

Fully aligned
with the Australian
Curriculum



Beneath our feet

Year 4

Earth and space sciences



Primary**Connections** project

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Australian Literacy Educators' Association
Australian Primary Principals Association
Australian Science Teachers Association
QLD Department of Education, Training and Employment
Independent Schools Council of Australia
Indigenous Education Consultative Body
National Catholic Education Commission
NSW Department of Education and Communities
NT Department of Education and Training
Primary English Teaching Association Australia
SA Department for Education and Child Development
TAS Department of Education
VIC Department of Education and Early Childhood Development
WA Department of Education



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Professional learning program

The Primary**Connections** program includes a sophisticated professional learning component and exemplary curriculum resources. Research shows that this combination is more effective than using each in isolation.

Professional Learning Facilitators are available throughout Australia to conduct workshops on the underpinning principles of the program: the Primary**Connections** 5Es teaching and learning model, linking science with literacy, investigating, embedded assessment and collaborative learning.

The Primary**Connections** website has contact details for state and territory Professional Learning Coordinators, as well as additional resources for this unit. Visit the website at:

www.science.org.au/primaryconnections

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We live in a world that is constantly changing. Even things that we might consider immovable, such as mountains or rock formations are gradually changing, sometimes with processes that are visible in our lifetimes. The modifications might affect us either through catastrophic events such as landslides or through gradual processes that change the quality and composition of soils we rely upon for sustenance.

The *Beneath our feet* unit is an ideal way to link science with literacy in the classroom. It provides opportunities for students to explore how natural processes and human activity shape their surroundings. Students' understanding of soils, rocks and landscapes and how they change over time is developed through hands-on activities and student-planned investigations. Students also investigate factors that affect the erosion of soils.



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Foreword

The Australian Academy of Science is proud of its long tradition of supporting and informing science education in Australia. 'Primary**Connections**: linking science with literacy' is its flagship primary school science program, and it is making a real difference to the teaching and learning of science in Australian schools.

The Primary**Connections** approach has been embraced by schools since its inception in 2004, and there is substantial evidence of its effectiveness in helping teachers transform their practice. It builds teacher confidence and competence in this important area, and helps teachers use their professional skills to incorporate elements of the approach into other areas of the curriculum. Beginning and pre-service teachers find the approach doable and sustainable. Primary**Connections** students enjoy science more than in comparison classes, and Indigenous students, in particular, show significant increases in learning using the approach.

The project has several components: professional learning, curriculum resources, research and evaluation, and Indigenous perspectives. With the development of a national curriculum in the sciences by ACARA in December 2010, it is an exciting time for schools to engage with science, and to raise the profile of primary science education.

Students are naturally curious. Primary**Connections** provides an inquiry-based approach that helps students develop deep learning, and guides them to find scientific ways to answer their questions. The lessons include key science background information, and further science information is included on the Primary**Connections** website (www.science.org.au/primaryconnections).

Science education provides a foundation for a scientifically literate society, which is so important for engagement in key community debates, such as climate change, carbon emissions, and immunisation, as well as for personal decisions about health and well-being. The inquiry approach in Primary**Connections** prepares students well to participate in evidence-based discussions of these and other issues.

Primary**Connections** has been developed with the financial support of the Australian Government, and has been endorsed by education authorities across the country. The Steering Committee, comprised of Department of Education and Academy representatives, and the Reference Group, which includes representatives from all stakeholder bodies including states and territories, have provided invaluable guidance and support over the last seven years. Before publication, the science teacher background information on science is reviewed by a Fellow of the Academy of Science. All these inputs have ensured an award-winning, quality program.

The Fellows of the Academy are committed to ongoing support for teachers of science at all levels. I commend Primary**Connections** to you and wish you well in your teaching.

Professor Suzanne Cory, AC, PresAA FRS

President

Australian Academy of Science

2010–2013

The PrimaryConnections program

Primary**Connections** is an innovative program that links the teaching of science and literacy in the primary years of schooling. It is an exciting and rewarding approach for teachers and students with a professional learning program and supporting curriculum resources. Further information about professional learning and other curriculum support can be found on the Primary**Connections** website: www.science.org.au/primaryconnections

The PrimaryConnections teaching and learning model

This unit is one of a series designed to exemplify the Primary**Connections** teaching and learning approach which embeds inquiry-based learning into a modified 5Es instructional model (Bybee, 1997) with the five phases: *Engage*, *Explore*, *Explain*, *Elaborate* and *Evaluate*. The relationship between the 5Es phases, investigations, literacy products and assessment are 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.science.org.au/primaryconnections/teaching-and-learning

Developing students' scientific literacy

The learning outcomes in Primary**Connections** contribute to 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.

(Programme for International Student Assessment & Organisation for Economic Co-operation and Development [PISA & OECD], 2009).

Linking science with literacy

PrimaryConnections 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.

PrimaryConnections develops the literacies of science that students need to learn and to represent their understanding of science concepts, processes and skills. Representations in PrimaryConnections are multi-modal 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 against the year level Achievement standards of the Australian Curriculum: Science (ACARA, 2012) is ongoing and embedded in PrimaryConnections units.

Assessment is linked to the development of literacy practices and products. Relevant understandings and skills for each lesson 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 of the Science Inquiry Skills, and of the Science Understanding in *Evaluate* phase.

Alignment with 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, 2012).

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
Use and influence of science	How science knowledge and applications affects peoples’ lives 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 regarding 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

 All the material in this table is sourced from the Australian Curriculum.

There are a minimum of four **PrimaryConnections** units for each year of primary school from Foundation to Year 6, at least one for each understanding sub-strand of the Australian Curriculum. Each unit contains detailed information about its alignment with all aspects of the Australian Curriculum: Science and its links to the Australian Curriculum: English and Mathematics.



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  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.

References

Australian Curriculum Assessment and Reporting Authority (ACARA). (2012). *Australian Curriculum: Science*. www.australiancurriculum.edu.au

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

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.

Unit at a glance

Beneath our feet

Phase	Lesson	At a glance
ENGAGE	Lesson 1 Lost location	To capture students' interest and find out what they think they know about soils, rocks and landscapes and how they change over time To elicit students' questions about how soils, rocks and landscapes change over time
EXPLORE	Lesson 2 Studying soils Session 1 What's in soil? Session 2 Soil solutions	To provide students with hands-on, shared experiences of soils and their features
	Lesson 3 Rock hard?	To provide students with hands-on, shared experience of rocks and their features, and how they have changed over time
	Lesson 4 Rollin' rock	To provide students with hands-on, shared experiences of rocks and how they change over time
	Lesson 5 Modelling mountains	To provide students with hands-on, shared experiences of how features of the landscape change over time
EXPLAIN	Lesson 6 Fabulous formations	To support students to represent and explain their understanding of soils, rocks and landscapes and how they change over time, and to introduce current scientific views about how landscapes are formed over time
ELABORATE	Lesson 7 Examining erosion	To support students to plan and conduct an investigation of factors that influence water erosion of soils
EVALUATE	Lesson 8 Meticulous maps	To provide opportunities for students to represent what they know about erosion and how soils, rocks and landscapes change over time, and to reflect on their learning during the unit

A unit overview can be found in Appendix 10, page 90.

Alignment with the Australian Curriculum: Science

This *Beneath our feet* unit embeds all three strands of the Australian Curriculum: Science. The table below lists sub-strands and their content for Year 4. This unit is designed to be taught in conjunction with other Year 4 units to cover the full range of the Australian Curriculum: Science content for Year 4.

For ease of assessment the table below outlines the sub-strands and their aligned lessons.

