of environmental changes on individual living things. Students explain how scientific knowledge helps us to solve problems and inform decisions and identify historical and cultural contributions.**

Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured and describe potential safety risks when planning methods. They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using appropriate representations and construct multimodal texts to communicate ideas, methods and findings.

The sections relevant to *Rising salt* are bolded above. By the end of the unit, teachers will be able to make evidence-based judgements on whether the students are achieving below, at or above the achievement standard for the sections bolded above.

Key ideas

In the Australian Curriculum: Science, six key ideas support the coherence and developmental sequence of science knowledge within and across year levels. In *Rising salt*, these key ideas are represented by:

Key idea	Incorporation in *Rising salt*
Patterns, order and organisation	Students make observations and identify patterns in plant growth in order to draw conclusions about salt tolerance at different stages of growth and for different plants.
Form and function	When designing improved irrigation systems or water troughs, students identify forms that best suit the function of reducing water consumption.
Stability and change	Students recognise that a plant's response to environmental change is relatively predictable (you can determine the salt tolerance of a particular type of lettuce), however on longer timescales plants evolve in response to climatic conditions, for example, salt-resistance types of plants can be bred.
Scale and measurement	Students use formal units of measurements to compare the growth of plants when affected by different amounts of salt in their water.
Matter and energy	Students recognise that under certain conditions plants can no longer create matter, that is, they stop growing.
Systems	By understanding how different plants respond to increasing salinity, students can discuss and predict ecosystem responses to changing conditions and suggest solutions.

Rising salt—Australian Curriculum: Science

Rising salt embeds all three strands of the Australian Curriculum: Science. For ease of reference, the table below outlines the sub-strands covered in *Rising salt*, the content descriptions for Year 6 and their aligned lessons.

Strand	Sub-strand	Code	Year 6 content descriptions	Lessons
Science Understanding	**Biological sciences**	ACSSU094	The growth and survival of living things are affected by the physical conditions of their environment	1–7
Science as a Human Endeavour	**Nature and development of science**	ACSHE098	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions	2, 3, 6
	Use and influence of science	ACSHE100	Scientific knowledge is used to solve problems and inform personal and community decisions	1–7
Science Inquiry Skills	**Questioning and predicting**	ACSIS232	With guidance, pose clarifying questions and make predictions about scientific investigations	1–6
	Planning and conducting	ACSIS103	Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks	2, 3, 6
		ACSIS104	Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate	2, 3, 6
	Processing and analysing data and information	ACSIS107	Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate	2, 3, 5, 6
	Evaluating	ACSIS108	Reflect on and suggest improvements to scientific investigations	3, 6, 7
	Communicating	ACSIS110	Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multimodal texts	1–7

AC All the material in the first four columns of this table is sourced from the Australian Curriculum.

General capabilities

The skills, behaviours and attributes that students need to succeed in life and work in the 21st century have been identified in the Australian Curriculum as general capabilities. There are seven general capabilities and they are embedded throughout the units. For further information see: www.australiancurriculum.edu.au

For examples of our unit-specific general capabilities information see the next page.

Rising salt—Australian Curriculum general capabilities

General capabilities	Australian Curriculum description	*Rising salt* examples
Literacy	Students develop a broader literacy capability as they explore and investigate their world. By learning the literacy of science, students understand that language varies according to context and they increase their ability to use language flexibly.	In *Rising salt* the literacy focuses are: • science journals • glossaries • TWLH charts • word walls • graphs • factual texts • ideas maps • posters • labelled diagrams.
Numeracy	Many elements of numeracy are evident in the Science Inquiry Skills. These include practical measurement and the collection, representation and interpretation of data from investigations.	Students: • collect and interpret data in tables • represent and interpret data in simple graphs • identify trends and patterns from numerical data.
Information and Communication Technology (ICT) Capability	Students develop ICT capability when they research science concepts and applications, investigate scientific phenomena and communicate their scientific understandings.	Students are given optional opportunities to: • use interactive resource technology to view, record and discuss information • use the internet to research further information on sustainable agricultural solutions • use ICT to create multimedia presentations.
Critical and Creative Thinking	Students develop capability in critical and creative thinking as they learn to generate and evaluate knowledge, ideas and possibilities, and use them when seeking new pathways or solutions. Creative thinking enables the development of ideas that are new to the individual, and this is intrinsic to the development of scientific understanding.	Students: • ask questions and design investigations to answer them • analyse data from investigations and use it to answer their questions • respond to questions and compare predictions with results to formulate conclusions • make evidence-based claims about how physical conditions affect the growth and survival of living things.
Personal and Social Capability	Students develop personal and social capability as they engage in science inquiry, learn how scientific knowledge informs and is applied in their daily lives, and explore how scientific debate provides a means of contributing to their communities.	Students: • work collaboratively in teams • listen to and follow instructions to safely complete investigations • participate in discussions.
Ethical understanding	Students develop the capacity to form and make ethical judgements in relation to experimental science, codes of practice, and the use of scientific information and science applications.	Students: • ask questions of others, respecting each other's point of view.
Intercultural understanding	Students learn to appreciate the contribution that diverse cultural perspectives have made to the development, breadth and diversity of science knowledge and applications.	• Cultural perspectives opportunities are highlighted. • Important contributions made to science by people from a range of cultures are highlighted where relevant.

All the material in the first two columns of this table is sourced from the Australian Curriculum.

Rising salt—Australian Curriculum: English

Strand	Sub-strand	Code	Year 6 content descriptions	Lessons
Language	**Expressing and developing ideas**	ACELA1524	Identify and explain how analytical images like figures, tables, diagrams, maps and graphs contribute to our understanding of verbal information in factual and persuasive texts	2, 3, 5, 6
Literacy	**Interacting with others**	ACELY1709	Participate in and contribute to discussions, clarifying and interrogating ideas, developing and supporting arguments, sharing and evaluating information, experiences and opinions	1–7
		ACELY1710	Plan, rehearse and deliver presentations, selecting and sequencing appropriate content and multimodal elements for defined audiences and purposes, making appropriate choices for modality and emphasis	5, 7
	Interpreting, analysing, evaluating	ACELY1712	Select, navigate and read texts for a range of purposes, applying appropriate text processing strategies and interpreting structural features, for example table of contents, glossary, chapters, headings and subheadings	1, 3–7
		ACELY1713	Use comprehension strategies to interpret and analyse information and ideas, comparing content from a variety of textual sources including media and digital texts	1, 3–7
	Creating texts	ACELY1714	Plan, draft and publish imaginative, informative and persuasive texts, choosing and experimenting with text structures, language features, images and digital resources appropriate to purpose and audience	5–7
		ACELY1717	Use a range of software, including word processing programs, learning new functions as required to create texts	7

AC All the material in the first four columns of this table is sourced from the Australian Curriculum.

Rising salt—Australian Curriculum: Mathematics

Strand	Sub-strand	Code	Year 6 content descriptions	Lessons
Number and Algebra	**Number and place value**	ACMNA123	Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers	2, 3, 6
	Fractions and decimals	ACMNA128	Add and subtract decimals, with and without digital technologies, and use estimation and rounding to check the reasonableness of answers	2, 3, 6
Statistics and Probability	**Data representation and interpretation**	ACMSP147	Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables	2, 3, 6

Rising salt—Australian Curriculum: Technologies

Strand	Sub-strand	Code	Year 6 content descriptions	Lessons
Design and Technologies	**Design and Technologies Knowledge and Understanding**	ACTDEK021	Investigate how and why food and fibre are produced in managed environments and prepared to enable people to grow and be healthy	1, 4
Design and Technologies	**Design and Technologies Knowledge and Understanding**	ACTDEK023	Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use	2, 3, 6
Design and Technologies	**Design and Technologies Processes and Production Skills**	ACTDEP024	Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions	4, 6
Design and Technologies	**Design and Technologies Processes and Production Skills**	ACTDEP028	Develop project plans that include consideration of resources when making designed solutions individually and collaboratively	5, 6

Cross-curriculum priorities

There are three cross-curriculum priorities identified by the Australian Curriculum:

- Aboriginal and Torres Strait Islander histories and cultures
- Asia and Australia's engagement with Asia
- Sustainability.

Two of these are embedded within *Rising salt*, as described below.

Aboriginal and Torres Strait Islander histories and cultures

The Primary**Connections** Indigenous perspectives framework supports teachers' implementation of Aboriginal and Torres Strait Islander histories and cultures in science. The framework can be accessed at: www.primaryconnections.org.au

Rising salt focuses on the Western science method of making evidence-based claims about how physical conditions of the environment affect the growth and survival of living things. It discusses how early European farming practices have affected the landscape, including contributing to salinity, and encourages students to explore modern innovations to make practices more ecologically sustainable.

Aboriginal and Torres Strait Islander Peoples might have other ways of understanding and interpreting changes to the growth and survival of living things. It is increasingly recognised that their management of the land was sophisticated, coined as 'farming without fences'. Many of these practices would not have been immediately recognisable to early European settlers, as the ecology and environmental conditions of Australia were so different to what they were used to.

Primary**Connections** recommends working with Aboriginal and Torres Strait Islander community members to access local and relevant cultural perspectives. Protocols for engaging with Aboriginal and Torres Strait Islander community members are provided in state and territory education guidelines. Links to these are provided on the Primary**Connections** website.

Sustainability

The *Rising salt* unit embeds a sustainability focus from the start through discussing one family's desire to meet their needs more sustainably. This unit adopts the Australian Curriculum definition of sustainable patterns of living as meeting 'the needs of the present without compromising the ability of future generations to meet their needs'. By introducing students to the challenges and opportunities faced by primary production systems, they gain a better understanding of intended and unintended environmental modifications and how they affect both plants and animals. This knowledge helps students to make decisions about individual and community actions that contribute to sustainable patterns of consumption of primary products.

Students identify that unsustainable practices can have effects that are far removed from the initial people who benefited. The water tables rose gradually after years of additions of water from both farms and cities, and it wasn't until the salt reached the roots of plants that the effects were felt. This helps students to understand that short-term gain can come at long-term cost, providing a framework for understanding the broader picture of sustainability.

Teacher background information

This information is intended as teacher information only. It provides teachers with information relevant to the science concept so they can feel more confident and competent to teach each lesson. The content and vocabulary of this information is at a more detailed and advanced level than what is required for students.

Introduction to the growth and survival of living things

Living things are affected by their conditions
Living things generally require a specific set of physical or environmental conditions to survive, such as temperature ranges, rainfall, energy source (food or sunlight) and shelter. Even when plants or animals live in the same or similar conditions, their needs vary. For example, in the deserts of Australia, brown snakes need to shelter on and around northeast-facing rocks in the desert, which hold heat to help warm their cold-blooded bodies, while bilbies need soft, sandy soil to dig deep, cool burrows to sleep in during the day.

Animals and plants have adaptations to help them survive in their specific environments. For example, *Eucalyptus* leaves hang straight down to help reduce exposure to the harsh midday sun. This leaf adaptation prevents water loss from heat, while ensuring the leaves capture enough sunlight for photosynthesis and growth.

Living things can require very specific environmental conditions to survive, without which they might stop growing, or become unhealthy from accumulation of minerals or toxins, or even die. Some living things are more tolerant to variations in environmental conditions, for example, cockroaches can thrive in a number of extreme conditions. Many species can survive in sub-optimal conditions but they do not grow as big or strong and might not reproduce successfully. The health of certain living things (bioindicators) can help indicate the health of an ecosystem.

Living things also rely on others for survival. A change in physical conditions might not directly affect them but it may still affect their food sources. For example, bilbies do not need to drink water to survive (they get all their water content from the food they eat), so a change in rainfall does not directly affect them. However, rainfall does affect the plants that they eat which can become less nutrient-dense, stop growing, or even dry out and die.

The effect of early European farming practices
Farming has developed to encourage the survival and growth of living things that are directly beneficial to humans. Humans modify environmental conditions to best meet their own needs and to maximise the growth and survival of the animals and plants that they depend on.

When European settlers first arrived in Australia they introduced existing crop plants and practices from Europe, such as clearing and tilling the soil and planting wheat. These crop plants were not suited to the Australian environment and climate, and therefore often required more water (irrigation) and fertilisers to grow. The native plants that were suited to the existing conditions were not grown as crops. This was partly due to an initial lack of knowledge from the settlers and also due to native species producing much lower yields. The water tables rise in particularly wet years, bringing dissolved salt to the surface. This process can be exacerbated by clearing the land and intensively growing short-rooted crop plants since they cause more water to filter into the ground.

Early European farming techniques are also likely to have contributed to other adverse environmental effects, such as soil erosion through clearing vegetation and the growth of blue-green algae due to nitrogen runoff. These farming practices also had other flow-on effects to Australian species. For example, deforestation for farming cattle and sheep meant that the previously widespread koala populations were no longer able to move about and rely on eucalyptus forests for food and shelter. Kangaroos, however, are grazers, so they thrived on the extra grasslands which they could access by jumping over farm fences.

Modern sustainable farming

Modern sustainable farming is based on understanding how the environment affects the growth of living things on the farm and how farming practices affect the environment. These practices are informed by scientific investigations into more sustainable production methods for the Australian landscape. For example, no-till cropping, which leaves the soil undisturbed, prevents erosion as water and soil are retained on the farm. Research shows that planting legumes in a field of crops helps fix nitrogen to the soil, reducing the demand for nitrogen fertilisers.

Scientists are working to develop local crop plant varieties that are more suited to extreme environments, for example, varieties that produce high yields with less water (more water efficient). Scientists are also developing higher yields from native plants that are already adapted to Australian conditions. There is a growing demand for sustainably grown edible indigenous plants, such as the Kakadu plum (called *gubinge*), or the native bush tomato, which is very high in Vitamin C.

Scientists are working to learn more about local Indigenous knowledge. It is increasingly recognised that the Indigenous people gathered food and resources from the Australian landscape in a sustainable way for native conditions. This purposeful cultivation of early Australia was so sophisticated that it has been coined as 'farming without fences'.

Students' conceptions

Taking account of students' existing ideas is important in planning effective teaching approaches that help students learn science. Students develop their own ideas during their experiences in everyday life and might hold more than one idea about an event or phenomenon.

Students might believe that plants take in food through their roots. Roots absorb water from the soil as well as essential nutrients such as nitrates. However calling these nutrients 'food' is misleading since animals gain energy from their food whereas green plants use photosynthesis. A green pigment called captures light energy from the Sun, which is used by plant cells to convert water and carbon dioxide into carbohydrates. These are later broken down to release energy or used as building material for cell walls. A by-product of photosynthesis is the oxygen we breathe.

To access more in-depth science information in the form of text, diagrams and animations, refer to the Primary**Connections** Science Background Resource, available on the Primary**Connections** website:
www.primaryconnections.org.au
Note: This background information is intended for the teacher only.

Lesson 1 Living sustainably

ENGAGE

AT A GLANCE

To capture students' interest and find out what they think they know about how the growth and survival of living things are affected by the physical conditions of their environment.

To elicit students' questions about living sustainably.

Students:

- discuss the relevance of products grown from farms in their lives and for Australia
- read a scenario and record their thoughts on what might be affecting the health and growth of plants and animals.

Lesson focus

The focus of the *Engage* phase is to spark students' interest, stimulate their curiosity, raise questions for inquiry and elicit their existing beliefs about the topic. These existing ideas can then be taken account of in future lessons.

Assessment focus

Diagnostic assessment is an important aspect of the *Engage* phase. In this lesson you will elicit what students already know and understand about how:

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

Key lesson outcomes

Science

Students will be able to represent their current understanding as they:

- explain their existing ideas about what living things need to grow and survive
- identify some physical conditions of the environment and their effect on the growth of living things
- identify their existing ideas about living sustainably
- identify how scientific knowledge might be used to solve poor growth and health issues of living things on a farm.

Literacy

Students will be able to:

- understand the purpose and features of a science journal, glossary, TWLH chart and word wall
- contribute to class discussions about living sustainably and what affects the growth of living things
- analyse information in a letter.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page xii).

Teacher background information

Farming in Australia

Farming is a major industry in Australia. Agricultural activities occur across large areas of land in Australia and contribute significantly to the economy. Farmers own and manage approximately 53% (406 million hectares) of the total land area of Australia. 93% of Australia's daily domestic food supply comes from our farms, with each farmer producing enough to feed 600 people on average. The industry is constantly changing in response to technology and the needs of consumers.

Challenges faced by farmers

Rising salinity of groundwater and soils is one of the most widespread problems affecting the Australian landscape, drinking water, and even infrastructure. The estimated cost to Australia's economy is $190 million dollars a year. All soils and most freshwater lakes, rivers, streams and aquifers have natural occurring levels of salt, but human activities can exacerbate the natural levels.