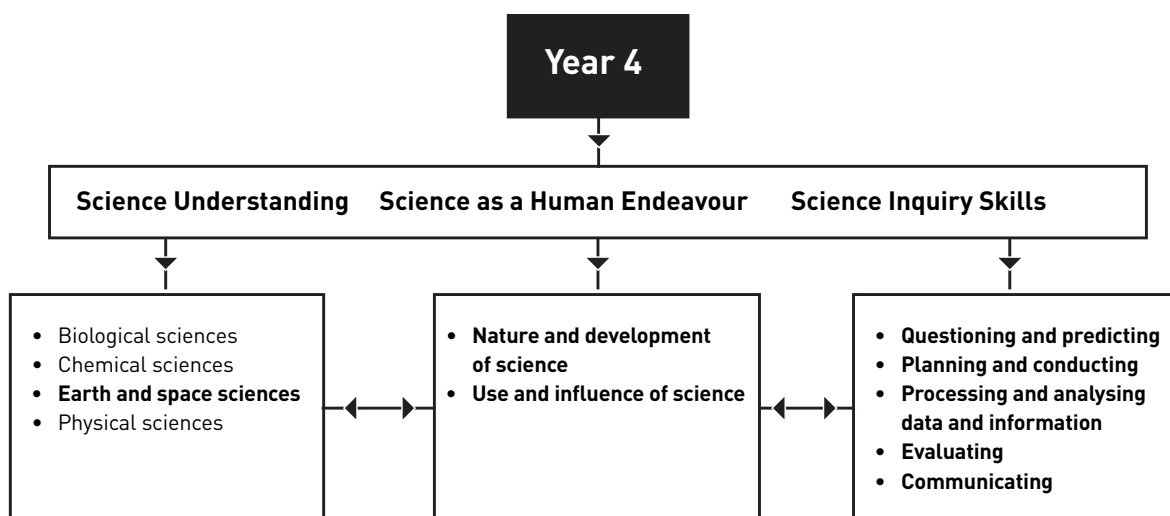
Strand	Sub-strand	Code	Year 4 content descriptions	Lessons
Science Understanding	Earth and space sciences	ACSSU075	Earth's surface changes over time as a result of natural processes and human activity	1–8
Science as a Human Endeavour	Nature and development of science	ACSHE061	Science involves making predictions and describing patterns and relationships	1,2,3,4,6,7
	Use and influence of science	ACSHE062	Science knowledge helps people to understand the effect of their actions	3,5
Science Inquiry Skills	Questioning and predicting	ACSIS064	With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge	1,3,7
	Planning and conducting	ACSIS065	Suggest ways to plan and conduct investigations to find answers to questions	2,4,7
		ACSIS066	Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate	2,3,4,5,7
	Processing and analysing data and information	ACSIS068	Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends	2,3,4,5,6,7
		ACSIS216	Compare results with predictions, suggesting possible reasons for findings	7
	Evaluating	ACSIS069	Reflect on the investigation, including whether a test was fair or not	2,4,7
	Communicating	ACSIS071	Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports	1,2,3,4,6,7




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

Interrelationship of the Science strands

The interrelationship between the three strands (Science Understanding, Science as a Human Endeavour and Science Inquiry Skills) and their sub-strands is shown below. Sub-strands covered in this unit are in bold.



 All the terms in this diagram are sourced from the Australian Curriculum.

Relationship to Overarching ideas

In the Australian Curriculum: Science, six overarching ideas support the coherence and developmental sequence of science knowledge within and across year levels. In *Beneath our feet*, these overarching ideas are represented as follows:

Overarching Idea	Incorporation in <i>Beneath our feet</i>
Patterns, order and organisation	Students observe and describe the patterns in landscapes that result from erosion over time.
Form and function	Students explore how the forms in the landscape affect how they are eroded which in turn affects their form.
Stability and change	Students understand that landscapes, which seem stable in our timescale, change over geological time.
Scale and measurement	Students compare the magnitude of events and processes at the Earth's surface that occur over very long periods of time.
Matter and energy	Students discuss the features of rocks and soils and how they can change over time.
Systems	Students describe interactions between non-living elements of ecosystems, such as the effect of water on rocks.

Curriculum focus

The Australian Curriculum: Science is described by year level but provides advice across four year groupings on the nature of learners. Each year grouping has a relevant curriculum focus.

Curriculum focus Years 3–6	Incorporation in <i>Beneath our feet</i>
Recognising questions that can be investigated scientifically and investigating them	Students discuss factors that influence the erosion of soils and pose questions for investigation. They use science inquiry skills to conduct fair tests of the effect of water erosion on soils.

Achievement standards

The achievement standards of the Australian Curriculum: Science indicate the quality of learning that students typically demonstrate by a particular point in their schooling, for example, at the end of a year level. These standards will be reviewed regularly by ACARA and are available from the ACARA website.





By the end of the unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the Australian Curriculum: Science Year 4 achievement standard. Rubrics to help teachers make these judgments are available on the website: www.science.org.au/primaryconnections/curriculum-resources

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 unit specific information see the next page. For further information see: www.australiancurriculum.edu.au/GeneralCapabilities/Overview/General-capabilities-in-the-Australian-Curriculum

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

Beneath our feet — Australian Curriculum General capabilities

General capabilities	Australian Curriculum description	Spot the difference examples
Literacy	<p>Literacy knowledge specific to the study of science develops along with scientific understanding and skills.</p> <p>PrimaryConnections learning activities explicitly introduce literacy focuses and provide students with the opportunity to use them as they think about, reason and represent their understanding of science.</p>	<p>In <i>Beneath our feet</i> the literacy focuses are:</p> <ul style="list-style-type: none"> • maps • science journals • TWLH charts • word walls • tables • labelled diagrams • graphs • annotated diagrams • procedural texts • factual texts.
 Numeracy	<p>Elements of numeracy are particularly evident in Science Inquiry Skills. These include practical measurement and the collection, representation and interpretation of data.</p>	<p>Students:</p> <ul style="list-style-type: none"> • collect, interpret and represent data through tables and graphs • use measurement.
Information and communication technology (ICT) competence	<p>ICT competence is particularly evident in Science Inquiry Skills. Students use digital technologies to investigate, create, communicate and share ideas and results.</p>	<p>Students are given optional opportunities to:</p> <ul style="list-style-type: none"> • use interactive resource technology to view, record and analyse information • use the internet to research further information about landforms, weathering and erosion.
 Critical and creative thinking	<p>Students develop critical and creative thinking as they speculate and solve problems through investigations, make evidence-based decisions, and analyse and evaluate information sources to draw conclusions. They develop creative questions and suggest novel solutions.</p>	<p>Students:</p> <ul style="list-style-type: none"> • use reasoning to develop questions for inquiry • formulate, pose and respond to questions • consider different ways of thinking about rocks, soils and landscapes • develop evidence-based claims about patterns of erosion.
Ethical behaviour	<p>Students develop ethical behaviour as they explore ethical principles and guidelines in gathering evidence and consider the ethical implications of their investigations on others and the environment.</p>	<p>Students:</p> <ul style="list-style-type: none"> • ask questions respecting each other's point of view.
 Personal and social competence	<p>Students develop personal and social competence as they learn to work effectively in teams, develop collaborative methods of inquiry, work safely, and use their scientific knowledge to make informed choices.</p>	<p>Students:</p> <ul style="list-style-type: none"> • work collaboratively in teams • follow a procedural text for working safely • participate in discussions.
 Intercultural understanding	<p>Intercultural understanding is particularly evident in Science as a Human Endeavour. Students learn about the influence of people from a variety of cultures on the development of scientific understanding.</p>	<ul style="list-style-type: none"> • 'Cultural perspectives' opportunities are highlighted where relevant • Important contributions made to science by people from a range of cultures are highlighted where relevant.

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 this unit as described below. For further information see: www.australiancurriculum.edu.au/CrossCurriculumPriorities



Aboriginal and Torres Strait Islander histories and cultures

PrimaryConnections has developed an Indigenous perspective framework which has informed practical reflections on intercultural understanding. It can be accessed at: www.science.org.au/primaryconnections/indigenous

Beneath our feet focuses on the Western science way of making evidence-based claims about how environmental factors, such as rain and wind, erode rocks and soil and are responsible for the creation of landscapes over time. When scientists study rock formations, they examine rock types and look at surrounding soils to create hypotheses about what the land looked like thousands and millions of years ago.

Indigenous cultures might have different explanations for why landscapes look the way they do, often referring to Dreamtime. For example, many groups have legends of the Rainbow Serpent, an immense serpent that created mountains and gorges. Dreamtime stories can be specific to particular people or communities or can be shared across different groups.


PrimaryConnections recommends working with Indigenous community members to access contextualised, relevant Indigenous perspectives. Protocols on seeking out and engaging Indigenous community members are discussed in state and territory Indigenous education policy documents and can be found on the PrimaryConnections website.

Sustainability

In *Beneath our feet* students discuss mechanisms of erosion and how these can affect soils and landscapes. This provides opportunities for students to develop understanding of how human impact on the environment affects soils and landscapes. This can assist them to develop knowledge, skills and values for making decisions about individual and community actions that contribute to sustainable patterns of use of the Earth's natural resources.

Alignment with the Australian Curriculum: English and Mathematics

Strand	Sub-strand	Code	Year 4 content descriptions	Lessons
English–Language	Language for interaction	ACELA1488	Understand that social interactions influence the way people engage with ideas and respond to others, for example, when exploring and clarifying the ideas of others, summarising students' own views and reporting them to a larger group	1–8
		ACELA1489	Understand differences between the language of opinion and feeling and the language of factual reporting or recording	1–8
	Expressing and developing ideas	ACELA1498	Incorporate new vocabulary from a range of sources into students' own texts, including vocabulary encountered in research	2,3,6,8
English–Literature	Responding to literature	ACELT1603	Discuss literary experiences with others, sharing responses and expressing a point of view	1,6
	Creating literature	ACELT1607	Create literary texts that explore students' own experiences and imagining	2,6,8
English–Literacy	Interacting with others	ACELY1687	Interpret ideas and information in spoken texts and listen for key points in order to carry out tasks and use information to share and extend ideas and information	1,3,4,5,6,7
		ACELY1688	Use interaction skills such as acknowledging another's point of view and linking students' response to the topic, using familiar and new vocabulary and a range of vocal effects such as tone, pace, pitch and volume to speak clearly and coherently	1–8
		ACELY1689	Plan, rehearse and deliver presentations incorporating learned content and taking into account the particular purposes and audiences	4,6,7
	Creating texts	ACELY1694	Plan, draft and publish imaginative, informative and persuasive texts containing key information and supporting details for a widening range of audiences, demonstrating increasing control over text structures and language features	2,3,6,8
Mathematics–Measurements and Geometry	Using units of measurement	ACMMG084	Use scaled instruments to measure and compare lengths, masses, capacities and temperatures	2,3,4,7
	Location and transformation	ACMMG090	Use simple scales, legends and directions to interpret information contained in basic maps	1,8
Mathematics–Statistics and Probability	Data representation and interpretation	ACMSP095	Select and trial methods for data collections, including survey questions and recording sheets	2,7
		ACMSP096	Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values	2,3,4,7

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

Other links are highlighted at the end of lessons where possible. These links will be revised and updated on the website: www.science.org.au/primaryconnections/curriculum-resources

Introduction to landforms

Teacher background information

The Earth's surface

The outer crust of the Earth is made up of rock. In places the rock is covered by soil or water. This outer shell isn't rigid and events, such as earthquakes and volcanos help shape the landscape as they impact on the rocky layer and bring new material to the surface. The word 'rock' in common usage can refer to large cliffs and boulders as well as to small stones or pebbles. Scientists are more precise when they use the word 'rock' and understand it to mean an aggregate of minerals. Geologists (scientists who study the origin, history and structure of the earth) classify rocks into three basic types depending on the way that they were formed: igneous, sedimentary and metamorphic. Igneous rocks are formed from the solidification of the minerals found in magma. Sedimentary rocks are formed at the Earth's surface from the accumulation and consolidation of sediment. Metamorphic rocks are formed from pre-existing rocks within the Earth's crust by changes in temperature, pressure and by chemical action.

A volcanic rock is formed when the molten minerals (magma) inside the Earth arrive at the surface, for example, through volcanic activity or sea rifts. Not all magma is extruded at the surface, some remains beneath the surface as intrusions into surrounding rock where it can cool. At the Earth's surface magma becomes lava. As it cools, the minerals change from liquid to solid and form igneous rocks. The nature of the materials formed depends on the rate of cooling. If lava has a long time to cool, then individual minerals separate as distinct crystals to produce, for example, basalt with many different grains of crystals. However, if the same lava cools quickly, the molten mineral mix will harden and form a glassy black rock called obsidian. If it cools quickly and captures air pockets, a light crumbly stone called pumice is created; this is not dense and floats on water. All these rocks will have the mineral composition of the lava that created them, which might also be specific to different regions.

Sedimentary rocks are the most common type covering approximately 75% of the surface of the continents. Some examples are: sandstone, siltstone, shale, limestone, chalk, gypsum and coal. Their formation involves weathering of pre-existing rock, transportation of the material away from the original site (erosion) and depositing the eroded material in the sea or in some other sedimentary environment. Sedimentary rocks typically occur in layers or strata that cover large parts of the continents. The Grand Canyon in the US is a good example of sedimentary rock strata. Sedimentary rocks are formed from sediments that have been compacted and cemented to form solid rock bodies.

Metamorphic rocks are formed from rocks that have been altered by heat, pressure and chemical action to such an extent that the diagnostic features of the original rocks are modified or obliterated. Some examples of metamorphic rocks include slate, quartzite and marble.

Rocks are made up of a variety of minerals put together in different ways resulting in different colours and textures. Geologists classify rocks based on their texture and composition. The texture of a rock refers to the size, shape and arrangement of the constituent mineral grains, whilst the composition of a rock is based on the chemical composition of the minerals it contains. Minerals have physical properties, such as cleavage, hardness, specific gravity, colour and streak (the colour of the powdered mineral).

Soil is composed of small particles of rocks and minerals, plus varying amounts of organic material (derived from living things), water and air. The particles are of different sizes ranging from sand to silt to clay. Sand makes a soil feel gritty; silts are similar to clays but have slightly larger particles; and clay feels silky to the touch because it has the smallest particles. The mixture of these particles gives soil its texture which influences how much water a soil can hold. Generally, the smaller the soil particles (the more silt and clay), the more water a soil can hold. Soil scientists use texture to classify soils, such as sand, loamy sand, loam, clayey sand and medium clay. The ideal soil texture for growing plants is loam, a mixture of clay, silt and sand.

Soil composition is different in different places. These differences can be seen in a very small distance, such as from one side of a garden or farm to the other, as well as from country to country. The differences depend on the type of rocky material the soil was made from and the kinds of organisms that live in, around and on the soil.

Colour is a simple method of classifying soil. Black or dark brown soil is generally fertile soil for growing plants. Plain brown or yellow soil often indicates that the level of nutrients and organic matter is low and the fertility of this soil is low. Pale soils need plenty of organic material and mulching to become fertile. Red soil usually indicates extensive weathering and good drainage, but often it needs nutrients and organic matter to be fertile. The red colour is due to the oxidising of iron compounds ('rusting') in the soil. Organic material that can still be decomposed is called compost, whereas organic material that is stable is called humus (a Latin word meaning earth or ground).