When a plant is watered by moderately salty water, the plant has to work harder to absorb water from the soil. As it is not effectively absorbing water, the plant soon begins to wilt, which can lead to slower growth and lead to lower yields. Salt also accumulates in crop plants' cells, becoming toxic at high concentrations. If salty water is sprayed directly on leaves, it can cause salt scorch and leaf damage, even at low levels of salt concentration.

Livestock depend on water from bores and/or streams to survive. They can drink water with less than 3,000 milligram of salt per litre (mg/L). However, when drinking moderately salty water livestock can consume up to 80% more water than they would if drinking freshwater. The quantity of water they drink also depends on what they are eating; livestock tolerate salty water better if they are consuming fresh green grass (with high moisture content) rather than dry feed.

High amounts of salt can cause physiological upset and, in extreme cases, death. What constitutes a high level of salt depends on the animal, species and variety. Birds such as chickens are more sensitive to low levels of salt, which negatively affect growth of young birds, and egg production and quality.

Sustainable patterns of living

Sustainability addresses the ongoing capacity of Earth to maintain all life. Sustainable patterns of living meet the needs of the present without compromising the ability of future generations to meet their needs. Agricultural sustainability is one form of sustainability and can include using ideas such as: not wasting water when irrigating plants, not causing adverse effects to the environment, and using renewable resources such as renewable energy and native plants for food for animals.

Students' conceptions

Our survival depends on a strong and productive source of food, however relatively few people know the conditions under which their food is produced. Just over half of Year 6 children in Australia can identify that cheese, bananas, and the ingredients to make bread come from farms. This lack of understanding about farming, or even negative attitudes towards it, extends beyond food production. Only around a quarter of Year 6 children in Australia can identify that the material of cotton socks comes from a plant product, and about 85% do not know that cardboard starts as a plant. For further information see: http://www.piefa.edu.au/resources/reports/foodfibrefuture.pdf.

Equipment

FOR THE CLASS

- class science journal
- TWLH chart
- word wall
- 1 enlarged copy of 'Dear experts' (Resource sheet 1)
- objects made from natural materials from farms (see 'Preparation')

FOR EACH STUDENT

- science journal
- 1 copy of 'Dear experts' (Resource sheet 1)

Preparation

- Gather objects made from natural materials from farms, for example, a pair of cotton socks, a piece of cardboard and a sandwich.
- Read 'How to use a science journal' (Appendix 2).
- Read 'How to use a word wall' (Appendix 3).
- Read 'How to use a TWLH chart' (Appendix 4). Prepare a four column chart for the class with the following headings:

***Rising salt* TWLH chart**

What we **T**hink we know	What we **W**ant to learn	What we **L**earned	**H**ow we know

- Read 'How to use a glossary' (Appendix 5).
- Prepare an enlarged copy of 'Dear experts' (Resource sheet 1).
- Prepare a page in the class science journal with the following:

Ask the experts

1. Why might the plants be unhealthy and dying?
2. Why might the animals be unwell?
3. What information would be useful to help work out what is happening?

- *Optional:* Display the class science journal, the TWLH chart and 'Dear experts' (Resource sheet 1) in a digital format.

ENGAGE

Lesson steps

1 Introduce the objects made from natural materials from farms (see 'Preparation') and ask questions such as 'Which of the items comes from a farm? Why do you think that?'.

2 Discuss where the materials the objects are made of come from (the cotton that is woven into cotton socks comes from a cotton farm, cardboard is made from wood from plantation forestry, and the foods that make up the sandwich come from various types of farms). Ask students:

- Have you heard of any of these types of farms before?
- What other types of farms do you think there are?
- Does Australia produce any of those materials? Where do you think they are produced?
- Is farming important for Australia? What makes you think that?
- What are some of the challenges for the Australian farming industry?

Optional: Ask students to find materials in the classroom that come from farms.

3 Introduce the enlarged copy of 'Dear experts' (Resource sheet 1) and read through with students. Discuss any new vocabulary.

4 Introduce the prepared page in the class science journal. Ask students to Think:Pair:Share their ideas with a partner.

5 Introduce the class science journal and discuss its purpose and features.

Literacy focus

Why do we use a science journal?

We use a **science journal** to record what we see, hear, feel and think so that we can look at it later to help us with our claims and evidence.

What does a science journal include?

A **science journal** includes dates and times. It might include written text, drawings, measurements, labelled diagrams, photographs, tables and graphs.

Record students' responses in the class science journal.

Note: In the *Engage* phase, do not provide any formal definitions or correct students' answers as the purpose is to elicit students' prior knowledge.

6 Refer to the term 'sustainable living' in 'Dear experts' (Resource sheet 1). Ask students if they have heard of 'sustainable living' and what that might mean. Record students' ideas in the class science journal.

7 Discuss the purpose and features of a glossary.

Literacy focus

Why do we use a glossary?

We use a **glossary** to provide definitions of technical terms that relate to a particular subject matter or topic.

What does a glossary include?

A **glossary** includes a list of technical terms in alphabetical order, accompanied by a description or an explanation of the term in the context of the subject.

8 Model how to develop a glossary using the term 'living sustainably'. Ask students to describe what they think the term means and add an agreed description to the glossary in the class science journal. This description can be modified and adapted during the unit.

Note: It is important to use the word 'describe' rather than 'define'. 'Definitions' are often viewed as fixed and unchangeable, whereas 'descriptions' support students to see that ideas can change as their understanding develops. Similarly, scientists' ideas develop as they find more evidence or think creatively about existing information.

9 Introduce the TWLH chart and discuss its purpose and features.

Literacy focus

Why do we use a TWLH chart?

We use a **TWLH chart** to show our thoughts and ideas about a topic before, during and after an investigation or activity.

What does a TWLH chart include?

A **TWLH chart** includes four sections with the headings: What we **T**hink we know, What we **W**ant to learn, What we **L**earned, and **H**ow we know. Words or pictures can be used to show our thoughts and ideas.

10 Introduce the title and first column of the TWLH chart ('What we **T**hink we know'). Invite students to contribute ideas. Ask questions such as:

- What do plants need to grow and stay healthy?
- What do animals need to grow and stay healthy?
- What things (variables) in the environment might affect how plants and animals grow and stay healthy?

Note: Please see Primary**Connections** unit *Growing well* for more information if students are unclear on the basic needs of living things, such as food and water.

What we Think we know	What we Want to learn	What we Learned	How we know
What do plants and animals need to grow and stay healthy? • Plants need water, nutrients, carbon dioxide and sun to grow. • Animals need food, oxygen, water and shelter to survive.	• In what ways do these essential needs help the plant? • How much water does an animal need to survive?		
What things in the environment might affect how plants and animals grow and stay healthy? • Too much sunlight • Diseases • weather • poor soil • Global warming • Extinction of other animals • Natural disasters (floods, drought) • Human actions – hunting, chopping down trees	• How do diseases affect plants and animals? • Do specific weather conditions affect plants and animals? • What makes soil 'poor soil'? • What effect does global warming have on plants and animals? • What happens to plants and animals in different types of natural disasters? • How does human activity affect plants and animals?		

Class work sample of TWLH chart at end of Lesson 1

11 Discuss with students what experts might need to know to reply to the letter in 'Dear experts' (Resource sheet 1). Introduce the second column on the TWLH chart ('What we **W**ant to learn') and ask students to contribute their questions.

12 Draw students' attention to the word wall and discuss its purpose and features.

Literacy focus

Why do we use a word wall?

We use a **word wall** to record words we know or learn about a topic. We display the **word wall** in the classroom so that we can look up words we are learning about and see how they are spelled.

What does a word wall include?

A **word wall** includes a topic title or picture and words which we have seen or heard about the topic.

13 Ask students what words from today's lesson they would like added to the word wall.

Curriculum links

Science

- Explore the variety of uses and importance plants have on our everyday lives. See: **https://education.abc.net.au/home#!/media/86196/plants-in-our-daily-lives**

English

- Research information to hold a class debate answering the question 'Is farming important to Australia?'

Geography

- Identify locations of different types of agricultural lands around Australia using maps.

Dear experts

Name: ______________________________ **Date:** ______________

Ask the experts

Dear experts,

A large vacant piece of farming land outside of town has been lying unused for decades. It was finally released for sale by the banks and my family and I were able to purchase it and follow our dream of growing everything we need and living sustainably.

To start with we have planted a small vegetable patch with tomatoes and lettuce and some cotton so that we can learn to make our own clothes. Later we want to grow wheat for bread and more fruits and vegetables. We have bought some Jersey cows as we hear they have the best milk for making cream, butter, cheese and yoghurt. We have some chickens so we can have fresh eggs. In time we'd like some sheep for wool, and to harvest the wood from the trees on our land to make our own furniture and keep ourselves warm.

The problem is that our plants are not looking healthy at all. We're worried it might be the summer heat, so we've started pouring water over them morning, noon and night but it doesn't seem to be helping. The cows are having stomach troubles. Parts of the pasture aren't growing much grass for the cows but we are supplementing it with quality dry feed. They seem to be drinking an awful lot of water too so we are refilling their small drinking dam almost as often as we water the plants. It seems wasteful to be using so much water, even if it comes from a well that goes deep underground so it isn't costing us money. We have a separate rainwater tank that is treated for our personal use.

The chickens are looking really unhappy, despite all the chicken feed and vegetable scraps we're providing, and they aren't producing any eggs. We're really worried about our plants and animals.
How can we care better for them?

- Concerned Lifestyler

Dear Concerned Lifestyler,
When you say 'pouring water' on the plants, are you using a watering can?
Some farms in that area have problems with salt on their land. Have you tested what is in your soil and water?

Lesson 2 Water worries

EXPLORE

AT A GLANCE

To provide students with shared experiences of how different methods of watering affect plant growth and health.

Students:

- as a class, investigate if different methods of watering affect the growth and health of tomato plants
- record and interpret observations.

Lesson focus

The *Explore* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Explore* phase ensures all students have a shared experience that can be discussed and explained in the *Explain* phase.

Assessment focus

Formative assessment is an ongoing aspect of the *Explore* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of how:

- the growth and survival of plants are affected by how they are watered.

You will also monitor their developing science inquiry skills (see page xi).

Key lesson outcomes

Science

Students will be able to:

- plan an investigation, with teacher support
- participate in a guided investigation of how different methods of watering affect tomato plant growth
- identify that results from scientific investigations are used to solve problems that directly affect people's lives.

Literacy

Students will be able to:

- participate in and contribute to discussions by sharing information to determine variables and a method for a guided investigation
- use oral language and visual language to report observations of the guided investigations.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page xii).

Teacher background information

One of the reasons plants need water is to transport nutrients from where they were absorbed, generally the soil, to where they are needed, generally the leaves. Our heart pushes blood (including water and nutrients) through our arteries and veins, but plants rely on different processes. One process is to open up pores (stomata) on their leaves. Water then evaporates into the air, cooling the leaves and causing water, and its dissolved nutrients, to rise up through small tubes in the stem called xylem vessels. This process is known as transpiration. Sap, which includes dissolved sugars produced by the leaves, circulates through a system of live tissue called phloem.

The timing of the supply of water, in particular having adequate water supply during flowering, is important for getting good grain yields. There are visible effects of over and under watering a plant that indicates that a plant is under stress. For example, when plants are over watered their leaves can turn yellow because roots need air in the soil to function; too much water displaces all the air in the soil and the roots drown. When plants are under watered they wilt and close their stomata which means they can no longer capture energy from sunlight using photosynthesis (as they no longer get carbon dioxide from the air).

The amount of water entering the soil, and therefore available to plants, depends on the rate of evaporation and type of rainfall. For example, heavy raindrops can splatter the soil particles, clogging the surface and preventing infiltration of water. The water runs along the surface carrying soil particles with it, causing erosion.

The rate of evaporation depends on many different variables, such as the amount and frequency of the rainfall, the strength of the sunlight, the wind speed, the ambient temperature, the humidity of the air, and the wetness of the soil surface.

In some areas, farmers are able to irrigate and so do not need to rely on sparse rain. However, irrigation water is limited and farmers should consider how to best use it, for example, drip irrigation uses less water than spray irrigation.

Farming techniques to maintain ground cover, such as mulching, help to reduce evaporation of water from the soil. Water restrictions imposed on urban gardeners during times of drought encourage gardeners to use water wisely, for example, by not watering during the hottest part of the day.

Students' conceptions

Some students might believe that plants will grow as long as they receive water. However, providing plants with too much or too little water can have adverse affects on them. The effect that different amounts of water, and the way they are delivered, have on the health and growth of plants can depend on variables such as the condition of the soil, the temperature and the wind.

Equipment

FOR THE CLASS

- class science journal
- TWLH chart
- word wall
- 1 enlarged copy of 'Dear experts' (Resource sheet 1) from Lesson 1
- 1 enlarged copy of 'Watering investigation planner' (Resource sheet 2)
- 1 water spray bottle
- 3 tomato seedlings or young plants in pots
- 3 popsticks
- 1 biodegradable cup
- 1 biodegradable cup with holes in bottom
- 1 x 50 mL measuring cup
- 1 permanent marking pen
- access to fresh water

FOR EACH STUDENT

- science journal

Preparation

- Read 'How to write questions for investigation' (Appendix 6).
- Read 'How to conduct a fair test' (Appendix 7).
- Read 'How to facilitate evidence-based discussions' (Appendix 8).
- Prepare an enlarged copy of 'Watering investigation planner' (Resource sheet 2). Collect three tomato seedlings or young plants that are roughly the same size and in separate containers.
- **Note:** This investigation is written as a **class activity** in order to limit equipment required and to model the science investigation skills required for the rest of the unit. If your students have well-developed science inquiry skills you might choose for them to work in collaborative learning teams to plan and conduct this investigation.
- Draw a variables grid in the class science journal:

Watering investigation variables grid

	Plant growth and health	

- *Optional:* Display 'Watering investigation planner' (Resource sheet 2) in a digital format.

Lesson steps

1 Review the watering practices described in 'Dear experts' (Resource sheet 1, see Lesson 1). Discuss possible reasons why the expert asked questions about how the plants were watered.

2 Discuss with students whether they think the plants are affected how they are watered. Ask questions such as:

- What are different ways that plants are watered? (Watering can, hose, drip watering, sprinklers, sprays.)
- Are there methods of watering that are better at giving plants water than others? Why do you think that?
- Can farmers rely on rain alone to water crops? What makes you think that?

Record students' ideas in the class science journal.

Optional: Organise for students to explore watering systems in the schoolyard or at home.

3 Explain that students will conduct a class investigation to explore whether a plant's growth is affected by how it is watered. Introduce the three tomato seedlings. Explain that the class will be watering tomato seedlings using different methods and then observing and recording what happens to the plants.

4 Introduce the enlarged copy of 'Watering investigation planner' (Resource sheet 2) and model how to write the question for investigation, for example:

- 'What happens to tomato plant growth and health when we change the method used to water them?'

5 Brainstorm what might affect how plants grow and stay healthy and record students' answers in the variables grid (see 'Preparation'). Variables might include:

- the amount of water
- the type of plant
- the size of the plants
- the location of the plants
- the time watering occurs
- the method of watering
- the frequency of watering (for example, once a day or twice a day)
- the temperature of the water.

6 Introduce the term 'variables' as things that can be changed, measured or kept the same. Ask students why it is important to keep some things the same when you are measuring changes (to make the test fair, and so we know what caused the observed changes).

7 Model how to use the variables grid to plan a fair test on the enlarged planner, by only changing one variable and keeping all others the same. Record that the class will:

- **Change:** the method of watering.
- **Measure/observe:** the plants' growth and health by measuring plant height (mm) and observing what they look like.
- **Keep the same:** the amount of water (50 mL), the location of the plants, the type of plants, the size of plant, the frequency of watering.

EXPLORE

8 Ask students what different watering methods could be used in the investigation, such as, misting, soaking and flooding types of watering. Discuss equipment that might be used to create these watering methods. For example: misting using a spray bottle, soaking using a biodegradable cup, and flooding by pouring water from the cup straight onto the plant. Discuss whether to water the plants with 50 mL once a day, or water them several times a day (as per the scenario) with the total water added being 50 mL per day.