Changes to the Earth's surface

The surface of the Earth is constantly changing. Land is being uplifted through processes such as plate tectonics and volcanic activity. Landforms are then further shaped through the processes of weathering and erosion. Weathering is the process by which rocks are chemically altered or physically broken into fragments and involves little or no transportation of the fragments. Rocks can be weathered, for example, by ice formation in rock cavities which breaks the rock apart, and changes in temperature causing the rocks to expand and contract which fractures it.

Rocks can also be weathered through chemical processes, for example, the mild acidity of some rainfall can cause minerals in the rock to slowly dissolve. This is how caves such as the Jenolan Caves in New South Wales were formed. Acid can also be released from living things, for example, the decay of organic material, or by direct secretion of acids (lichens).

The rate at which weathering occurs depends on three main factors: climate, the susceptibility of minerals to weathering and the amount of surface exposed to the atmosphere. The Devils Marbles in the Northern Territory are an example of rock bodies modified by weathering.

Erosion is the process that loosens sediments and moves them from one place to another. Agents of erosion include water, ice, wind and gravity. Erosion is affected by variations in the Earth's surface. For example, if a creek flows over a cliff, a deep pool often forms at its base because the impact of the water falling from a height causes more erosion. Once there is mild erosion, subsequent water tends to flow in the same place, creating deeper and deeper river beds. Human activity can also lead to erosion, for example, the removal of vegetation and constructions such as fences or dams affect erosion rates.

Trees bind soil with their roots, slowing erosion, but their roots can also assist to break up rocks. The decay of once-living things (organic matter) can cause water to become more acidic, inducing chemical weathering of rocks. Rainfall and wind corridors are in turn influenced by the landscape.

By clearing plants away and leaving soil bare after harvest, farmers can leave soils vulnerable to erosion. The top layer of the soil is the most susceptible to being blown away. This is also the richest source of nutrients for crops that farmers grow.

Time scale of change

Many rocks take a long time to be broken down and worn away in natural conditions. However, some rocks can be weathered very quickly once they are exposed. For example, the limestone of the Twelve Apostles formation in Victoria developed around 20 million years ago on land. Between 7000 and 10000 years ago, at the end of the last ice age, sea levels rose and the limestone was exposed to the sea. Since then the force of the waves has slowly weathered and eroded the cliffs to create isolated stacks of rocks. In 2005, one of the stacks collapsed, leaving eight standing. The rate of erosion at the base of the limestone stacks is approximately 2 cm per year. Due to wave action eroding the cliff face, existing headlands are expected to become new limestone stacks in the future.

The creation of soils can take hundreds of years; however the erosion of soils can happen very quickly. For example, a mound of loose soil on a hill can be destabilised by water or by vibrations from an earthquake. The hillside might then suddenly collapse due to gravity. The presence of plants such as trees provides a buffer against wind, and all plant roots can help bind soil, reducing the amount blown or washed away.

Australian soil

Most of Australia's landmass is away from tectonic plate margins and has been exposed above sea level for a very long time. This has allowed weathering to occur over a long period. Long-term stability, and a relatively dry climate, ensured that soil-producing activity was very slow. Igneous basalts are often the basis of rich soils. However, only small regions of such soils exist in Australia. The Liverpool Plains, near Gunnedah and north to Narrabri, are perhaps the best example of soils produced from volcanic activity in Australia (350–330 million years ago). This area has some of the deepest and most fertile soils in NSW. Australia is the flattest continent, with no high mountains, as well as the lowest, with a mean elevation of 300 m, compared with the world's mean of 700 m. Low relief contributes to low rainfall. There is little water available for weathering of rocks, and for transporting weathered material. This means that there has been little renewal of soils across most of the continent for millennia. In much of Australia, the vegetation cover is sparse, contributing to a slow rate of soil formation. Arid climate also results in lower levels of organic matter being available to enrich soils. This means Australian soils are generally very old, nutrient poor and slow forming, and need to be protected from loss by erosion.

Students' conceptions

Taking account of students' existing ideas is important in planning effective teaching approaches which 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 think that soils have always existed. This is because the rates at which soils form can be very slow. However, untended house gutters may develop a thin layer of soil in just a few years.

Students might think that rocks are hard and unchangeable because in their lifetime little natural change is visible. This is reinforced by expressions in everyday language such as 'hard as a rock'. However, some rocks might crumble easily, for example, sedimentary rocks that are made of sand, shells and pebbles that are compressed together. All rocks are susceptible to changes due to weathering; harder rocks tend to weather more slowly. Over the life of Planet Earth, its rocks have changed many times.

Students might think that the Earth's crust consists mainly of soil with some rocks embedded in it. However, the Earth's crust is primarily rock, with a thin layer of soil on top which varies in thickness.

References

- Ford, D.J. (2005). The challenges of observing geologically: third graders' descriptions of rock and mineral properties. *Science Education*, 89, 276–295.
- Hapkiewicz, A. (1999). Naïve Ideas in Earth Science. *MSTA Journal*, 44(2) (Fall'99), pp. 26–30
- Philips, W (1991) 'Earth Science Misconceptions' *Science Teacher* 58(2) pp. 21–23
- Skamp, K. (Ed.). (2012). *Teaching Primary Science Constructively* (4th Ed.). South Melbourne: Cengage Learning Australia.

To access more in-depth science information in the form of text, diagrams and animations, refer to the Primary**Connections** Science Background Resource which has now been loaded on the Primary**Connections** website: www.science.org.au/primaryconnections/science-background-resource/

Note that this background information is intended for the teacher only.

Lesson 1 Lost location

AT A GLANCE

To capture students' interest and find out what they think they know about soils, rocks and landscapes and how they change over time.

To elicit students' questions about how soils, rocks and landscapes change over time.

Students:

- discuss a map and what features of the landscape change over time
- explore soil and rock samples
- record their ideas and questions on a TWLH chart.

ENGAGE

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:

- the changes to the Earth's surface over time as a result of natural processes and human activity.

Key lesson outcomes

Students will be able to represent their current understanding as they:
• describe landscape features on a map
• create a journal entry to represent and communicate their ideas
• identify possible questions for investigation on a TWLH chart
• contribute to a class word wall
• contribute to discussions about soils, rocks and landscapes and their features.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

The term 'property' refers to an attribute of an object or material, normally used to describe attributes common to a group. However, in the case of rocks and soils it is the minerals they are composed of that exhibit these properties. For ease of understanding it is suggested that the term 'feature' is used to allow students to describe aspects of an object or material. Typically, a student description of a rock might mention some properties of minerals (hard, jagged, colour) and many that are not properties (big, small, round, smooth).

Features of landscapes might include: mountains, cliffs, headlands, beaches, dunes, canyons, valleys, roads, vegetation, buildings.

Review the Teacher background information in 'Introduction to landforms' for more information.

Students' conceptions

Students might think that the Earth's crust consists mainly of soil with some rocks embedded in it. However, the Earth's crust is primarily rock, with a thin layer of soil on top which varies in thickness.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team roles chart
- team skills chart
- 1 mystery map (see 'Preparation')
- 1 enlarged copy of 'Information note for families' (Resource sheet 1)
- *optional*: Cards or paper strips for words for the word wall

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- rock samples (see 'Preparation')
- soil sample (see 'Preparation')
- 2 clear plastic cups
- disposable gloves per team member
- 1 copy of 'Information note for families' (Resource sheet 1) per team member
- clay and sand (enough to make 3 balls)

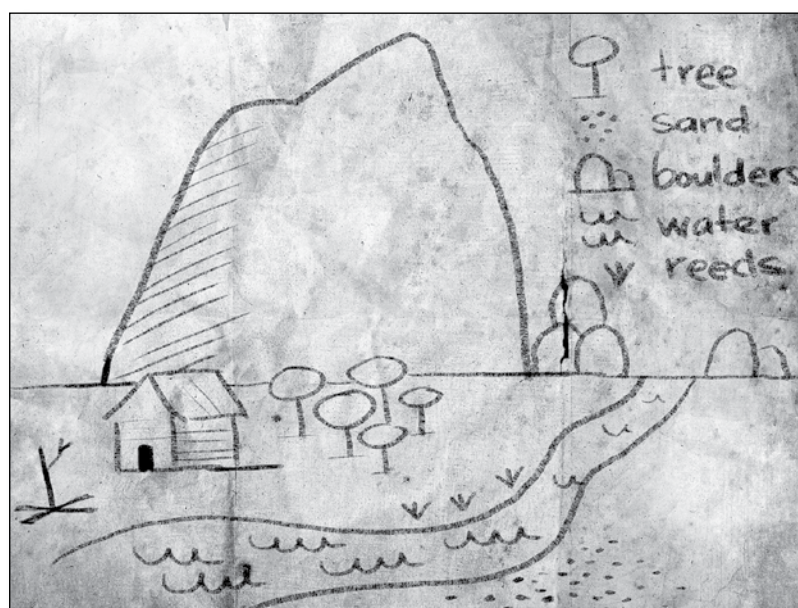
Preparation

- Check preparation requirements for all lessons in the unit so that sufficient time is allocated to collect jars and soil and rock samples.
- Read 'How to organise collaborative learning teams' (Appendix 1). Display an enlarged copy of the team skills chart and the team roles chart in the classroom. Prepare team wristbands or badges.
- 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) and prepare a large five-column chart for the class with the following headings:

Topic	What we think we know	What we want to learn	What we learned	How we know
soils				
rocks				
landscapes				

- Identify a place in the local area with rocks and soil. Collect rock samples so that each team has at least one rock to examine. Collect enough soil for each team to have a plastic cupful to study, for example, fill a 2 L ice cream container. Keep some of the soil sample (250 mL) for an activity in Lesson 2, Session 1, Lesson step 15.
- Draw a large map that might have been drawn by someone hundreds of years ago to mark the area where the rocks and soil came from using simplistic stylistic features. Include features that are likely to have changed, such as short-lived vegetation, a pile of small rocks, a stick marking the spot. Dabbing cold coffee on the paper and allowing it to dry in the sun will give it an aged appearance, as will tearing the edges and burning them with a match.



Example of a mystery map

- Decide when students will be sharing their findings from the 'Soil and rock collection' project with the class and write this information on the 'Information note for families' (Resource sheet 1). Prepare an enlarged copy of 'Information note for families' (Resource sheet 1).
- Begin collecting transparent jars with a screw top that can hold at least 400 mL of water to use in Lesson 2. The class will need four and it is advisable to have spares for students who forget to bring a jar (see 'Information note for families', Resource sheet 1).

- Prepare dried model rocks for each team to use in Lesson 4. Knead equal portions of clay and sand together ensuring the mixture stays moist. Mould balls about 2 cm in diameter and leave them to dry completely in a warm, dry place. Ensure that they are dry and hard before use. Try to keep ball size as uniform as possible. Each team will need three balls of approximately the same size. Make some spare balls in case some are damaged.
- *Optional:* Display the mystery map, the 'Information note for parents' (Resource sheet 1) and the TWLH chart on an interactive whiteboard or on a computer connected to a projector. Check the **PrimaryConnections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections/

Lesson steps

- 1 Explain to students that you have a map that could be a copy of a map drawn many years ago by explorers. Introduce the map (see 'Preparation') and the accompanying soil and rock samples.



- 2 Discuss the purpose and features of a map, asking questions such as:
 - What features does this map have?
 - Is this map similar to other maps you have seen?
 - What is different about this map? What is similar?
 - Is there evidence that humans were around when the map was made? How do you know?

Literacy focus

Why do we use a map?

We use a **map** to show where things are, how far apart they are and how to get between them.

What does a map include?

A **map** includes a title, labels, symbols and a key to explain the symbols. It might include arrows to show a path and scale to show distances.

- 3 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' ideas about the map in the class science journal.



- 4 Brainstorm ideas about what features of the map might still be useful hundreds of years later. Discuss what features might change. Record students' ideas 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.



- 5 Explain that students will be working in collaborative learning teams to observe soil and rock samples from the site. Ask students to record their thoughts and ideas about the samples in their science journals.

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 wear team wristbands or badges to help them (and you) know which role each team member has.

Draw students' attention to the equipment table and discuss its use. Explain that this table is where the Managers will collect and return equipment.

- 6 Form teams and allocate roles. Ask Managers to collect team soil and rock samples in plastic cups.



- 7 Allow time for students to investigate the samples. Ask questions such as:

- Have you seen something like this before?
- Where do you think this came from?
- How would you describe this?
- What features does it have?
- How deep beneath your feet do you think it is from?
- If you left it outside, do you think it would look the same in ... years?

Ask teams to record their thoughts on the samples in their science journals. Discuss the term 'features' (see 'Teacher background information') and record a description in the class science journal.

- 8 Introduce the TWLH chart and discuss its purposes 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.



- 9 Introduce the title and first column of the TWLH chart ('What we **think** we know'). Invite students to contribute ideas about soils, rocks and landscapes and how they change over time. Ask questions such as:

- What do we know about...?
- Where do they come from?
- How do they change?

- Why do or don't they change?
- How long does it take for them to change?

Record students' answers in the appropriate row of the TWLH chart.



- 10** Introduce the second column of the TWLH chart ('What we **want** to learn') and ask students to suggest questions they have about soils, rocks, landscapes and how they change. Record their questions on the chart.

Note: An optional opportunity for students to do research on their specific questions that are not currently answered in the *Explore* lessons is provided in the *Explain* lesson. If there is an interesting and relevant question that leads to a feasible investigation consider adding an *Explore* lesson to investigate it.

- 11** Discuss words or phrases that students know about soils, rocks, landscapes and how they change. Record students' responses on cards or paper strips. Discuss which words could be grouped, for example, words about soils. Group the words according to students' suggestions for display on the word wall. Add headings and words 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.



Invite students to contribute words from different languages to the word wall, reminding students that Standard Australian English is one of many social dialects used in Australia.



- 12** Ask students to reflect and record their ideas about the lesson activities in their science journal.

- 13** Introduce the enlarged copy of 'Information note for families' (Resource sheet 1) and read through it with the class. Discuss places that students might find soil or rock samples, for example, in their backyard. Discuss the type of information to record when taking samples, such as location, date and a description of the surrounds.

Curriculum links

English

- Discuss the words on the word wall and how English has been influenced by many other languages, for example, Latin and Greek for scientific terms.

History

- Invite students to pose a range of questions about past landscape in the local area to research.

Information and Communication Technology (ICT)

- Download Google Earth and view terrain in the local area and around Australia or the world: www.google.com/earth/
- Use Google Maps to pinpoint the school, then the suburb, the locality and the state. Invite students to take turns to find their street or use directions to find their route to school from home.
- Create a GPS (global positioning system) treasure hunt for families in the school community to local landforms. Find information on the hobby at the Geocaching website: www.geocaching.com

Information note for families

Name: _____ Date: _____

Introducing the 'Soil and rock collection' project

This term our class will explore the features of soils, rocks and landscapes in a science unit called *Beneath our feet*. As part of this unit, we are collecting rock and soil samples to compare and contrast their features.