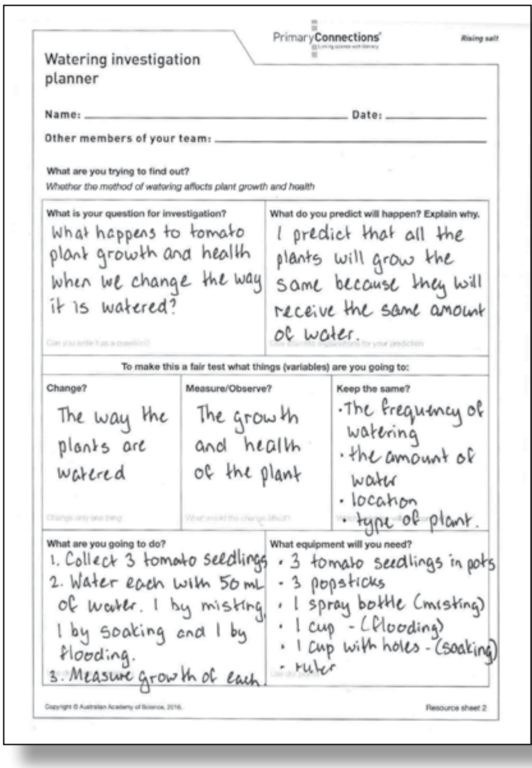
Watering investigation set up

9 Record an agreed equipment list and procedure on the enlarged copy of ‘Watering investigating planner’ (Resource sheet 2). For example:

- Collect the materials and equipment.
- Label each tomato pot with the method of watering it will receive using a permanent marking pen or self-adhesive label on a popstick.
- Water each tomato plant with 50 mL of water using its watering method.
- Measure and record the growth of the tomato plants and observe their health every second day.

10 Model how to water the plants with each method of watering. Allocate a team to water the plants each day. Ask the teams to record observations and measurements every second day, for example, Monday, Wednesday and Friday, on the enlarged copy of ‘Watering investigation planner’ (Resource sheet 2).

11 Ask students what they predict might happen to each tomato plant and the reasons for their predictions.



PrimaryConnections

Rising salt

Watering investigation planner

Name: ____________________ Date: __________

Other members of your team: ____________________

What are you trying to find out?
Whether the method of watering affects plant growth and health

What is your question for investigation?	**What do you predict will happen? Explain why.**
What happens to tomato plant growth and health when we change the way it is watered?	I predict that all the plants will grow the same because they will receive the same amount of water.
Can you write it as a question?	Give scientific explanations for your prediction

To make this a fair test what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
The way the plants are watered	The growth and health of the plant	• The frequency of watering • the amount of water • location • type of plant.
Change only one thing	What would the change affect?	

What are you going to do?	**What equipment will you need?**
1. Collect 3 tomato seedlings 2. Water each with 50 mL of water. 1 by misting, 1 by soaking and 1 by flooding. 3. Measure growth of each	• 3 tomato seedlings in pots • 3 popsticks • 1 spray bottle (misting) • 1 cup - (flooding) • 1 cup with holes - (soaking) • ruler

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Resource sheet 2

Work sample of 'Watering investigation planner' (Resource sheet 2)

12 Discuss possible predictions and model recording one on the enlarged planner.

13 After one week, look at the completed 'Recording results' table of 'Watering investigation planner' (Resource sheet 2). Discuss using the QCER framework (see Appendix 8), asking questions such as:

- What was our question for investigation?
- What claim about different methods of watering can we make from this investigation? Add to the '**L**' section of the TWLH chart.
- What evidence did we collect to support our claim?
- Why do you think this happened? What is the reasoning behind our claim? Add to the '**H**' section of the TWLH chart.
- Was your prediction accurate? Why or why not?
- What problems did we have doing this investigation?
- How could we improve this investigation? (Fairness, accuracy?)

Record students' responses in the class science journal.

14 Update the word wall and glossary with words and images.

Curriculum links

Science

- Explore what happens when farmers use too much water from the Murray-Darling Basin. See: **https://education.abc.net.au/home#!/media/86328/**

EXPLORE

Watering investigation planner

Name: ______________________ **Date:** ______________

Other members of your team: ______________________

What are you trying to find out?
Whether the method of watering affects plant growth and health

What is your question for investigation?	**What do you predict will happen? Explain why.**
Can you write it as a question?	Give scientific explanations for your prediction

To make this a fair test what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
Change only one thing	What would the change affect?	Which variables will you control?

What are you going to do?	**What equipment will you need?**
Use drawings if necessary	Use dot points

Recording results

Record your results in a table.

Measurements of plant growth and observations of plant health

Day			
1	Height: ____________ mm Observations:	Height: ____________ mm Observations:	Height: ____________ mm Observations:
	Height: ____________ mm Observations:	Height: ____________ mm Observations:	Height: ____________ mm Observations:
	Height: ____________ mm Observations:	Height: ____________ mm Observations:	Height: ____________ mm Observations:
	Height: ____________ mm Observations:	Height: ____________ mm Observations:	Height: ____________ mm Observations:

Lesson 3 Salt solutions

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of how different concentrations of salt water affect living things.

Session 1 Make it salty

Students:

- work in teams to plan and conduct a fair test of how different concentrations of salt water affect the growth and health of plants
- observe and record the results of their investigation.

Session 2 Sorting out the solution

Students:

- graph the investigation results
- make claims supported with evidence based on the investigation
- read a factual text on the effect of salty water on animals.

Lesson focus

The *Explore* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Explore* phase ensures all students have a shared experience that can be discussed and explained in the *Explain* phase.

Assessment focus

Formative assessment is an ongoing aspect of the *Explore* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of how:

- the growth and survival of plants and animals are affected by the environmental conditions in which they grow, for example, the concentration of salt in the water.

You will also monitor their developing science inquiry skills (see page xi).

Key lesson outcomes

Science

Students will be able to:

- identify that the effect of salt on living things depends on the concentration of salt present
- make, record and interpret observations
- plan and conduct an investigation that is a fair test
- suggest improvements to the investigation
- identify that results from scientific investigations are used to solve problems that directly affect peoples' lives.

Literacy

Students will be able to:

- use a table to record observations
- engage in discussion to compare ideas
- identify the features and purpose of a factual text
- use oral, written and visual language to design, implement and report on their investigation.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page xii).

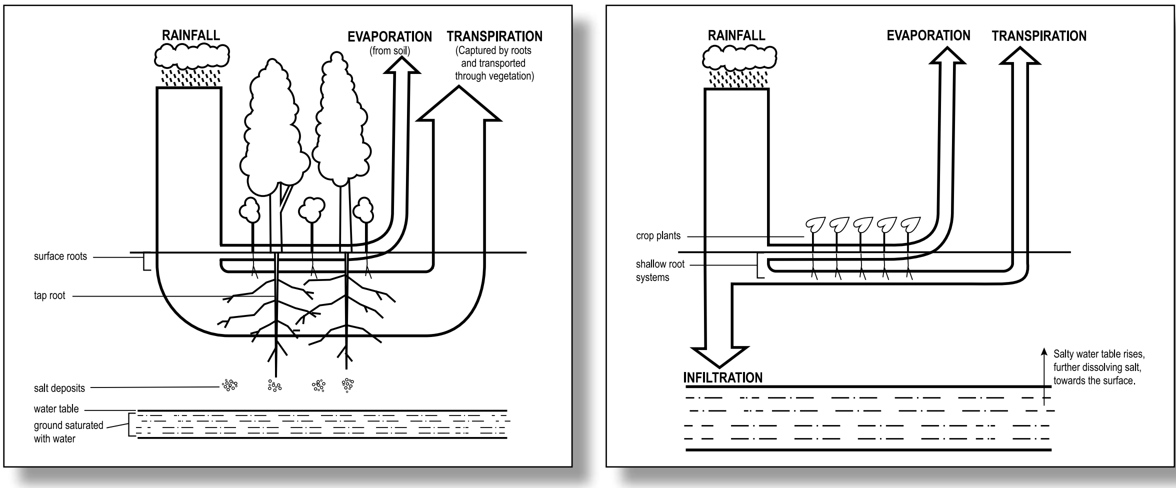
Teacher background information

Soil and salinity

Characteristics of the soil, such as acidity and nitrogen levels, affect the health and growth of plants. Sustainable farming considers soil characteristics in a management plan, including how to replenish depleted nutrients. Different varieties of plants have specific soil characteristics on which they thrive. For example, Canola is sensitive to acidity and grows well only on limed soil, whereas wheat can tolerate acidity.

The salinity, or salt content, of soils and water affects plant and animal growth and survival. High levels of salts, for example, sodium chloride (table salt), can have drastic consequences for living things, though some can tolerate them better than others. For example, Canola is moderately tolerant of salinity, although it is more sensitive during germination and as a seedling. Salt accumulates in the soil in various natural ways, such as when the wind carries ocean salts or when weathered rocks release salts. Rainwater filtering down through the soil dissolves the salt and transports it to the water table: the layer of soil below the ground that is permanently saturated with water. The level of the water table varies. For example, it is close to the surface near the sea, which is why when you dig in the sand at the beach you quickly get to a depth where the hole will keep filling up with water.

It is not uncommon for Australian soils to contain naturally accumulated salt. Water below their water table is therefore also salty. The water table levels were historically low in many parts of Australia because the deep-rooted vegetation absorbed almost all of the rainwater before it could reach the water table. Excess water filtering down through the soil causes a water table to rise, bringing dissolved salts with it. If the water reaches the surface it evaporates, leaving the salts behind. In some extreme cases salt is deposited on the surface of the soil. Rising salinity of soils is known as 'dryland salinity'.



How agriculture can affect water table levels

EXPLORE

Excess water entering the water table can occur through natural processes (primary salinity), for example, persistent heavy rainfall, or natural events causing vegetation to diminish, for example, bushfires. Human activities can also cause the water table to rise (secondary salinity) through processes such as clearing land and planting short-rooted crops. Irrigation adds excess water which filters through to the water table but can also directly add salt to the soil if it is drawn from a saline water source such as bore water.

Note: Different types of salinity are identified by different organisations and research groups how water accumulates in the soil. For example, irrigation salinity, urban salinity and industrial salinity.

Plants and salt

Salt can have adverse effects on plant health and growth. When water available to plants contains higher concentrations of salt, the roots of the plant absorb less water. If concentrations of salt are high enough, the salt water around the roots will draw water out of the plant through a process known as reverse osmosis. The whole plant loses moisture, and suffers stress. Symptoms of high salt damage are similar to those of high moisture stress: leaf tip dieback, leaf edges yellowing, scorching and turning brown or black, followed by leaf fall of dead leaves. Salt can also accumulate in the leaves, causing them to die.

Some plants have adaptations to deal with salinity. For example, mangroves can secrete excess salt through salt glands in their leaves. Although not a complete solution to the problem of salinity in Australia, some crossbred hybrid species of rice and wheat grow reasonably well in low levels of salty water.

Drinking salty water

Livestock need to drink fresh water to be healthy. Most mammals and birds will develop problems if the water they have available to drink has too much salt, however they often need a small amount of salt in their diet. The quality of water that livestock will drink varies greatly. Livestock can become accustomed to regular variations in water quality over the year, and can drink it without problems. However, livestock suddenly introduced to salty water may either refuse to drink it or suffer ill effects, such as weight loss, reduced nutrient absorption or even death.

Reference: https://www.agric.wa.gov.au/livestock-biosecurity/water-quality-livestock

Students' conceptions

Students might have varying conceptions about how salt affects living things. Some students might believe that lots of salt is helpful for plant growth. Conversely, some students might believe that any level of salt will be harmful to plant growth. All living things can tolerate a certain level of salt with no harm, but the amount varies between species and varieties.

Session 1 Make it salty

Equipment

FOR THE CLASS

- class science journal
- team skills chart
- team roles chart
- TWLH chart
- word wall
- 1 enlarged copy of 'Dear experts' (Resource sheet 1) from Lesson 1
- 3 plastic bottles of salty water at different concentrations (see 'Preparation')
- 1 enlarged copy of 'Salt water investigation planner' (Resource sheet 3)
- access to fresh water
- *optional:* digital camera

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Salt water investigation planner' (Resource sheet 3) per team member
- 4 lettuce seedling pots (see 'Preparation')
- 4 popsticks
- 1 x 50 mL measuring cup
- 1 ruler
- 1 permanent marking pen

EXPLORE

Preparation

- Read 'How to organise collaborative learning teams Year 3–Year 6' (Appendix 1). Display an enlarged copy of the team skills chart and the team roles chart in the classroom. Prepare role wristbands or badges.
- Prepare an enlarged copy of 'Salt water investigation planner' (Resource sheet 3).
- *Optional:* Display 'Salt water investigation planner' (Resource sheet 3) in a digital format.
- Lettuce seedlings are required for this lesson, and can be purchased in pots. If lettuce seedlings are unavailable, they can be substituted with other seedlings that are available in the current time of the year.
- Identify a location in the classroom for storing the lettuce pots that is not too hot but has direct sunlight.
- Make the following salt solutions and store in marked plastic bottles for the teams to use. *Optional:* Teams make their own salt solutions.

Salt concentration	Grams of salt in 1 L of water
0.5%	5 g
1.5%	15 g
3.5% (seawater)	35 g

1 teaspoon of salt is approximately 5.5 grams of salt

EXPLORE

Lesson steps

1 Review 'Dear experts' (Resource sheet 1, see Lesson 1). Focus students' attention on their thoughts about what might be affecting the plants and animals, and the expert's question about testing the water.

2 Ask students whether the expert might be worried about salt in the water. Ask questions, such as:

- Could salt in the water supply be the reason the plants and animals aren't healthy or growing well? What signs do you think indicate that salt might be in the water?
- How much salt do you think plants are able to tolerate in their water supply? For example, as much salt as in seawater?
- How can we find out how much salt plants can tolerate in their water?

3 Explain that students will be working in collaborative learning teams to explore how different concentrations of salt water affect plant growth.

4 Introduce the prepared bottles of salt water at different concentrations (see 'Preparation'). Explain that each team will pour a different concentration of salty water on three of their four plants.

5 Explain that the fourth lettuce seedling will be the 'control' plant and will be watered with water not containing added salt. Discuss why there needs to be a 'control' plant. (So we know what the seedling's growth and health would have been like without additional salt in the same conditions.)

6 Show students the equipment table and explain that teams will:

- Use concentrations of salt water in their investigation.
- Plan the investigation method.
- Set up and conduct the investigation.

7 Brainstorm variables that might affect how salt water affects plant growth and record a list in the class science journal, such as:

- the concentration of salt in the water
- the amount of water
- the type of plant
- the frequency of watering
- the type of watering
- the amount of soil
- the type of pot
- the type of soil.

8 Introduce the enlarged copy of ‘Salt water investigation planner’ (Resource sheet 3). Review the process of writing questions for investigation (see Appendix 6) and model how to develop a question on the enlarged planner, for example, ‘What happens to a plant’s growth and health when we change the concentration of salt in the water it is watered with?’.

9 Model recording predictions of the effect of the different salt solutions on the lettuce seedling growth on the enlarged copy of ‘Salt water investigation planner’ (Resource sheet 3).

10 Ask teams to discuss how they will conduct their investigation. Ask questions such as:

- How will you set up the investigation?
- How will you measure/observe plant growth?
- What safety precautions will you take?

11 Discuss why it is important to change only one thing in order to conduct a fair test. Ask teams to record what they will:

- **Change:** the concentration of salt in the water.
- **Measure/Observe:** measure the length of the longest lettuce leaf (mm) and observe the plant. **Note:** If you are using another type of plant, it may be more appropriate to measure height instead.
- **Keep the same:** the type of plant, the type of pot, the amount of soil, the type of soil, the location, the amount of water (50 mL), the watering frequency.

12 Introduce the enlarged copy of the ‘Recording results’ page of the ‘Salt water investigation planner (Resource sheet 3). Ask the teams to record observations and measurements every second day, for example, Monday, Wednesday and Friday.

13 Form teams and allocate roles. Ask Managers to collect team equipment.

If students are using collaborative learning teams for the first time, introduce and explain the team skills chart and the team roles chart. Explain that students will use role wristbands or badges to help them (and you) know which role each member has.

14 Ask teams to plan, set up and start their investigations, including recording their measurements and observations of the lettuce in the results table in the ‘Day 1’ row.

15 Ask teams to place their lettuce pots in a safe location that is not too hot but has direct sunlight. Ensure that teams water their plants each day with 50 mL of the matching solution.

16 Update the TWLH chart and word wall with words and images.

Salt water investigation results

EXPLORE

Salt water investigation planner

Name: ______________________ **Date:** ____________

Other members of your team: ______________________

What are you trying to find out?

____

What is your question for investigation?	**What do you predict will happen? Explain why.**
Can you write it as a question?	Give scientific explanations for your prediction

To make this a fair test what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
Change only one thing	What would the change affect?	Which variables will you control?

What are you going to do?	**What equipment will you need?**
Use drawings if necessary	Use dot points

Recording results

Record your results in a table.

Measurements of plant growth and observations of plant health

Day	Control (fresh water)	0 5% salt water	1.5% salt water	3.5% salt water
1				

Session 2 Sorting out the solution

Equipment

FOR THE CLASS

- class science journal
- team skills chart
- team roles chart
- TWLH chart
- word wall
- 1 enlarged copy of 'Dear experts' (Resource sheet 1) from Lesson 1
- 1 enlarged copy of 'Salt water investigation planner' (Resource sheet 3) from Session 1
- 1 enlarged copy of 'Salt water investigation results' (Resource sheet 4)
- 1 enlarged copy of 'Salt and animals' (Resource sheet 5)

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Salt water investigation planner' (Resource sheet 3) per team member from Session 1
- 1 copy of 'Salt water investigation results' (Resource sheet 4) per team member
- 1 copy of 'Salt and animals' (Resource sheet 5) per team member

EXPLORE

Preparation

- Read 'How to construct and use a graph' (Appendix 9).
- Prepare enlarged copies of 'Salt water investigation results' (Resource sheet 4) and 'Salt and animals' (Resource sheet 5).
- *Optional:* Display 'Salt water investigation results' (Resource sheet 4) and 'Salt and animals' (Resource sheet 5) in a digital format.

Lesson steps

1. Remind students of their investigation set-up using the enlarged copy of 'Salt water investigation planner' (Resource sheet 3).
2. Explain that teams will make and record their final observations, construct a graph of their results, compare their results with their predictions and use the results as evidence to make a claim.
3. Introduce the enlarged copy of 'Salt water investigation results' (Resource sheet 4). Discuss the purpose and features of a graph.

Literacy focus

Why do we use a graph?

We use a **graph** to organise information so we can look for patterns. We use different types of graphs, such as picture, column or line graphs, for different purposes.

What does a graph include?

A **graph** includes a title, axes with labels on them and the units of measurement.

Discuss with students the conventions of constructing a scientific graph. The vertical axis usually represents the variable that was measured and the horizontal axis represents the variable that was changed.

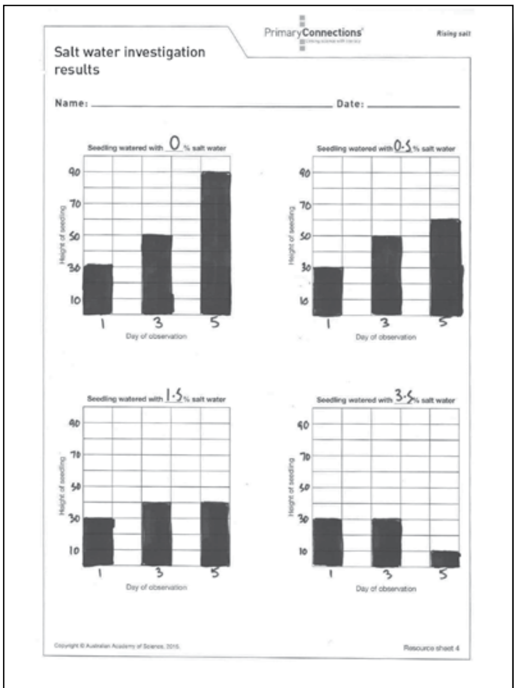
4 Model how to create a graph on the enlarged copy of 'Salt water investigation results' (Resource sheet 4). Ask students to create a different graph to represent the growth of each plant and then consider the questions under 'Explaining results'.

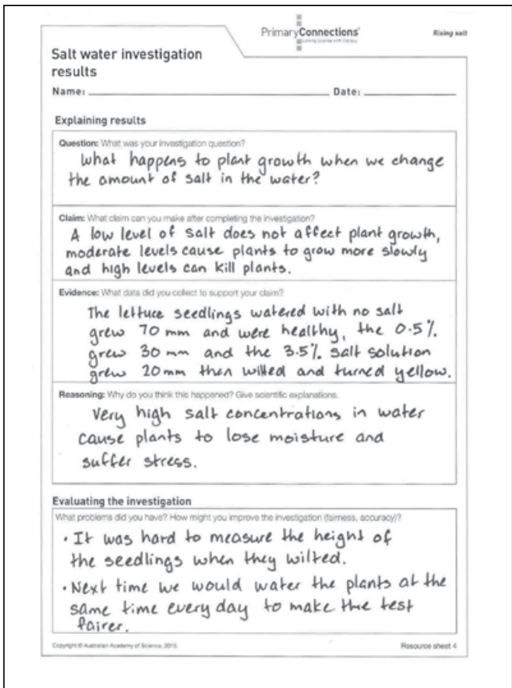
5 Re-form teams. Allow time for teams to complete their copies of 'Salt water investigation results' (Resource sheet 4).

6 Ask Speakers to share their team's results and analysis, asking questions such as:

- What is the story of the graphs?
- Which concentration of salt in the water resulted in lettuce growing the most? And the least?
- What claim have you made about the effect of salt water on plant growth based on your data and graphs?
- How did the result compare with your prediction?
- Why do you think the result was different from your prediction?
- How might different people taking the measurements affect your data?
- If you were to repeat the investigation again, how would you improve it?

Ask students to question each other using the 'Science question starters' (see Appendix 8).





PrimaryConnections

Rising salt

Salt water investigation results

Name:

Date:

Explaining results

Question: What was your investigation question?

What happens to plant growth when we change the amount of salt in the water?

Claim: What claim can you make after completing the investigation?

A low level of salt does not affect plant growth, moderate levels cause plants to grow more slowly and high levels can kill plants.

Evidence: What data did you collect to support your claim?

The lettuce seedlings watered with no salt grew 70 mm and were healthy, the 0.5% grew 30 mm and the 3.5% salt solution grew 20 mm then wilted and turned yellow.

Reasoning: Why do you think this happened? Give scientific explanations.

Very high salt concentrations in water cause plants to lose moisture and suffer stress.

Evaluating the investigation

What problems did you have? How might you improve the investigation (fairness, accuracy)?

- It was hard to measure the height of the seedlings when they wilted.
- Next time we would water the plants at the same time every day to make the test fairer.

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Resource sheet 4

Work sample of 'Salt water investigation results' (Resource sheet 4)

7 Record a summary of the class findings in the class science journal.

8 As a class, discuss which three concentrations of salt they would choose to use if they were to conduct the investigation again and wanted a 'low', a 'medium' and a 'high' concentration of salt. Ask students to provide reasons for their answers. Record three agreed concentrations in the class science journal.

9 Introduce the enlarged copy of 'Salt and animals' (Resource sheet 5). Discuss the purpose and features of a factual text.

Literacy focus

Why do we use a factual text?

We use a **factual text** to inform, teach or persuade someone reading it. We can read a **factual text** to collect information.

What does a factual text include?

A **factual text** includes a title, text and pictures. It might include labels, diagrams, maps and photographs.

EXPLORE

10 After students have read the text, discuss it as a class. Ask questions such as:

- What did you find interesting in the text? Why?
- Could drinking salty water explain what is happening to the animals in 'Dear experts' (Resource sheet 1)? What other explanations might there be?
- Will an animal always have the same symptoms after drinking salty water? Why or why not?

Record students' thoughts in the class science journal.

11 Organise for the control seedlings to be kept alive so they can be used for Lesson 6 (see Lesson 6, 'Preparation').

12 Update the 'What we **L**earned' and '**H**ow we know' columns of the TWLH chart. For example, in the '**L**' column: 'Very high salt concentrations in water cause plants to droop and die'. In the '**H**' column: 'We watered lettuce seedlings with different salt concentrations. The control plants grew 70 mm, those watered with 0.5% salt grew 30 mm and those watered with 3.5% salt grew only 20 mm.'

13 Update the word wall with words and images.

Curriculum links

Science

- Explore how livestock can be affected by salt poisoning, which animals are most at risk, and what methods are available for prevention and treatment. See: https://www.agric.wa.gov.au/livestock-biosecurity/preventing-salt-poisoning-livestock

Salt water investigation results

Name: ______________________ **Date:** ______________

Recording results

Control seedling watered with fresh water

Height of seedling (mm)

Day of observation

Seedling watered with _________% salt water

Height of seedling (mm)

Day of observation

Seedling watered with _________% salt water

Height of seedling (mm)

Day of observation

Seedling watered with _________% salt water

Height of seedling (mm)

Day of observation

Salt water investigation results

Name: ______________________________ **Date:** ______________

Explaining results

Question: What was your investigation question?
Claim: What claim can you make after completing the investigation?
Evidence: What data did you collect to support your claim?
Reasoning: Why do you think this happened? Give scientific explanations.

Evaluating the investigation

What problems did you have? How might you improve the investigation (fairness, accuracy)?

Salt and animals

Name: ______________________ **Date:** ____________

Animals need salt in their diets. Salt is important, for example, it helps muscles to contract and digestive systems to keep working. However, too much salt causes problems too, including:

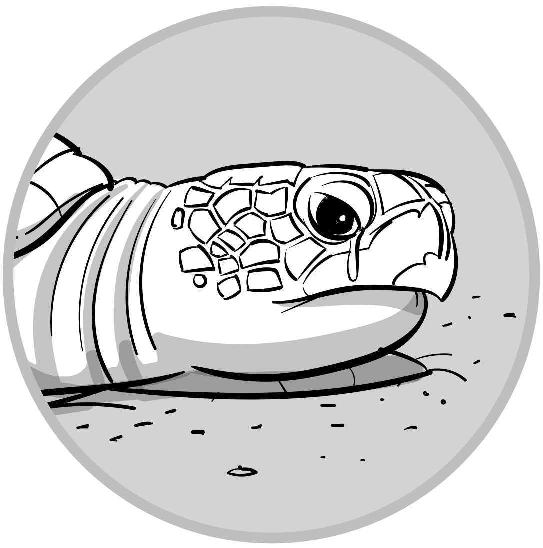
- Excessive thirst
- Loss of appetite
- Stomach pain
- Diarrhoea
- Increased urination

How much salt is too much varies from animal to animal. Humans and poultry are sensitive to salt and should not drink high concentrations in their water.

Some livestock, such as cattle and sheep, can tolerate slightly higher concentrations of salt, although it makes them drink a lot more water. They will drink very salty water if very thirsty but it makes them sick and even thirstier.

Animals can tolerate different amounts of salt water depending on their age: older cattle can drink saltier water than young ones. If animals are getting extra fresh water from other sources, for example, from fresh green grass, then they can drink saltier water.

Some animals can drink very salty water. Cats can drink seawater as their kidneys can process the salt. Sea turtles expel salt out of ducts near their eyes, which makes it look like they are crying.



Lesson 4 Sustainable systems

AT A GLANCE

To support students to represent and explain their understanding of how the growth and survival of living things are affected by the physical conditions of their environment.

To introduce current scientific views about the causes of salinity and how to address it.

Students:

- make evidence-based claims on what environmental conditions might be affecting the growth and health of plants and animals
- identify links between land and water management and rising salinity
- brainstorm and research innovations to improve conditions for plants and animals.

EXPLAIN

Lesson focus

In the *Explain* phase students develop a literacy product to represent their developing understanding. They discuss and identify patterns and relationships within their observations. Students consider the current views of scientists and deepen their own understanding.

Assessment focus

Formative assessment is an ongoing aspect of the *Explain* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of how:

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

You will also monitor their developing science inquiry skills (see page xi).

You are also able to look for evidence of students' use of appropriate ways to represent what they know and understand about how the growth and survival of living things are affected by the physical conditions of their environment, and give them feedback on how they can improve their representations.

Key lesson outcomes

Science

Students will be able to:

- explain that different concentrations of salt and methods of watering (or types of rainfall) affect the growth and survival of plants and animals
- discuss other physical conditions that might affect living things
- analyse information in a video
- identify how water use can affect the physical environment by causing salty water to rise to the surface
- identify how scientific understanding can be used to solve rising salinity issues.

Literacy

Students will be able to:

- represent and communicate their ideas in a variety of ways
- contribute to discussions about rising water tables and possible innovations.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page xii).

EXPLAIN

Teacher background information

Removing native plants that are adapted to the environment and replanting with crops that are not naturally occurring in the area can have adverse affects on the environment. When deep-rooted plants are removed from the land and replaced with short-rooted crops, rainfall is less likely to be completely absorbed. Water can seep through the soil reaching the underground water table, causing it to rise. If the water table rises high enough it exposes plant roots to its salty water; salt can even be deposited on the soil surface (e.g. Doradine Creek, NSW).

Farmers can regenerate salt-affected or eroded land by planting native trees and windbreaks, and by practicing no-till cropping (leaving the soil undisturbed after harvesting). They can also review which crops they plant and the area they use, based on water availability forecasting tools.

Plant productivity can be twice as high when farms use irrigation rather than relying on rainfall alone. If water is added in excess to plant needs, or on unsuitable soils, the water can also seep into the water table and lead to its rising. In Australia, irrigation often uses bore water. Bore water draws from aquifers, which are layers of soil saturated in water— either just below the water table level or deeper below (artesian bores). Using bore water at the surface can also add some salt directly to the soil and is not used if the water is too salty.

Modern techniques, such as drip irrigation, low-pressure pivots and submersible pumps, use less water than spray irrigating from a bore. Watering appropriately for the plant's stage of development also reduces the quantity of water used in irrigation while maximizing growth, for example, plants in the mid-stage of their growth cycle require more water than at other stages.

Farmers are business people so they also plant the crop that will offer the greatest financial return for the water available. Farmers grow cotton (usually in rotation with other crops such as wheat, barley, corn and sunflowers) in areas with long hot summers, fertile soils, on floodplains with reliable water, because it often gives them the best return per unit of water. Scientists are constantly working on developing more water efficient varieties in our food and fibre crops and on water conservation techniques that minimise the risk of rising salinity.

Designing more efficient systems for delivering water to livestock not only ensures less water use but also helps to prevent evaporation, which concentrates salt in the water. There are companies that specialise in treatment of salty bore water to ensure animals get the best quality water.

An Australian agricultural scientist, Gordon McClymont, coined the term 'sustainable agriculture' in 1980. The basic principle is to meet human food and fibre needs, to not use more of a natural resource than is naturally renewable and to ensure the long-term health of the local ecosystems, including the land that is being farmed. This standard is now fundamental to Australian farms, with the vast majority actively undertaking some form of natural resource management, for example, re-planting native deep-rooted trees, as part of their sustainable agriculture practices.

Equipment

FOR THE CLASS

- class science journal
- TWLH chart
- word wall
- 1 enlarged copy of 'Dear experts' (Resource sheet 1) from Lesson 1
- video – 'Soil salinity in Australia' (see 'Preparation')
- collection of multimedia resources on agricultural innovations (see 'Preparation')
- video – 'First Australians were also the first farmers' (see 'Preparation')

FOR EACH STUDENT

- science journal
- 1 copy of 'Dear experts' (Resource sheet 1) from Lesson 1

Preparation

- View and prepare the video 'Soil salinity in Australia' (CSIRO): **https://csiropedia.csiro.au/soil-salinity-australia-2001/**
  A transcript of this video is also available at the above website.
- Identify multimedia resources, including books and videos, for students to explore the innovative techniques that Australian farmers and scientists are developing, to work towards sustainable farming practices.

- Draw an ideas map in the class science journal or on a large sheet of paper (see Lesson step 5).
- View and prepare the video ‘First Australians were also the first farmers’. See: **https://education.abc.net.au/home#!/media/29898/indigenous-eelfarming?source=search**

Lesson steps

1. Review the previous lessons using the class science journal, glossary TWLH chart and word wall, focusing students’ attention on what they have learned about the effect that some physical conditions have the growth and survival of plants and animals.
2. Remind students of ‘Dear experts’ (Resource sheet 1). Explain that students will draft the beginning of a response as experts in their science journals, outlining possible explanations for what is happening to the plants and animals. Ask students to provide evidence and reasoning for their claims about what might be happening.
3. When students have completed the activity, discuss as a class. Ask questions such as:
    - Can we be sure that we have identified the sources of the issues? What makes you say that?
    - What else might be affecting the plants and animals? Suggestions might include watering at different times in the day, harmful pathogens in the water, and the dry feed (which has high salt levels) may be dehydrating the animals.

    Record students’ answers in the class science journal.
4. Discuss how scientists and experts might be sure of their research but may be uncertain whether it is the only variable affecting such a complicated scenario. Explain that even with the uncertainty they can still provide suggestions for improvements.
5. Introduce the class ideas map (see ‘Preparation’). Discuss the purpose and features of an ideas map.

Literacy focus

Why do we use an ideas map?