Tasks to do

- 1 Students collect 1 cup (250 mL) of soil. Preferably this soil is not from a garden bed but from a natural area, such as a lawn or nature strip. When collecting this soil, students are asked to carefully record the location and a description of the immediate areas and attach their notes to the sample with adhesive tape. They are also to include their name and date of collection.
- 2 Students bring this soil to class, preferably in a transparent screw-top jar that can hold at least 400 mL of water.

Students are asked to bring this soil sample to class by _____

- 3 Students collect different types of rocks. Students are asked not to bring rocks that are too large or heavy, or that might cause harm due to sharp edges. Students are asked to carefully record the location of these rocks when they collect them and attach their notes to the rock, for example, with adhesive tape or a rubber band. They are also to include their name and date of collection.

Students are asked to bring their rocks to class by _____

Class teacher



Lesson 2 Studying soils

AT A GLANCE

To provide students with hands-on, shared experiences of soils and their features.

Session 1 What's in soil?

Students:

- explore and describe the features of different soils
- discuss different components of soils.

Session 2 Soil solutions

Students:

- draw an annotated diagram of their soil solutions
- discuss what components of soils could change over time.

EXPLORE

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:

- the characteristics of soil.

Key lesson outcomes

Students will be able to:
<ul style="list-style-type: none"> • contribute to discussions about different soils and how this knowledge might help communities
<ul style="list-style-type: none"> • work in teams to safely use appropriate materials to observe features of soils
<ul style="list-style-type: none"> • record observations of the characteristics of soils in a table and a labelled diagram
<ul style="list-style-type: none"> • draw conclusions about how soils change
<ul style="list-style-type: none"> • review their investigation and suggest improvements, for example, in data collection
<ul style="list-style-type: none"> • represent and communicate ideas and findings in a variety of ways, including a table.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

Soil

There are many different classifications of soil used. Geotechnical engineers classify soils according to their engineering properties as they relate to use for foundation support or building material, whilst soil scientists usually classify soils based on morphology within a soil profile. This is usually linked to how a soil is used, for example, by farmers to grow crops or in management of soils. Sometimes plants can be characteristic of certain soil types, for example, halophytes grow in soils containing salts. Soils have different properties, such as permeability (the rate at which water moves through the soil), water holding capacity (the ability of soil micro-pores to hold water for plant use), porosity (amount of small spaces or voids) and pH (a measure of the acidity or alkalinity). These properties can be used to classify soil types and depend on which components the soils are made of, and are affected by the texture of a soil.

Colour is a simple method of classifying soil as is texture. If a soil feels gritty this indicates the presence of sand, whilst a silky feeling soil has clay or silt.

Review the Teacher background information in 'Introduction to landforms' for more information.

Students' conceptions

Students might think there is only one type of soil. However, soil is an amalgamation of plant detritus, animal life, air, and products of the erosion of rocks and water. Soils reflect their place of origin and, although there are certain broad types, all soils have specific details and can change over time.

Students might not have clear ideas about what soil consists of, for example, they might not think that soil has plant material that worms eat. Although soil is not nutritious for mammals, other organisms, such as bacteria, fungi, nematodes and earthworms digest its organic material as a source of energy.

Students might not think that all soils, including 'dry soil', have water. However, water is an integral part of soils. A dry soil contains water but it is not available for plants to use.

Soil contains micro-organisms which might produce spores that some students are allergic to. Soils might also contain chemicals or treatments. It is important to ensure that students do not inhale or taste the soil. Remind students to wash their hands carefully after handling soil, even after wearing gloves.

Session 1 What's in soil?

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team roles chart
- team skills chart
- mystery map with associated soil sample (see Lesson 1)
- 1 enlarged copy of 'Exploring soil samples' (Resource sheet 2)
- 4 transparent screw-top jars
- 4 labels
- 4 small plastic bags
- source of water
- permanent marker
- self-adhesive tape

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 3 different samples of soil collected by teacher (see 'Preparation')
- 3 clear plastic cups
- 1 copy of 'Exploring soil samples' (Resource sheet 2)
- 1 transparent screw-top jar per team with sample of soil from home (see Lesson 1)
- 3 sheets of blank A4 paper
- 1 magnifying glass
- *optional*: 1 sieve
- 1 label per team member
- 400 mL water per team member
- 1 small plastic resealable bag per team member
- self-adhesive tape
- disposable gloves per team member
- A spoon

Preparation

- Allow sufficient time to collect jars and soil samples.
- Collect enough soil from at least three different locations for each team to have 1 cup (200 ml) of each sample to study. For example, fill a 2 L ice cream container at each location. Label the container with the site of collection and a number.
- Try to locate samples that have different colour, amounts of sand, clay, silt, decomposing organic matter. Near a sand pit you might find soil with high sand content. Sports fields and ovals often have higher clay content. Soil from a garden will usually have higher humus content (organic matter).

Note: Avoid using potting mix as it does not contain living materials.



- Check for student allergies to soil components, for example, potential fungal spores. Ask students not to attempt to smell the soil.
- For each team, place 1 cup (250 mL) of the first soil type in a clear plastic cup and write 'Sample 1' on the cup with a waterproof marker. Repeat for each soil type.
- Finish collecting jars to use in Lesson step 15 (see Lesson 1, 'Preparation'). Each student will need a transparent jar or hard plastic container with a screw top that can hold at least 400 mL of water, and the class will need four. If jars or containers are difficult to source then one per team will suffice.
- Organise an area for the jars to be placed and not disturbed.
- Prepare an enlarged copy of 'Exploring soil samples' (Resource sheet 2).
- *Optional:* Display 'Exploring soil samples' (Resource sheet 2) on an interactive whiteboard or on a computer connected to a projector. Check the PrimaryConnections website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

- 1 Review the previous lesson, referring to the class science journal, the mystery map and the word wall. Draw students' attention to the first two columns of the TWLH chart and ask them to recall what they thought about soils.



- 2 Introduce the three different soil samples and explain that students will be working in collaborative learning teams to examine their features. Review the description of the term 'features' in the class science journal.



Ask students not to taste or smell the soil for safety reasons. Remind students to wear disposable gloves and always wash their hands after handling soil.



- 3 Introduce the enlarged copy of 'Exploring soil samples' (Resource sheet 2) and explain that students will be filling out a table for each soil sample. Discuss the purpose and features of a table.

Literacy focus

Why do we use a table?

We use a **table** to organise information so that we can understand it more easily.

What does a table include?

A **table** includes a title, columns with headings and information organised under each heading.

Features of soil samples	
Soil sample <u>1</u>	Observations
What can you see?	Small stones, dirt, leaves it is brown, some bits are white
What can you feel?	gritty
What can you hear?	Scratching sounds

Work sample of 'Exploring soil samples'

Optional: Alternatively, assist students to construct tables in their science journal.

4 Model how to investigate a soil sample, for example:

- look at the soil through the clear plastic cup and describe characteristics, such as colours and layers
- spread the soil on a piece of paper and look for details, such as types of particles and leaves
- use the magnifying glass to look at particles closely
- rub the soil between fingers to feel its consistency
- listen as the soil is rubbed onto the paper.

Optional: Sieve the soil to separate particles according to size.

Ask students if they can think of other ways to investigate the soil.

5 Model recording results on the enlarged copy of 'Exploring soil samples' (Resource sheet 2) and by drawing observations in the class science journal.

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



7 Allow time for teams to complete the task. Ask questions such as:

- Could you tell me more about this?
- What do you mean by that?
- Can you see anything else?






8 Ask Speakers to share their results with the class. Ask questions such as:

- What did you notice?
- In what way were the soils similar?
- In what ways were the soils different?
- Can you think of other soils that you have seen that are different from all these soils?

- Why do you think it is useful to compare the soils?
- Why do you think scientists want to know about different types of soil?
- How could your findings help people in the community?