We use an **ideas map** to show our thoughts about a topic.

What does an ideas map include?

An **ideas map** includes a title in the centre. Ideas are written around it and arrows are drawn between similar ideas. An **ideas map** might include pictures and symbols.

6. Record on the ideas map students’ thoughts on further evidence and information they need and possible innovations to improve conditions for the plants and animals in the scenario. For example, more efficient watering systems that reduce loss of water due to evaporation and encourage plant growth.

EXPLAIN

7 Watch the video 'Soil salinity in Australia' (see 'Preparation'). Ask students questions such as:

- What are the causes of rising salinity in soils?
- How might the people's use of water be contributing to the rising salinity?

Record students' thoughts in the class science journal.

8 Revise and update the class brainstorm of possible innovations.

9 Discuss how the farming techniques imported by early European settlers were not adapted to Australian conditions. Explain that farmers and scientists have been working to improve techniques. Discuss how Australian research findings are being used by people in other countries facing similar issues, and vice versa.

10 Introduce the collected resources (see 'Preparation'). Ask students to consult them to update the ideas map.

11 Discuss how traditional Indigenous knowledge is an important source of knowledge for farmers and scientists since it is based on years of experience in managing Australian environments.

12 Watch the video 'First Australians were also the first farmers' (see 'Preparation'). Discuss how Western scientists are still learning about the types of farming Aboriginal and Torres Strait Islander people were engaged with prior to European settlement.

13 Update the TWLH chart, word wall and glossary with words and images.

Curriculum links

Science

- Research the contributions that Australian scientists, farmers and engineers have made to improve sustainable practice, in particular in semi-arid regions and in those affected by salt.
- Explore how water is used on a cotton farm. See: **https://cottonaustralia.com.au/assets/general/Education-resources/CA-resources/Primary/Water-and-Irrigation-Technology-on-a-Cotton-Farm-in-Central-Queensland.pdf**

Lesson 5 Design challenges

AT A GLANCE

To support students to plan and design an irrigation system or water trough to decrease water consumption.

Students:

- plan and design an improved system
- create a poster to share their ideas.

Lesson focus

In the *Elaborate* phase students plan and conduct an open investigation to apply and extend their new conceptual understanding in a new context. It is designed to challenge and extend students' science understanding and science inquiry skills.

Assessment focus

Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase (see pages v and xi).

Key lesson outcomes

Science

Students will be able to:

- generate ideas to make an irrigation system or a water trough for animals
- develop criteria for a successful design
- assess designs using the criteria.

Literacy

Students will be able to:

- brainstorm and sketch ideas
- create a labelled diagram
- produce a poster to explain ideas
- engage in discussions to compare ideas
- analyse information in a letter.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page xii).

Equipment

FOR THE CLASS

- class science journal
- team skills chart
- team roles chart
- TWLH chart
- word wall
- 1 enlarged copy of 'Dear experts' (Resource sheet 1) from Lesson 1
- *optional:* multimedia resources on managing water (see 'Preparation')

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- materials to create posters

Preparation

- *Optional:* Identify multimedia resources, including books and videos, for students to explore some irrigation and livestock watering techniques, for example:
    - The UF/IFAS Solutions series of videos on irrigation techniques: https://www.youtube.com/playlist?list=PLPl8i90YEmZ0AA6WHqHnhGcZ1veWmHAXK
    - A website discussing advantages and disadvantages of different irrigation systems: http://www.agriinfo.in/?page=topic&superid=1&topicid=21

Lesson steps

ELABORATE

1. Review the enlarged copy of 'Dear experts' (Resource sheet 1) from Lesson 1, focusing students' attention on concerns about wasting water. Discuss students' experiences of conserving water when at home, for example, not watering the garden on certain days or taking shorter showers.
2. Discuss how the practices described in 'Dear experts' (Resource sheet 1) use a lot of water. Ask questions such as:
    - What do you think about providing water to cattle in an open-air dam? What might happen to the water? (For example, water is exposed and can be lost to evaporation or wind might blow it out.)
    - What do you think about manually pouring water on the crops? Is this an efficient use of water?
    - Both systems require a lot of time and energy from the family. Can you think of improvements to make their life easier? (For example, different types of irrigation systems.)

    Record students' thoughts in the class science journal.
3. Explain that students will work in their collaborative learning teams to plan and design one of the following:
    - An irrigation system that supplies the plants with an appropriate amount of water at the right time without flooding the plants.
    - A water trough for the animals that minimises water loss due to evaporation and ensures they always have enough without overflowing.

4 Explain that each team will produce a poster of their completed design that will be assessed by others in the class using a set of agreed criteria. Discuss the purpose and features of a poster.

Literacy focus

Why do we use a poster?

We use a **poster** to display ideas and information. We can view a **poster** to collect information about a topic.

What does a poster include?

A **poster** includes a title, words and pictures. It might include graphs, photos and tables as well as borders, arrows and labels.

5 Discuss how the class will decide if each team has completed the task successfully by agreeing on a set of criteria. For example:

- uses information gained from investigations in previous lessons
- is interesting/imaginative
- is not expensive to build
- has minimal impact on the environment.

Record students' ideas for criteria in the class science journal.

6 Explain that teams will:

- use brainstorming and sketching to collate ideas before selecting one
- choose materials that are required to build the design
- include a possible costing of the design
- create a poster of the design which includes labelled drawings and text.

7 Discuss the purpose and features of the labelled diagram. Ask students to include at least one labelled diagram to help illustrate their design.

Literacy focus

Why do we use a labelled diagram?

We use a **labelled** diagram to show the shape, size and features of an object.

What does a labelled diagram include?

A **labelled diagram** might include a title, an accurate drawing, a scale to show the object's size and labels showing the main features. A line or arrow connects the label to the feature.

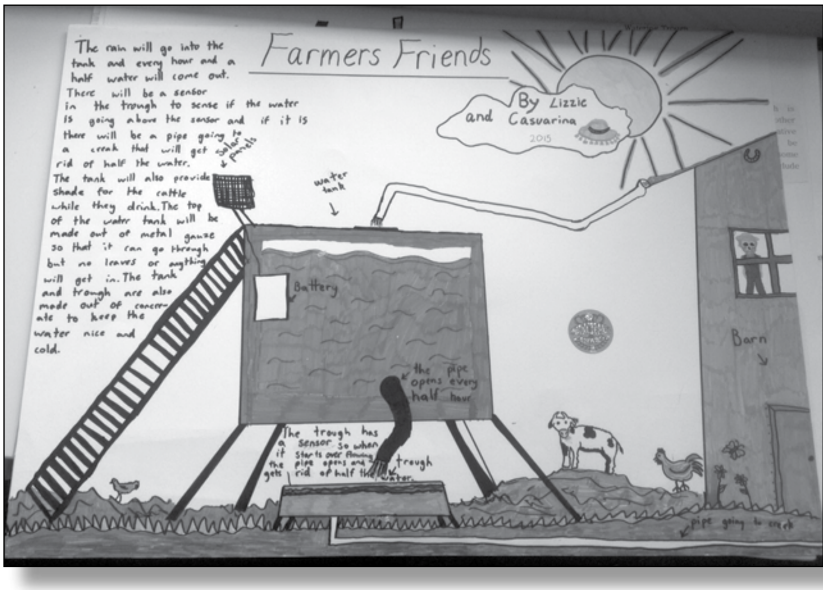
8 Form teams. Allow time for teams to complete the activity.

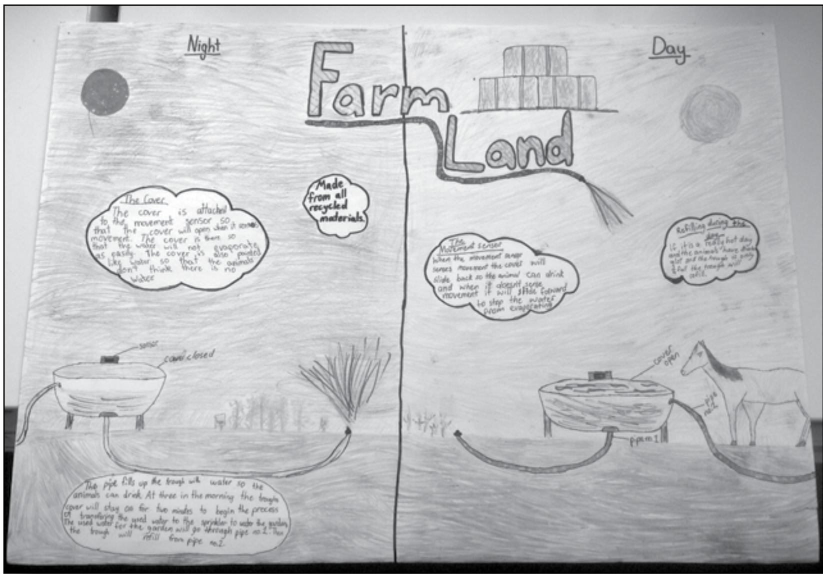
9 Ask Speakers to present their team's poster.

10 Ask students to assess each team's poster using the agreed design criteria, and to make suggestions about how their design solution could be improved.

Optional: Teams build a model of their designs using a planned production process.

11 Update the TWLH chart and word wall with words and images.





Work samples of posters of improved systems

Lesson 6 Testing improvements *(Optional)*

AT A GLANCE

To support students to plan and conduct an open investigation into variables that might affect a plant's tolerance to salinity.

Session 1 Further investigation

Students:

- discuss variables that might affect salinity tolerance
- work in collaborative learning teams to plan and conduct an open investigation.

Session 2 Sharing results

Students:

- collect, analyse and present the data from open investigations.

Lesson focus

In the *Elaborate* phase students plan and conduct an open investigation to apply and extend their new conceptual understanding in a new context. It is designed to challenge and extend students' science understanding and science inquiry skills.

ELABORATE

Assessment focus

Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase (see pages v and xi).

Key lesson outcomes

Science

Students will be able to:

- formulate a question and make predictions about the effect of physical conditions on living things
- work in collaborative learning teams to plan and conduct an investigation
- provide evidence to support their claims.

Literacy

Students will be able to:

- contribute their ideas to a class discussion
- use scientific vocabulary appropriately in their writing and discussions.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page xii).

Session 1 Further investigation

Equipment

FOR THE CLASS

- class science journal
- TWLH chart
- word wall
- team roles chart
- team skills chart
- 3 salt solutions in 6 one litre bottles (see 'Preparation')
- fertiliser solution
- 1 enlarged copy of 'Further investigation planner' (Resource sheet 6)
- access to water
- *optional:* digital camera

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Further investigation planner' (Resource sheet 6) per team member
- each team member's copy of 'Salt water investigation planner' (Resource sheet 3) from Lesson 3
- 4 seedlings (see 'Preparation')
- 4 popsticks
- 1 x 50 mL measuring cup
- 1 ruler
- 1 permanent marking pen

Preparation

- Prepare an enlarged copy of 'Further investigation planner' (Resource sheet 6).
- Prepare two bottles of each of the three salt concentrations decided upon in Lesson 3 (see Lesson 3, Session 2, Lesson step 8).
- Collect seedlings for teams to experiment with, for example:
  - The lettuce seedlings that were watered with no salt from Lesson 3.
  - Seedlings from a variety of plants with varying salt tolerances.
- *Optional:* Display 'Further investigation planner' (Resource sheet 6) in a digital format.

Lesson steps

1. Review students' ideas map from Lesson 4, focusing students' attention on information they wanted to know more about.
2. Remind students that the results of their salt water investigation in Lesson 3 were specific to one plant (lettuce) at one particular time in its development (seedlings). Discuss the variables that affected animals' ability to tolerate drinking salty water in 'Salt and animals' (Resource sheet 5).
   Ask students questions such as:
   - Do you think plants would react the same way to different concentrations of salty water if they were more established/larger? Why do you think that?
   - Do you think different plants react the same way to different concentrations of salty water? Why do you think that?
   - Do you think plants would react the same way to different concentrations of salty water if the soil also has fertiliser? Why do you think that?

   Record students' thoughts in the class science journal.
3. Explain that students will be working in collaborative learning teams to plan and conduct an investigation to provide evidence to help answer one of those questions.
4. Introduce the enlarged copy of 'Further investigation planner' (Resource sheet 6). Explain that teams can refer to their completed copies of 'Salt water investigation planner' (Resource sheet 3) in order to plan and conduct their investigation.
5. Remind students of the process of creating questions for investigation, for example:
   - What happens to the growth and survival of [name of plant] exposed to different concentrations of salty water when we change the age of the plant?
   - What happens to the growth and survival of seedlings exposed to different concentrations of salty water when we change the type or variety of plant?
   - What happens to the growth and survival of [name of plant] exposed to different concentrations of salty water when we change the amount of fertiliser in the soil?
6. Explain that students will be changing one thing, compared to their investigation in Lesson 3, in order to compare their results against that first experiment. Ask students to use the same methods to measure and observe their plant growth.

   Optional: Teams use a digital camera to record observations
7. Draw students' attention to the equipment table and ask them to plan their investigation using only equipment from the table.
8. Form teams and allocate roles. Allow time for teams to plan their investigation and record their predictions.
9. When the team's Speaker has confirmed with you that their plan is appropriate, ask Managers to collect the necessary equipment.
10. Allow time for teams to set up their investigations.
11. Explain that students will record their results over the week, and analyse and interpret their results in the next session.

Further investigation planner

Name: ______________________ **Date:** ____________

Other members of your team: ______________________

What are you trying to find out?

____

What is your question for investigation?	**What do you predict will happen? Explain why.**
Can you write it as a question?	Give scientific explanations for your prediction

To make this a fair test what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
Change only one thing	What would the change affect?	Which variables will you control?

What are you going to do?	**What equipment will you need?**
Use drawings if necessary	Use dot points

Recording results

Record your results in a table.

Measurements of plant growth and observations of plant health

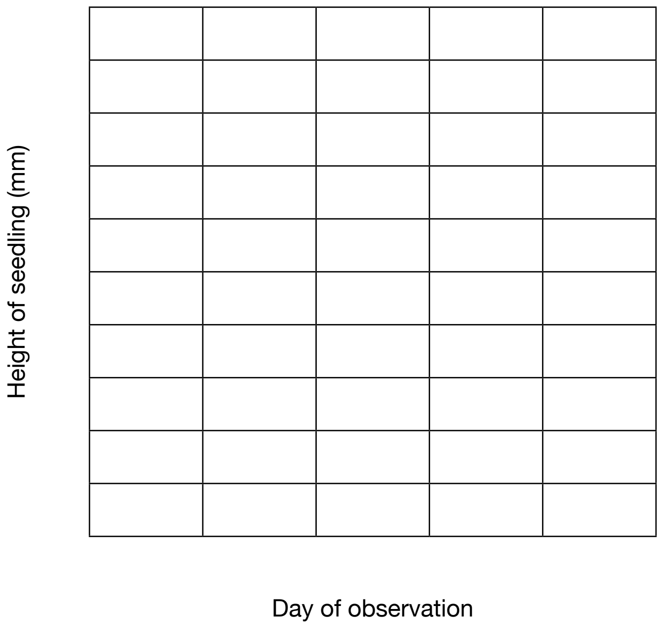
Day				

Further investigation results

Name: ______________________________ **Date:** ______________

Recording results

____



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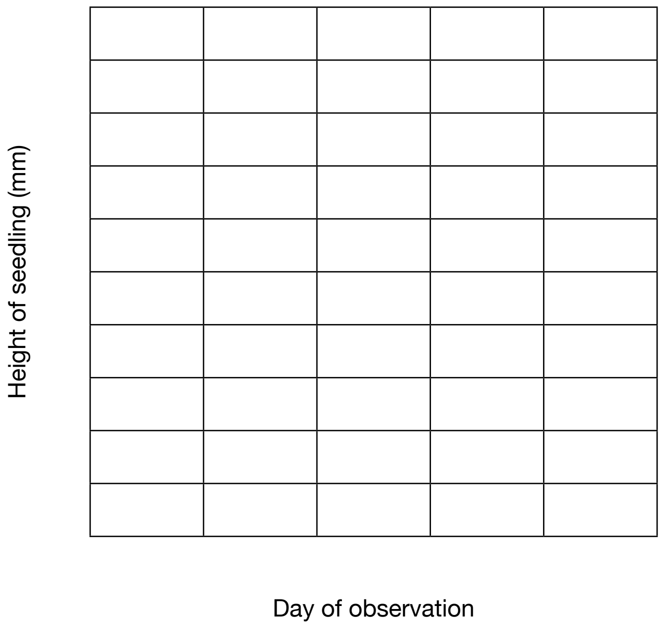

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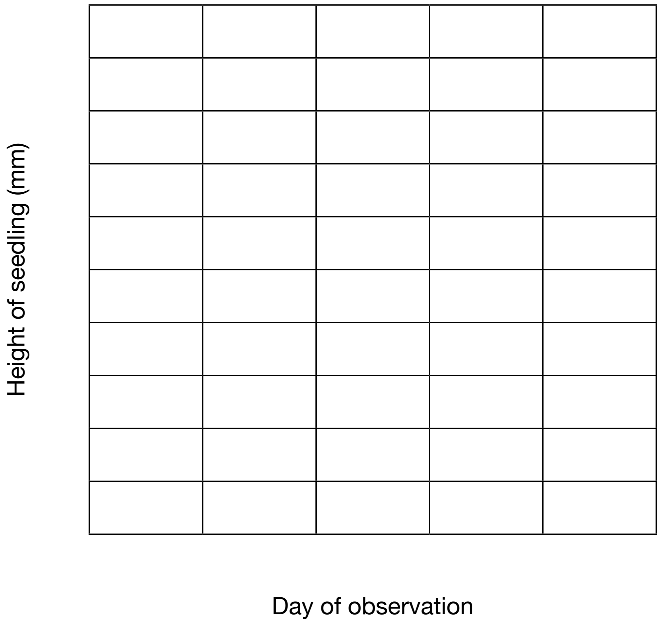

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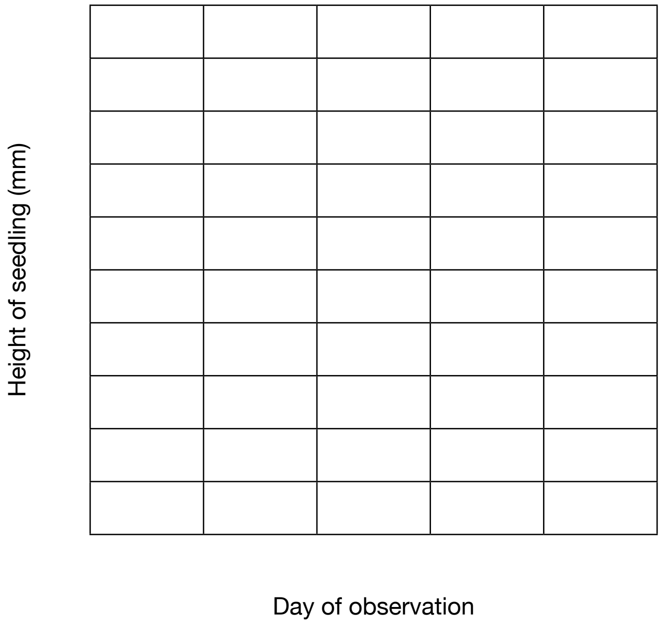


Further investigation results

Explaining results

Question: What was your investigation question?
Claim: What claim can you make after completing the investigation?
Evidence: What data did you collect to support your claim?
Reasoning: Why do you think this happened? Give scientific explanations.

Evaluating the investigation

What problems did you have? How might you improve the investigation (fairness, accuracy)?

Session 2 Sharing results

Equipment

FOR THE CLASS

- class science journal
- TWLH chart
- word wall
- team roles chart
- team skills chart
- 1 enlarged copy of 'Further investigation planner' (Resource sheet 6)

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- each team member's copy of 'Salt water investigation results' (Resource sheet 4) from Lesson 3, Session 2
- each team member's copy of 'Further investigation planner' (Resource sheet 6)

Preparation

- **Note:** This session must take place at least seven days after the previous session to ensure the teams have enough time to collect their results.

Lesson steps

ELABORATE

1. Remind students of their investigation set-up using the enlarged copy of 'Further investigation planner' (Resource sheet 6).
2. Explain that teams will make and record their final observations, construct a graph of their results and then make evidence-based claims using their data.
3. Review the purpose and features of a graph. Remind students to compare with their results on 'Salt water investigation results' (Resource sheet 4) to see if the plants' responses have changed.
4. Re-form teams and allow time for students to complete their copies of 'Further investigation planner' (Resource sheet 6).
5. Ask Speakers to share their team's claim, evidence and reasoning with the class. Encourage students to question each other using the 'Science question starters' (see Appendix 8).
6. Ask teams to share if they had any difficulties with their investigation. Ask questions such as:
   - What went well with the investigation?
   - What did not go well? How might you change it to improve it?
   - Was the quality of data collected enough to make your evidence-based claims?
   - How could the collection of data be improved?
   - What are you still wondering about?
7. Update the TWLH chart and word wall with words and images.

Lesson 7 Sustainable solutions

AT A GLANCE

To provide opportunities for students to represent what they know about how the growth and survival of living things are affected by the physical conditions of their environment, and to reflect on their learning during the unit.

Students:

- work in collaborative learning teams to prepare a presentation in response to ‘Dear experts’ (Resource sheet 1)
- participate in a class discussion to reflect on their learning during the unit.

Lesson focus

In the *Evaluate* phase students reflect on their learning journey and create a literacy product to re-represent their conceptual understanding.

Assessment focus

Summative assessment of the Science Understanding descriptions is an important aspect of the *Evaluate* phase. In this lesson you will be looking for evidence of the extent to which students understand how:

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

Key lesson outcomes

Science

Students will be able to:

- identify physical conditions of the environment that affect the growth and survival of living things
- explain how different methods of watering and concentrations of salt affect living things using evidence-based claims
- explain how evidence-based claims from investigations can be used to provide solutions to improve watering methods and concentrations of salt in a farmland.

Literacy

Students will be able to:

- plan, draft and publish informative texts, including images and digital resources appropriate to purpose and audience
- contribute to discussions about their learning journey
- communicate ideas, explanations and processes in a response to a letter.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page xii).

Equipment

FOR THE CLASS

- class science journal
- team skills chart
- team roles chart
- TWLH chart
- word wall
- 1 enlarged copy of 'Dear experts' (Resource sheet 1) from Lesson 1

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Dear experts' (Resource sheet 1) from Lesson 1 per team member

Lesson steps

1. Review the unit using the TWLH chart, glossary and class science journal. Ask questions such as:
   - What did we think when we first read 'Dear experts' (Resource sheet 1)?
   - What questions did we have?
   - What have we learned? What claims have we made?
2. Discuss the idea of 'living sustainably'. Review students' descriptions of the word 'sustainable' in the class science journal.
3. Explain to students that they will be working in their collaborative learning teams to develop an expert response to the letter on 'Dear experts' (Resource sheet 1). Ask students to answers questions such as:
   - Why might the plants be unhealthy and dying?
   - Why might the animals be unwell?
   - What claims can you make about why the plants and animals might be unhealthy and dying?
   - What evidence do you have to support your claims?
   - What is the reasoning for your claims?
   - What practices can you suggest to help to make the farm sustainable?
4. As a class, discuss the type of presentations the collaborative learning teams might use to prepare their expert advice (such as oral presentation, video, brochure, email, letter, report, poster, PowerPoint presentation, blog, etc.) and record ideas in the class science journal.
5. Discuss the criteria that will be used to assess the quality of the information and how it is presented:
   - Well-organised information
   - Clear, concise communication

- Evidence of knowledge of the topic
- Use of evidence and reasoning to support claims
- Quality/creativity of the presentation.

6 Remind teams to use the word wall, the TWLH chart and their science journals for information and their evidence-based claims.

7 Re-form teams and allocate roles. Allow teams time to create their presentations.

8 Invite an audience, such as another class, parents or principal to view the presentations.

9 Ask students to conduct a self-assessment of learning by completing sentences in their science journal, such as:

- Before I thought… and now I know…
- My ideas haven't changed about…
- The activity that helped me learn the most was…
- What I have learned about how scientists work is…
- I am still not sure about…
- I really enjoyed… because….
- I didn't enjoy… because…
- I would like to know more about…

Dear Concerned Lifestyler

To start off with, I think it is good that it is great that your family is following your dream of growing everything you need. I hope my response will help answer your questions.

It is great that you are growing your own plants but you say they are not looking healthy at all so you started pouring water over them morning, noon and night. The problem is that you are probably overwatering your plants. Overwatering just floods the plants and causes them to die. But not enough water will affect the plants too. You need to perhaps just water once or twice a day and use less water.

It is awesome that your family is putting in time and effort to become sustainable. It is not a good thing that your cows are having stomach troubles. Try wetting down their dry feed to make it easier for them to digest the food. It is also not very good that they are drinking a lot of water. You say that your water comes from a well deep underground. This well might have a lot of salt in the water which will make the cows dehydrated, make them drink more and make them unwell. A way to fix this problem is you may have to think about using a new water source. The high amount of salinity could also be the reason why some of your pastures are not growing because plants don't like too much salt in their water either.

It is great to have chickens, as who doesn't like eggs for breakfast! You say in your letter that your chickens aren't producing any eggs. This might also be because of the salt in the water. So again maybe check your water for too much salt and decide what you need to do.

I hope my answers will help you with your concerns and will help you follow your dream by growing everything you need and living sustainably.

From

The Experts

Work sample of 'expert response' letter

EVALUATE

Appendix 1
How to organise collaborative learning teams (Year 3–Year 6)

Introduction

Students working in collaborative teams is a key feature of the Primary**Connections** inquiry-based program. By working in collaborative teams students are able to:

- communicate and compare their ideas with one another
- build on one another's ideas
- discuss and debate these ideas
- revise and rethink their reasoning
- present their final team understanding through multimodal representations.

Opportunities for working in collaborative learning teams are highlighted throughout the unit.

Students need to be taught how to work collaboratively. They need to work together regularly to develop effective group learning skills.

The development of these collaborative skills aligns to descriptions in the Australian Curriculum: English. See page xv.

Team structure

The first step towards teaching students to work collaboratively is to organise the team composition, roles and skills. Use the following ideas when planning collaborative learning with your class:

- Assign students to teams rather than allowing them to choose partners.
- Vary the composition of each team. Give students opportunities to work with others who might be of a different ability level, gender or cultural background.
- Keep teams together for two or more lessons so that students have enough time to experience working together successfully.
- If you cannot divide the students in your class into teams of three, form two teams of two students rather than one team of four. It is difficult for students to work together effectively in larger groups.
- Keep a record of the students who have worked together as a team so that by the end of the year each student has worked with as many others as possible.

Team roles

Students are assigned roles within their team (see below). Each team member has a specific role but all members share leadership responsibilities. Each member is accountable for the performance of the team and should be able to explain how the team obtained its results. Students must therefore be concerned with the performance of all team members. It is important to rotate team jobs each time a team works together so that all students have an opportunity to perform different roles.

For Year 3–Year 6, teams consist of three students: Director, Manager and Speaker. (For F–Year 2, teams consist of two students: Manager and Speaker.) Each member of the team should wear something that identifies them as belonging to that role, such as a wristband, badge, or coloured clothes peg. This makes it easier for you to identify which role each student is doing and it is easier for the students to remember what they and their team mates should be doing.

Manager

The Manager is responsible for collecting and returning the team's equipment. The Manager also tells the teacher if any equipment is damaged or broken. All team members are responsible for clearing up after an activity and getting the equipment ready to return to the equipment table.

Speaker

The Speaker is responsible for asking the teacher or another team's Speaker for help. If the team cannot resolve a question or decide how to follow a procedure, the Speaker is the only person who may leave the team and seek help. The Speaker shares any information they obtain with team members. The teacher may speak to all team members, not just to the Speaker. The Speaker is not the only person who reports to the class; each team member should be able to report on the team's results.

Director (Year 3–Year 6)

The Director is responsible for making sure that the team understands the team investigation and helps team members focus on each step. The Director is also responsible for offering encouragement and support. When the team has finished, the Director helps team members check that they have accomplished the investigation successfully. The Director provides guidance but is not the team leader.

Team skills

Primary**Connections** focuses on social skills that will help students work in collaborative teams and communicate more effectively.

Students will practise the following team skills throughout the year:

- Move into your teams quickly and quietly
- Speak softly
- Stay with your team
- Take turns
- Perform your role.

To help reinforce these skills, display enlarged copies of the team skills chart (see the end of this Appendix) in a prominent place in the classroom.

Supporting equity

In science lessons, there can be a tendency for boys to manipulate materials and girls to record results. Primary**Connections** tries to avoid traditional social stereotyping by encouraging all students, irrespective of their gender, to maximise their learning potential. Collaborative learning encourages each student to participate in all aspects of team activities, including handling the equipment and taking intellectual risks.

Observe students when they are working in their collaborative teams and ensure that both girls and boys are participating in the hands-on activities.

TEAM ROLES

Manager
Collects and returns all materials the team needs

Speaker
Asks the teacher and other team speakers for help

Director
Makes sure that the team understands the team investigation and completes each step

TEAM SKILLS

1. Move into your teams quickly and quietly
2. Speak softly
3. Stay with your team
4. Take turns
5. Perform your role

Appendix 2
How to use a science journal

Introduction

A science journal is a record of observations, experiences and reflections. It contains a series of dated, chronological entries. It can include written text, drawings, measurements, labelled diagrams, photographs, tables and graphs.

Using a science journal provides an opportunity for students to be engaged in a real science situation as they keep a record of their observations, ideas and thoughts about science activities. Students can use their science journals as a useful self-assessment tool as they reflect on their learning and how their ideas have changed and developed during a unit.

Monitoring students' journals allows you to identify students' alternative conceptions, find evidence of students' learning and plan future learning activities in science and literacy.

Keeping a science journal aligns to descriptions in the Australian Curriculum: Science and English. See pages xi and xv.

Using a science journal

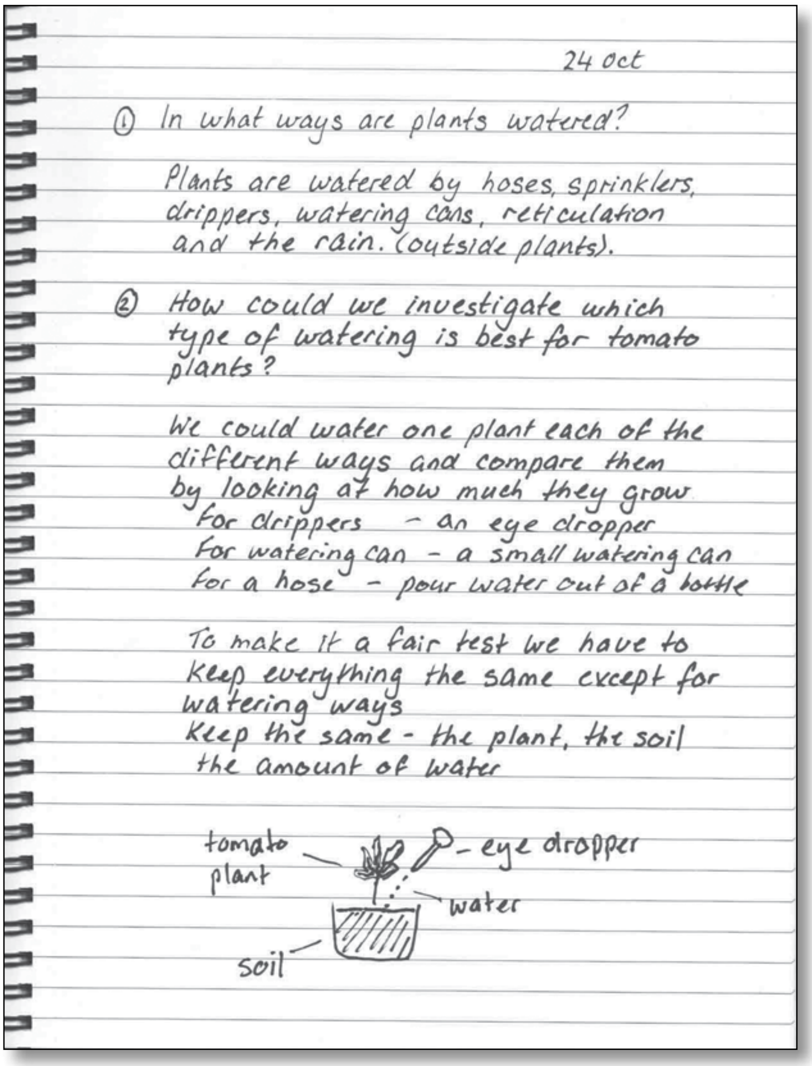
1. At the start of the year, or before starting a science unit, provide each student with a notebook or exercise book for their science journal or use an electronic format. Tailor the type of journal to fit the needs of your classroom. Explain to students that they will use their journals to keep a record of their observations, ideas and thoughts about science activities. Emphasise the importance of including pictorial representations as well as written entries.
2. Use a large project book or A3 paper to make a class science journal. This can be used at all year levels to model journal entries. With younger students, the class science journal can be used more frequently than individual journals and can take the place of individual journals.
3. Make time to use the science journal. Provide opportunities for students to plan procedures and record predictions, and their reasons for predictions, before an activity. Use the journal to record observations during an activity and reflect afterwards, including comparing ideas and findings with initial predictions and reasons. It is important to encourage students to provide evidence that supports their ideas, reasons and reflections.
4. Provide guidelines in the form of questions and headings and facilitate discussion about recording strategies, such as note-making, lists, tables and concept maps. Use the class science journal to show students how they can modify and improve their recording strategies.
5. Science journal entries can include narrative, poetry and prose as students represent their ideas in a range of styles and forms.
6. In science journal work, you can refer students to display charts, pictures, diagrams, word walls and phrases about the topic displayed around the classroom. Revisit and revise this material during the unit. Explore the vocabulary, visual texts and ideas that have developed from the science unit, and encourage students to use them in their science journals.