Record students' ideas in the class science journal. Remind students of the mystery map and soil samples. Discuss how the information that they have gathered could help determine a possible location on the mystery map, for example, by matching characteristics of the soils.

- 9 Ask students if they recognise the components they have described, for example, sand or clay. Introduce other terms, such as humus, and discuss their meaning. Add the words to the word wall.
- 10 Explain that students will examine soil in more detail by creating soil solutions with the soil samples they brought from home (see 'Information for families', Resource sheet 1).
- 11 Model creating a soil solution by placing 1 cup (250 mL) of one of the soils the class studied into a transparent screw-top jar. Fill the jar with water (approximately 400 mL), leaving a small space at the top and screw the jar closed. Add a label to the jar, including your name, a description of the soil used, and the date and location of collection. Discuss with students why labelling things accurately is important in scientific investigations.
-  12 Place a few tablespoons of the same soil into a small plastic resealable bag. Label the bag and attach it to the jar using adhesive tape. Discuss with students why this might be useful, for example, to be able to compare the wet soil with how it looked originally.
-  13 Discuss how to work safely with glass in the classroom. Explain that students will be asked to gently shake their jars once you have checked that the lids are screwed on tightly. Remind students to use two hands when shaking the jar and to stay away from tables and other hard furniture (if students shake too hard glass jars could break).
- 14 Ask students to create their own soil solution jars using the soil and jars they brought from home.
- 15 Create soil solution jars for the class, one for each of the soils studied during the lesson and one for the mystery soil from Lesson 1.
- 16 Ask students to watch their jar as the soil settles for a couple of minutes, and then describe in their science journal what they see. Remind students to leave their jars in a place where they will not be disturbed. The soil solutions will be examined in the next session after they have settled (see 'Preparation' for Session 2). It could take up to two weeks to settle completely depending on the soil type.
-  17 Review the TWLH chart. Record what students have learned and answer any questions that can be answered.
- 18 Update the word wall with words and images.

Exploring soil samples

Name: _____ Date: _____

Team members' names: _____

Features of soil samples

Soil sample_____	Observations
What can you see?	
What can you feel?	
What can you hear?	

Features of soil samples

Soil sample_____	Observations
What can you see?	
What can you feel?	
What can you hear?	

Features of soil samples

Soil sample_____	Observations
What can you see?	
What can you feel?	
What can you hear?	

Session 2 Soil solutions

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- Mystery soil solution (see Lesson 2, Session 1, Lesson step 15)
- 3 jars with different soil solutions collected by the teacher (see Lesson 2, Session 1, Lesson step 15)

FOR EACH STUDENT


(or team if sufficient jars are hard to source)

- role wristbands or badges for Director, Manager and Speaker
- science journal
- jar with soil solution brought from home (see Lesson 2, Session 1)
- ruler
- 1 magnifying glass

Preparation

- Check that student's soil solutions have had enough time to settle. The water should be clear, and the soil should be deposited in layers at the bottom with organic matter possibly floating at the surface. This could take two weeks or more, depending on the soil type. The longer it rests the clearer the water will become.

Lesson steps

- 1 Review the previous session using the class science journal, the TWLH chart and the word wall. Focus students' attention on the three soil samples they explored in Lesson 2, session 1.
- 2  Allow time for students to examine the three soil solutions made from the soils they explored. Discuss similarities and differences between the solutions. Record students' responses in the class science journal.
- 3 Explain that students will be creating labelled diagrams of their soil solution in their science journal. Discuss the purpose and features of labelled diagrams, in particular the focus on accurate representation of the object representing scale.

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.



Sample of a labelled diagram



- 4 Model how to use a ruler to measure the dimensions of the jar. Ask students to record the measurements of each layer next to their drawing. Discuss the importance of observation in scientists' work, and the importance of drawing accurate representations.

- 5 Ask students to carefully pick up their soil solution jars and bring them to their desk ensuring they aren't bumped otherwise some layers might disappear with their components mixing in the water again. Allow time for students to complete the task.



- 6 After students have completed their observations and drawings, ask them to share their findings about their soil solutions with a talking partner, for example, the person sitting next to them. Ask questions such as:
- Do the soils look similar? Why or why not?
 - Do the soil solutions look similar? Why or why not?
 - Are there differences between your soil solution and your partner's?
 - Why do you think this is?

Ask students to also compare their soils in the plastic resealable bags attached to their soil solutions.

Optional: Allow time for students to examine other soil solutions in the class. As a class, group different soil solutions according to their characteristics.



- 7 Ask students to discuss some of their findings by asking questions such as:
- What is similar about your soils?
 - What is different about your soils?
 - What kinds of things are soils made of?
 - Where do the living things come from?
 - How are the non-living things formed?
 - Why are there different-sized pieces in the soil?

Record students' answers in the class science journal.

- 8 Remind students of the mystery map and the soil sample that came with it. Introduce the soil solution of the mystery soil. Discuss with students whether it resembles any of the samples they have seen, and where they are from. Ask students how they could use this technique to help identify where soils are from.



- 9** Discuss with students what components of soils might help scientists identify things about the surrounding environment, for example, specific mineral components or specific types of plants. Ask questions such as:
- How do you think soils change over time?
 - What things might mean that soils change, for example, if the vegetation changes?
 - What do you think you did well in the soil solution activity? If you were to repeat it would you do it differently? Why? How?

Record answers in the class science journal.

- 10** Ask students to compare the colour and consistency of their soil samples to identify similarities and differences between areas that students live in.
- 11** Ask students to reflect on their learning by completing the following sentence starters in their science journal:
- Today we...
 - I learned that...
 - Things I'm not sure about...
 - Things I'm interested to find out about are....



- 12** Review the TWLH chart. Record what students have learned and any questions that can be answered.
- 13** Update the word wall with words and images.
- 14** Ask students who want to keep their soil solution to bring in a fresh jar for the next lesson. Keep the soil solutions created for the class.

Curriculum links

Science

- Discuss features of soils, for example, water-holding capacity and acidity.
- Investigate the relationship between plants and different types of soil, for example, some plants require specific soil features to thrive or survive.

Lesson 3 Rock hard?

AT A GLANCE

To provide students with hands-on, shared experience of rocks and their features and how they have changed over time.

Students:

- work in teams to examine the features of different rocks
- describe rocks using a game of 'Twenty questions'
- discuss how to choose rocks for a purpose based on their features.

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:

- the characteristics of rocks.

Key lesson outcomes

Students will be able to:
• contribute to discussions about rocks, their features and how this knowledge can be used in communities
• discuss what types of data to collect about rocks
• work in teams to safely use appropriate materials to observe different features of rocks
• record their observations, including using an accurate labelled diagram
• identify how features of rocks can be used to help with scientific classifications
• represent their ideas about features of rocks in their science journal.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

Features of rocks

A rock is made of mineral materials in a solid state. Geologists use features such as the mineral composition and the shape, size and orientation of the fragments in the rock to classify rocks according to their origin. Both the composition of the minerals and the circumstances under which it was formed determine the features and properties of the rock. Some commonly measured properties include:

- **Density:** the ratio of mass to volume for a material. Measuring identifies tell you if a material is heavy for its size. A rock that floats in water is less dense than water.
- **Hardness:** how resistant solid matter is to various kinds of permanent shape change when a force is applied. A common measure is to see whether the rock scratches different surfaces to determine if it is harder than the material it is being scratched against. Hardness is usually measured for minerals rather than rocks. The hardest mineral known is diamond whilst the softest is talc. The Mohs hardness scale developed by Fredrich Mohs ranks 10 common minerals based on their hardness.

Review the Teacher background information in 'Introduction to landforms' for more information.