7 Combine the use of resource sheets with journal entries. After students have pasted their completed resource sheets in their journal, they might like to add their own drawings and reflections.

8 Use the science journal to assess student learning in both science and literacy. For example, during the *Engage* phase, use journal entries for diagnostic assessment as you determine students' prior knowledge.

9 Discuss the importance of entries in the science journal during the *Explain* and *Evaluate* phases. Demonstrate how the information in the journal will help students develop literacy products, such as posters, brochures, letters and oral or written presentations.

Rising salt **science journal entry**



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① In what ways are plants watered?

Plants are watered by hoses, sprinklers, drippers, watering cans, reticulation and the rain. (outside plants).

② How could we investigate which type of watering is best for tomato plants?

We could water one plant each of the different ways and compare them by looking at how much they grow
For drippers – an eye dropper
For watering can – a small watering can
for a hose – pour water out of a bottle

To make it a fair test we have to keep everything the same except for watering ways
Keep the same - the plant, the soil the amount of water

Appendix 3
How to use a word wall

Introduction

A word wall is an organised collection of words and images displayed in the classroom. It supports the development of vocabulary related to a particular topic and provides a reference for students. The content of the word wall can be words that students see, hear and use in their reading, writing, speaking, listening and viewing.

Creating a class word wall, including words from different dialects and languages, aligns to descriptions in the Australian Curriculum: English. See page xv.

Goals in using a word wall

A word wall can be used to:

- support science and literacy experiences of reading, viewing, writing and speaking
- provide support for students during literacy activities across all key learning areas
- promote independence in students as they develop their literacy skills
- provide a visual representation to help students see patterns in words and decode them
- develop a growing bank of words that students can spell, read and/or use in writing tasks
- provide ongoing support for the various levels of academic ability in the class
- teach the strategy of using word sources as a real-life strategy.

Organisation

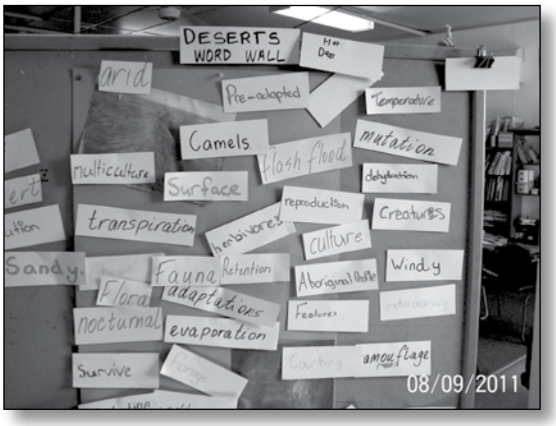
Position the word wall so that students have easy access to the words. They need to be able to see, remove and return word cards to the wall. A classroom could have one main word wall and two or three smaller ones, each with a different focus, for example, high-frequency words.

Choose robust material for the word cards. Write or type words on cardboard and perhaps laminate them. Consider covering the wall with felt-type material and backing each word card with a self-adhesive dot to make it easy for students to remove and replace word cards.

Word walls do not need to be confined to a wall. Use a portable wall, display screen, shower curtain or window curtain. Consider a cardboard shape that fits with the unit, for example, an apple for a needs unit.

The purpose is for students to be exposed to a print-rich environment that supports their science and literacy experiences.

Organise the words on the wall in a variety of ways. Place them alphabetically, or put them in word groups or groups suggested by the unit topic, for example, words for a *Rising salt* unit might be organised under headings, such as ‘Watering types’, ‘Salinity’ and ‘Sustainability’.



Desert survivors word wall

Creators and destroyers word wall

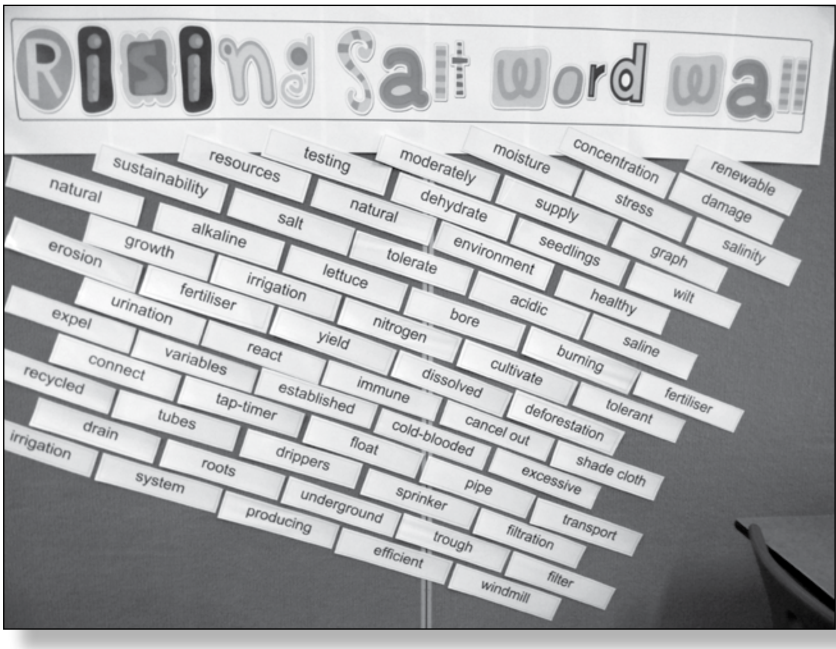
Using a word wall

1 Limit the number of words to those needed to support the science and literacy experiences in the classroom.

2 Add words gradually, and include images where possible, such as drawings, diagrams or photographs. Build up the number of words on the word wall as students are introduced to the scientific vocabulary of the unit.

3 Encourage students to interact with the word wall. Practise using the words with students by reading them and playing word games. Refer to the words during science and literacy experiences and direct students to the wall when they need a word for writing. Encourage students to use the word wall to spell words correctly.

4 Use the word wall with the whole class, small groups and individual students during literacy experiences. Organise multi-level activities to cater for the individual needs of students.



Rising salt word wall

Appendix 4
How to use a TWLH chart

Introduction

A learning tool commonly used in classrooms is the KWL chart. It is used to elicit students' prior **K**nowledge, determine questions students **W**ant to know answers to, and document what has been **L**earned.

Primary**Connections** has developed an adaptation called the **TWLH** chart.

T – 'What we **think** we know' is used to elicit students' background knowledge and document existing understanding and beliefs. It acknowledges that what we 'know' might not be the currently accepted scientific understanding.

W – 'What we **want** to learn' encourages students to list questions for investigation. Further questions can be added as students develop their understanding.

L – 'What we **learned**' is introduced as students develop explanations for their observations. These become documented as 'claims'.

H – '**How** we know' or 'How we came to our conclusion' is used in conjunction with the third column and encourages students to record the evidence and reasoning that lead to their new claim, which is a key characteristic of science. This last question requires students to reflect on their investigations and learning, and to justify their claims.

As students reflect on their observations and understandings to complete the third and fourth columns, ideas recorded in the first column should be reconsidered and possibly confirmed, amended or discarded, depending on the investigation findings.

Rising salt TWLH chart

What we **think** we know	What we **want** to learn	What we **learned** (What are our claims)	**How** we know (What is our evidence)
We think that salty water harms plants. →	How does salty water affect plants? →	Lettuce seedlings can tolerate a small amount of salty water but at higher concentrations their growth slows and they can die. →	We watered lettuce seedlings with different salt concentrations. We measured growth and observed their health.

Appendix 5
How to use a glossary

Introduction

A glossary is a list of technical terms that relate to a particular subject matter or topic, generally accompanying a document. Each term is accompanied by a description or explanation of the term within the context of the subject. A glossary entry is generally more descriptive than a dictionary definition.

Creating a class glossary can be used to:

- elicit students' prior understanding of subject-specific terms
- develop a growing bank of descriptions to help students understand and use new words in written and oral tasks
- support students' understanding of scientific descriptions and explanations
- develop the strategy of using word sources as a real-life, valuable investigative research strategy.

Using a class glossary

1. Introduce a term and discuss what it might mean within the context of the unit. Possible strategies include students connecting the word to a feature or aspect of the topic, and students using the word in a spoken sentence to explain topic, concept or context.
2. Create a shared understanding of the term, and record it in the science journal or as part of the word wall.
3. Introduce the conventional technical meaning of the term where appropriate.
4. Encourage students to practise using the terms in the glossary to become familiar with them. Students may wish to amend a description of a word after becoming more familiar with how it is used in a particular context. This may occur when writing, talking or making annotations to diagrams.
5. Integrate the glossary across all curriculum areas where appropriate. For example, in a literacy lesson discuss various meanings for the term.
6. The glossary could be a part of the science journal or the word wall for a particular unit.

   Note: It is important to ask students for 'descriptions' of the terms rather than 'definitions'. 'Definitions' are often viewed as fixed and unchangeable, whereas 'descriptions' support students to see that ideas can change as their understanding develops.

Appendix 6
How to write questions for investigation

Introduction

Scientific inquiry and investigation are focused on and driven by questions. Some questions are open to scientific investigation, while others are not. Students often experience difficulty in developing their own questions for investigation.

This appendix explains the structure of questions and how they are related to variables in a scientific investigation. It describes an approach to developing questions for investigation and provides a guide for constructing investigable questions with your students. Developing their own questions for investigation helps students to have ownership of their investigation and is an important component of scientific literacy.

The structure of questions for investigation

The way that a question is posed in a scientific investigation affects the type of investigation that is carried out and the way information is collected. Examples of different types of questions for investigation include:

- How does/do …?
- What effect does …?
- Which type of …?
- What happens to …?

All science investigations involve *variables.* Variables are things that can be changed (independent), measured (dependent) or kept the same (controlled) in an investigation.

- The **independent variable** is the thing that is changed during the investigation.
- The **dependent variable** is the thing that is affected by the independent variable, and is measured or observed.
- **Controlled variables** are all the other things in an investigation that could change but are kept the same to make it a fair test.

An example of the way students can structure questions for investigation is:
What happens to____________________ when we change____________________?
dependent variable **independent variable**

The type of question for investigation in *Rising salt* refers to two things (variables) and the relationship between them, for example, an investigation of the things (variables) that affect plant growth might consider the effect of the method of watering or the salt water strength. The question for investigation could be:

Q1: What happens to plant growth when we change the method of watering?

In this question, *plant growth* depends on *the method of watering*. The method of watering is the thing that is **changed** (independent variable) and the plant growth is the thing that is **measured or observed** (dependent variable).

Q2: What happens to plant growth when we change the amount of salt in the water?

In this question, *plant growth* depends on *the amount of salt in the water*. The amount of salt in the water is the thing that is **changed** (independent variable) and the plant growth is the thing that is **measured or observed** (dependent variable).

Developing questions for investigation

The process of developing questions for investigation is to:

- Provide a context and reason for investigating.
- Pose a general focus question in the form of:

  'What things might affect __________ (**dependent variable**)?'.

  For example, 'What things might affect plant growth?'
- Use questioning to elicit the things (**independent variables**) students think might affect the dependent variable, for example, plant growth.

  By using questions, elicit the things that students can investigate, such as the amount of water, the type of plant, the size of the plants, the location of the plant, the frequency of watering, the temperature of the water, the amount of soil, the type of soil, the type of pot, the time watering occurs and the method of watering. These are the things that could be changed (**independent variables**), which students predict will affect the thing that is measured or observed (**dependent variable**).
- Each of the independent variables can be developed into a question for investigation.
- Use the scaffold 'What happens to __________ when we change __________?' to help students develop specific questions for their investigation.

  For example, 'What happens to plant growth when we change the method of watering?' or 'What happens to plant growth when we change the amount of salt in the water?'.
- Ask students to review their question for investigation after they have conducted their investigation and collected and analysed their information.
- Encouraging students to review their question will help them to understand the relationship between what was changed and what was measured in their investigation. It also helps students to see how the information they collected relates to their prediction.

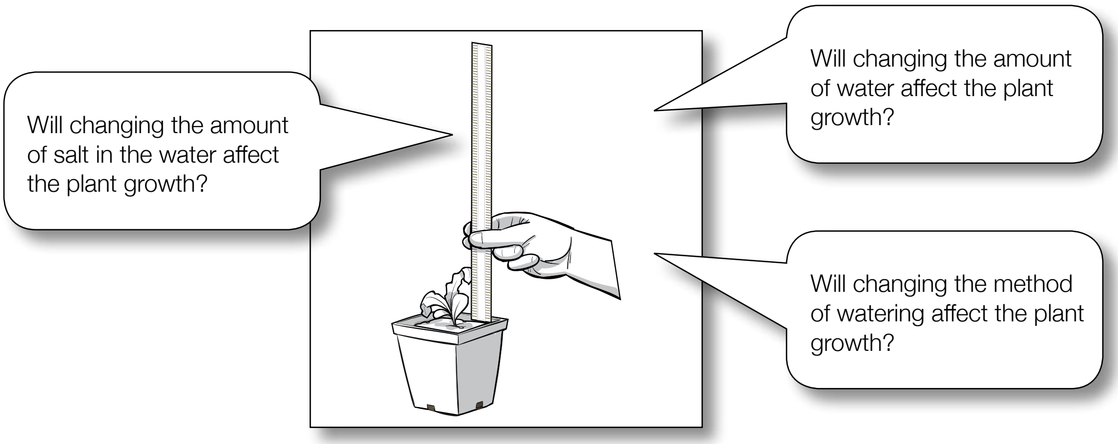
Appendix 7
How to conduct a fair test

Introduction

Scientific investigations involve posing questions, testing predictions, planning and conducting tests, interpreting and representing evidence, drawing conclusions and communicating findings.

Planning a fair test

In *Rising salt*, students investigate things that affect the rate of growth of a plant seedling.



All scientific investigations involve *variables*. Variables are things that can be changed (independent), measured/observed (dependent) or kept the same (controlled) in an investigation. When planning an investigation, to make it a fair test, we need to identify the variables.

It is only by conducting a fair test that students can be sure that what they have changed in their investigation has affected what is being measured/observed.

'**C**ows **M**oo **S**oftly' is a useful scaffold to remind students how to plan a fair test:

Cows: **Change** one thing (independent variable)

Moo: **Measure/Observe** another thing (dependent variable)

Softly: keep the other things (controlled variables) the **Same**.

To investigate things that affect the rate of growth of a plant seedling, students could:

CHANGE	The amount of salt in the water	Independent variable
MEASURE/ OBSERVE	The height of the lettuce seedling	Dependent variable
KEEP THE **SAME**	The amount of water, the size and type of lettuce seedling, the frequency of watering, the location, the type and amount of soil, the type of pot.	Controlled variables

Appendix 8
How to facilitate evidence-based discussions

Introduction

Argumentation is at the heart of what scientists do; they pose questions, make claims, collect evidence, debate with other scientists and compare their ideas with others in the field.

In the primary science classroom, argumentation is about students:

- articulating and communicating their thinking and understanding to others
- sharing information and insights
- presenting their ideas and evidence
- receiving feedback (and giving feedback to others)
- finding flaws in their own and others' reasoning
- reflecting on how their ideas have changed.

It is through articulating, communicating and debating their ideas and arguments that students are able to develop a deep understanding of science content.

Establish norms

Introduce norms before starting a science discussion activity. For example:

- Listen when others speak.
- Ask questions of each other.
- Criticise ideas not people.
- Listen to and discuss all ideas before selecting one.

Claim, Evidence and Reasoning

In science, arguments that make claims are supported by evidence. Sophisticated arguments follow the **QCER** process:

Q – What **question** are you trying to answer? For example, 'What happens to plant growth when we change the amount of salt in the water?'

C – The **claim**. For example, 'A low level of salt does not affect plant growth, moderate levels cause plants to grow more slowly and high levels can kill plants'.

E – The **evidence**. For example, 'I watered lettuce seedlings with different concentrations of salt in the water. The seedlings watered with higher concentrations did not measure as high after a week and the ones with very high concentrations looked very unhealthy, all wilted and yellow'.

R – The **reasoning**. For example, 'Very high salt concentrations in water cause plants to lose moisture and suffer stress.'

Students need to be encouraged to move from making claims only, to citing evidence to support their claims. Older students develop full conclusions that include a claim, evidence and reasoning. This is an important characteristic of the nature of science and an aspect of scientific literacy. Using science question starters (see next section) helps to promote evidence-based discussion in the classroom.

Science question starters

Science question starters can be used to model the way to discuss a claim and evidence for students. Teachers encourage team members to ask these questions of each other when preparing their claim and evidence. They might also be used by audience members when a team is presenting its results. (See Primary**Connections** 5Es video, *Elaborate*).

Science question starters

Question type	Question starter
Asking for evidence	I have a question about ______ . What is your evidence to support your claim?
Agreeing	I agree with ______ because ______ .
Disagreeing	I disagree with ______ because ______ . One difference between my idea and yours is ______ .
Questioning further	I wonder what would happen if ______? I have a question about ______ . I wonder why ______? What caused ______? How would it be different if ______?
Clarifying	I'm not sure what you meant there. Could you explain your thinking to me again?

DISCUSSION SKILLS

- Listen when others speak
- Ask questions of each other
- Criticise ideas not people
- Listen to and discuss all ideas before selecting one

Appendix 9
How to construct and use a graph

Introduction

A graph organises, represents and summarises information so that patterns and relationships can be identified. Understanding the conventions of constructing and using graphs is an important aspect of scientific literacy.

During a scientific investigation, observations and measurements are made and measurements are usually recorded in a table. Graphs can be used to organise the data to identify patterns, which help answer the research question and communicate findings from the investigation.

The Australian Curriculum: Mathematics Statistics and Probability 'Data representation and interpretation' content descriptions for Year 6 are:

- Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables.
- Interpret secondary data presented in digital media and elsewhere.

Once you have decided to construct a graph, two decisions need to be made:

- What type of graph? and
- Which variable goes on each axis of the graph?

What type of graph?

The type of graph used depends on the type of data to be represented. Many investigations explore the effect of changing one variable while another is measured or observed.

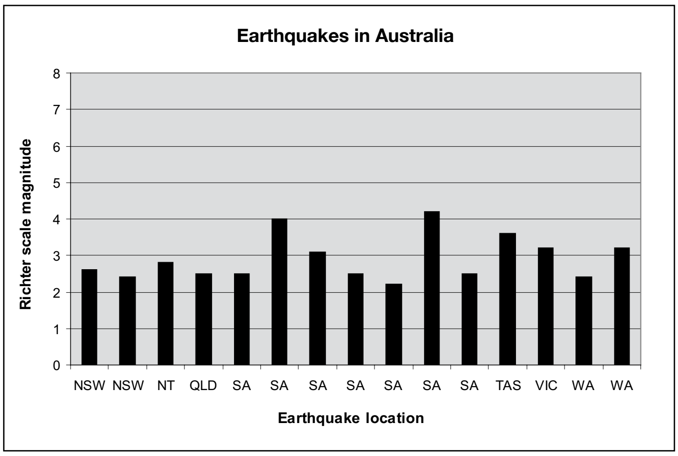
Column graph

Where data for one of the variables are in **categories** (that is, we use **words** to describe it, for example, earthquake location) a **column graph** is used. In *Earthquake explorers*, students analyse and compare secondary data. Students use their understanding of earthquakes to explain the patterns in the data. Graph A below shows the magnitude of earthquakes in Australian states and territories **(data in categories)** and is presented as a **column graph**.

Table A: Earthquake magnitude recorded in Australian states and territories from October 2008 to November 2008.

Earthquake magnitude (Richter scale)	Australia
2.6	Australia (NSW)
2.4	Australia (NSW)
2.8	Australia (NT)
2.5	Australia (QLD)
2.5	Australia (SA)
4.0	Australia (SA)
3.1	Australia (SA)
2.5	Australia (SA)
2.2	Australia (SA)
4.2	Australia (SA)
2.5	Australia (SA)
3.6	Australia (TAS)
3.2	Australia (VIC)
2.4	Australia (WA)
3.2	Australia (WA)

Graph A: Earthquake magnitude recorded in Australian states and territories from October 2008 to November 2008.



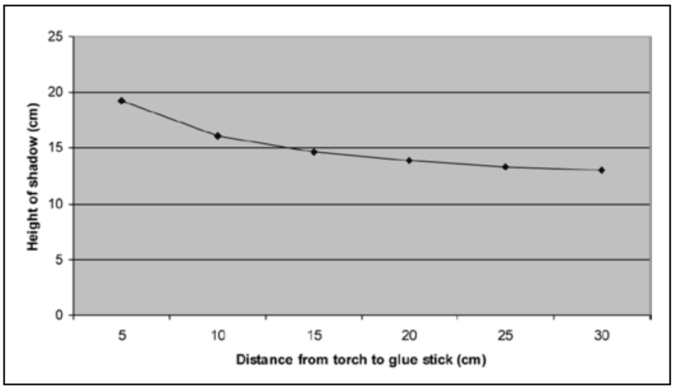
Line graph

Where the data for both variables are **continuous** (that is, we use **numbers** that can be recorded on a measurement scale, such as length in centimetres or mass in grams), a **line graph** is usually constructed. Graph B below shows how the results from an investigation of the effect of distance from a light source **(continuous data)** on the shadow height of an object **(continuous data)** have been constructed as a **line graph**.

Table B: The effect of distance from a torch on the shadow height of a glue stick.

Distance from torch to glue stick (cm)	Height of shadow (cm)
5	19.3
10	16.1
15	14.7
20	13.9
25	13.3
30	13

Graph B: The effect of distance from a torch on the shadow height of a glue stick.



Which variable goes on each axis?

It is conventional in science to plot the variable that has been changed on the horizontal axis (X axis) and the variable that has been measured/observed on the vertical axis (Y axis) of the graph.

Graph titles and labels

Graphs have titles and each variable is labelled on the graph axes, including the units of measurement. The title of the graph is usually in the form of 'The effect of one variable on the other variable'. For example, 'The effect of distance from a torch on the shadow height of a glue stick' (Graph B).

Steps in analysing and interpreting data

Step 1—Organise the data (for example, construct a graph) so you can see the pattern in data or the relationship between data for the variables (things that we change, measure/observe, or keep the same).

Step 2—Identify and describe the pattern or relationship in the data.

Step 3—Explain the pattern or relationship using science concepts.

Questioning for analysis

Teachers use effective questioning to assist students to develop skills in interrogating and analysing data represented in graphs. Such as:

- What is the story of your graph?
- Do the data in your graph reveal any patterns?
- Is this what you expected? Why?
- Can you explain the pattern? Why did this happen?
- What do you think the pattern would be if you continued the line of the graph?
- How certain are you of your results?

Analysis

Analysis of Graph B shows that the further the distance from the torch the shorter the height of the glue stick's shadow. This is because as light travels in straight lines, the closer the object to a light source, the more light it blocks out and therefore the bigger the shadow.

Appendix 10 ***Rising salt*** **equipment list**

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	3	3	4	5	6	6	7
		SESSION			1	2			1	2	
Equipment and materials											
3 salt solutions in six one litre bottles	per class								●		
50 mL measuring cup	1 per class			●							
50 mL measuring cup	1 per team				●				●		
biodegradable cup	1 per class			●							
biodegradable cup with holes in bottom	1 per class			●							
farm-produced items e.g, cotton socks, cardboard, sandwich	per class		●								
lettuce seedling pots	4 per team				●						
materials to create posters	quantity per team							●			
popsticks	3 per class			●							
popsticks	4 per team				●				●		
permanent marking pen	1 per class			●							
permanent marking pen	1 per team				●				●		
plastic bottle	6 per class				●						
ruler	1 per team				●				●		
seedlings	4 per team								●		
tomato seedlings or young plants in pots	3 per class			●							
access to fresh water	quantity per class			●	●				●		
water spray bottle	1 per class			●							

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	3	3	4	5	6	6	7
		SESSION			1	2			1	2	
Resource sheets											
‘Dear experts’ (RS1)	1 per student		●				●				●
‘Dear experts’ (RS1), enlarged	1 per class		●	●	●	●	●	●			●
‘Watering investigation planner’ (RS2), enlarged	1 per class			●							
‘Salt water investigation planner’ (RS3)	1 per team member				●	●			●		
‘Salt water investigation planner’ (RS3), enlarged	1 per class				●	●					
‘Salt water investigation results’ (RS4)	1 per team member					●				●	
‘Salt water investigation results’ (RS4), enlarged	1 per class					●					
‘Salt and animals’ (RS5)	1 per team member					●					
‘Salt and animals’ (RS5), enlarged	1 per class					●					
‘Further investigation planner’ (RS6)	1 per team member								●	●	
‘Further investigation planner’ (RS6), enlarged	1 per class								●	●	
Teaching tools											
class science journal	1 per class		●	●	●	●	●	●	●	●	●
student science journal	1 per student		●	●	●	●	●	●	●	●	●
word wall	1 per class		●	●	●	●	●	●	●	●	●
TWLH chart	1 per class		●	●	●	●	●	●	●	●	●
team roles chart	1 per class				●	●		●	●	●	●
team skills chart					●	●		●	●	●	●
role wristbands or badges for Director, Manager and Speaker	1 set per team				●	●		●	●	●	●
Multimedia											
collection of multimedia resources on agricultural innovations	per class						●				
multimedia resources on managing water *optional*	per class							●			
digital camera *optional*	1 per class				●				●		
video – ‘First Australians were also the first farmers’	per class						●				
video – ‘Soil salinity in Australia’	per class						●				

Appendix 11
Rising salt unit overview

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to represent their current understanding as they:	Students will be able to:	Students:	
ENGAGE	**Lesson 1** Living sustainably	• explain their existing ideas about what living things need to grow and survive • identify some physical conditions of the environment and their effect on the growth of living things • identify their existing ideas about living sustainably • identify how scientific knowledge might be used to solve poor growth and health issues of living things on a farm.	• understand the purpose and features of a science journal, glossary, TWLH chart and word wall • contribute to class discussions about living sustainably and what affects the growth of living things • analyse information in a letter.	• discuss the relevance of products grown from farms in their lives and for Australia • read a scenario and record their thoughts on what might be affecting the health and growth of plants and animals.	**Diagnostic assessment** • Science journal entries • Class discussions • TWLH chart contributions
EXPLORE	**Lesson 2** Water worries	• plan an investigation, with teacher support • participate in a guided investigation of how the method of watering affects tomato plant growth • identify that results from scientific investigations are used to solve problems that directly affect people's lives.	• participate in and contribute to discussions by sharing information to determine variables and a method for a guided investigation • use oral language and visual language to report observations of the guided investigations.	• as a class, investigate if different methods of watering affect the growth and health of tomato plants • record and interpret observations.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xv for English and page xvi for Mathematics.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLORE	**Lesson 3** Salt solutions	• identify that the effect of salt on living things depends on the concentration of salt present • make, record and interpret observations • plan and conduct an investigation that is a fair test • suggest improvements to the investigation • identify that results from scientific investigations are used to solve problems that directly affect people's lives.	• use a table to record observations • engage in discussion to compare ideas • identify the features and purpose of a factual text • use oral, written and visual language to design, implement and report on their investigation.	***Session 1*** Make it salty • work in teams to plan and conduct a fair test on the effects of different concentrations of salt water on the growth and health of plants • observe and record the results of their investigation. ***Session 2*** Sorting out the solution • graph the investigation results • make claims supported with evidence based on the investigation • read a factual text on the effect of salty water on animals.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions • 'Salt water investigation planner' (Resource sheet 3) • 'Salt water investigation results' (Resource sheet 4)

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xv for English and page xvi for Mathematics.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLAIN	**Lesson 4** Sustainable systems	• explain that different concentrations of salt and methods of watering (or types of rainfall) affect the growth and survival of plants and animals • discuss other physical conditions that might affect living things • analyse information in a video • identify how water use can affect the physical environment by causing salty water to rise to the surface • identify how scientific understanding can be used to solve rising salinity issues.	• represent and communicate their ideas in a variety of ways • contribute to discussions about rising water tables and possible innovations.	• make evidence-based claims on what environmental conditions might be affecting the growth and health of plants and animals • identify links between land and water management and rising salinity • brainstorm and research innovations to improve conditions for plants and animals.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions • Ideas map contributions
ELABORATE	**Lesson 5** Design challenges	• generate ideas to make an irrigation system or a water trough for animals • develop criteria for a successful design • assess designs using the criteria.	• brainstorm and sketch ideas • create a labelled diagram • produce a poster to explain ideas • engage in discussions to compare ideas • analyse information in a letter.	• plan and design an improved system • create a poster to share their ideas.	**Summative assessment** of Science Inquiry Skills • Science journal entries • Class discussions • TWLH chart contributions • Posters

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xv for English and page xvi for Mathematics.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
ELABORATE	**Lesson 6** Testing improvements *(Optional)*	• formulate a question and make predictions about the effect of physical conditions on living things • work in collaborative learning teams to plan and conduct an investigation • provide evidence to support their claims.	• contribute their ideas to a class discussion • use scientific vocabulary appropriately in their writing and discussions.	***Session 1*** **Further investigation** • discuss variables that might affect salinity tolerance • work in collaborative learning teams to plan and conduct an open investigation. ***Session 2*** **Sharing results** • collect, analyse and present the data from open investigations.	**Summative assessment** of Science Inquiry Skills • Science journal entries • Class discussions • TWLH chart contributions • 'Further investigation planner' (Resource sheet 6)
EVALUATE	**Lesson 7** Sustainable solutions	• identify physical conditions of the environment that affect the growth and survival of living things • explain how the method of watering (or type of rainfall) and concentrations of salt affect living things using evidence-based claims • explain how evidence-based claims can be used to provide solutions to improve watering methods and concentrations of salt in a farmland.	• plan, draft and publish informative texts, including images and digital resources appropriate to purpose and audience • contribute to discussions about their learning journey.	• work in collaborative learning teams to prepare a presentation in response to 'Dear experts' (Resource sheet 1) • participate in a class discussion to reflect on their learning during the unit.	**Summative assessment** of Science Understanding • Science journal entries • Class discussions • TWLH chart contributions • Presentations

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xv for English and page xvi for Mathematics.

Rising salt was developed in collaboration with the Primary Industries Education Foundation Australia (PIEFA).

The Primary Industries Education Foundation Australia (PIEFA) is the peak body for Food and Fibre Education in Australia. Using a small secretariat to achieve its vision of 'An Australia Community that understands and values its primary industries sector', they work with schools, teachers and systems to promote and encourgae teaching and learning related to the production of our food and fibre resources in the context of the mainstream curriculum.

PIEFA works with many others, such as Primary**Connections**, to strategically coordinate and facilitate initiatives, resources and programs.

PIEFA operates a one-stop web portal for schools, www.primezone.edu.au, where many resources may be found across all grades and learning areas to support the Australian Curriculum with a focus on food and fibre production as the context.

PIEFA is a not-for-profit company limited by guarantee and is governed by a skills based board of directors and operated by a CEO and supporting staff.

For more information www.piefa.edu.au or www.primezone.edu.au

PrimaryConnections
Linking science with literacy

PrimaryConnections Units

Year	Biological sciences	Chemical sciences	Earth and space sciences	Physical sciences
F	*Staying alive* *Growing well*	*That's my hat!* *What's it made of?*	*Weather in my world*	*On the move*
1	*Schoolyard safari* *Dinosaurs and more*	*Spot the difference* *Bend it! Stretch it!*	*Changes all around* *Up, down and all around*	*Look! Listen!*
2	*Watch it grow!*	*All mixed up*	*Water works*	*Machine makers* *Push-pull*
3	*Feathers, fur or leaves?*	*Melting moments*	*Night and day*	*Heating up*
4	*Plants in action* *Friends or foes?* *Among the gum trees*	*Material world* *Package it better*	*Beneath our feet*	*Magnetic moves* *Smooth moves*
5	*Desert survivors*	*What's the matter?*	*Earth's place in space*	*Light shows*
6	*Marvellous micro-organisms* *Rising salt*	*Change detectives*	*Creators and destroyers* *Earthquake explorers*	*Circuits and switches* *Essential energy*