Students' conceptions

Students might think all rocks have the same properties and features, for example, they might think rocks are all heavy. However, some rocks, for example, pumice, can be quite light. The classification of an object as a rock is not determined by size, and sand can be considered as loose rocks. Students might not realise that 'pebble' and 'boulder' are categories of rocks based on size rather than being different things.

Different rocks have different properties. The features might be due to the composition of the rock (colour, texture, reaction to acid) or due to the shape of the rock (jagged or smooth, large or small). Scientists distinguish rocks based on their intrinsic characteristics (the size and nature of its minerals and their properties) rather than on external characteristics that can be influenced by other things (a rock can be weathered or polished to change its shape).

Students might not recognise synthetic rocks such as concrete as being rocks. Also, they might think that natural rocks that have been cut and polished by people, for example, marble, are synthetic.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- 4 soil solutions (see 'Preparation')
- collection of rocks (see 'Preparation')
- *optional*: bucket full of water for density testing

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- a collection of rocks (see 'Preparation')
- 3 paper towels or cleaning cloths
- 1 magnifying glass
- *optional*: old glass to scratch for hardness testing
- *optional*: ½ cup of vinegar to clean the rocks with

Preparation

- Read 'How to facilitate evidence-based discussions' (Appendix 5).
- Place the four class soil solutions on display (see Lesson 2, Session 2).
- Remind students to bring samples of rocks from home (see 'Information note for families', Resource sheet 1).
- Collect a variety of different rocks for the class to also examine, such as granite, limestone and a soft sedimentary rock, for example, chalk. If your selection has limited variety consider adding a rock kit or a museum loan collection.
- Access information on how Indigenous Australians used knowledge of rocks to create tools. If you have contact with local Indigenous community members and/or Indigenous Education Officers (see page 6) invite them to discuss what they know about the traditional tools. Alternatively, information can be found on websites such as www.ghcma.vic.gov.au/community/cultural-heritage/aboriginal-tools



Lesson steps

- 1 Review the previous lesson using the class science journal, TWLH chart and word wall. Ask questions such as:
 - How would you describe the soil samples you observed?
 - What did you find in the soil?
 - Where do you think the particles came from?
- 2 Explain that students will be working in collaborative learning teams to examine the characteristics of the rocks that they have brought in (see 'Preparation').
- 3 Brainstorm with the students the kind of things they might examine, for example:
 - what it looks like, for example, colour, shape, size of grains
 - what it sounds like when you rub it on paper



- whether it scratches glass (the property of hardness)
- whether it floats or sinks in water (the property of density).

Record students' answers in the class science journal. Introduce the terms 'hardness' and 'density' (see 'Teacher background information') and record a description of them in the science journal. Add new vocabulary to the word wall.



- 4** Explain that each collaborative learning team will examine the rocks that they have collected using magnifying glasses. Each team member will be responsible for recording at least one different labelled diagram of a rock sample with accompanying descriptions. Review the purpose and features of a labelled diagram (see Lesson 1).

Optional: Rocks can be cleaned with vinegar to enable better observations.



- 5** Form teams and allocate roles. Ask Managers to collect team equipment. Allow time for teams to complete the task. Ask questions such as:

- Can you tell me more about this?
- What do you mean by that?
- Could you explain what you did?
- I wonder what would happen if...?



- 6** Ask the Speaker from each team to share their team's observations. Ask students in the audience to use the 'Science question starters' (see Appendix 5) to ask each team about their investigation.

- 7** As a class discuss how different rocks can have different properties and characteristics, for example, not all rocks are 'hard'.

Optional: Ask students to complete the rocks and soils activity at www.bbc.co.uk/schools/scienceclips/teachersresources/ages7_8/tr_rocks_soils_lp.shtml

Ask questions such as:

- What properties of rocks did the activity allow you to test?
- What did you discover about different rocks?

- 8** Ask students to think of a series of Yes/No questions, for example, from a game of 'Twenty questions' that would allow them to quickly determine which rock in the classroom another student is thinking of. For example, is it bigger than my hand? Is it a dark colour?



- 9** Allow time for students to practise the game with each other. Discuss as a class which questions were about the properties of the material of the rock (hardness, density) and which were the characteristics of the object (for example, the size). Discuss how questions about characteristics of the material of the rock might be used to determine the scientific names of rocks, to catalogue a collection or to help identify where it was found.



- 10** Discuss how communities, including Indigenous Australians, have used the properties of rocks to create tools. Ask students if they can think of examples from their communities. Introduce information collected (see 'Preparation'), asking questions such as:

- Why do you think that tool was selected for that purpose?
- What other properties could be useful to consider when choosing a rock to create a tool?



- 11** Remind students of the mystery map and the accompanying rocks. Ask questions such as:

- Does anyone have rocks that look like this one?
- Do you think the rocks might help us identify the place shown in our mystery map?
- Do you think rocks remain the same over time? Why or why not?

Record answers in the class science journal.



- 12** Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

- 13** Update the word wall with words and images.

Curriculum links

History

- Share narratives detailing the influx of migrants in search of gold in the mid to late 1800s.

Lesson 4 Rollin' rock

AT A GLANCE

To provide students with hands-on, shared experiences of rocks and how they change over time.

Students:

- investigate a model of the physical weathering of rocks
- discuss how rocks might change over time.

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:

- the changes to rocks over time as a result of natural processes.

Key lesson outcomes

Students will be able to:
• identify the features that made their investigation a fair test and why scientists use models in their work
• follow a procedural text to investigate a model of the weathering of a rock in a stream
• work in teams to identify and safely use appropriate equipment to test whether water weathers rocks
• record their measurements and observations and present their results in a table
• discuss and compare their results with the class to form common understandings
• reflect on their investigation
• represent their ideas about characteristics of rocks in their science journal.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

Mechanical weathering

Mechanical weathering is the physical breaking down of rocks into smaller pieces. Wind and water can break off pieces of rocks as they move past them. Ice can also cause weathering, for example, if water drips into a crack in a rock it will expand as it freezes, putting pressure on the crack. Also, glaciers can scrape underlying rock as they move through a valley. Abrasion from living things such as animals can break rocks into smaller pieces. Plant roots can grow into crevices in rocks, forcing the cracks wider until the rock breaks.

In this lesson, students model a rock being tumbled in a river or stream. As the water flows, it moves the rocks downstream. During this process, the rocks are rubbed together and small pieces are broken off. Eventually, this causes the characteristic smoothness of river rocks. However, the model rock balls used in this activity are much softer and break down much more quickly than real rocks.

Validity of investigation results

In this lesson, the students investigate what happens to a rock in a stream by shaking a model rock ball in a jar of water. The students will be looking for changes in the size of the ball after shaking for a few minutes. Some students may be concerned about the accuracy of their ball measurement as they tend to change shape as well as size during the process. The students might suggest ways to measure so that the results are comparable across teams, for example, they might want to use a set of scales to measure the mass rather than measure the circumference of the ball. If scales are used, ensure that they can measure small masses.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team roles chart
- team skills chart
- 1 enlarged copy of 'Weathering investigation planner' (Resource sheet 3)
- 4 soil solutions (see 'Preparation')
- bottle of frozen water (see 'Preparation')
- *optional*: measuring scales for light masses

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Weathering investigation planner' (Resource sheet 3) per team
- 1 tape measure
- 3 screw-top jars
- 3 balls of dried clay-sand (see 'Preparation', Lesson 1)
- 1 spoon to scoop out the ball of clay-sand
- 500 mL water
- 1 stopwatch or wristwatch with second hand
- newspaper to protect the working surface

Preparation

- Read 'How to write questions for investigation' (Appendix 6).
- Read 'How to conduct a fair test' (Appendix 7).
- Read 'How to construct and use a graph' (Appendix 8). This lesson involves constructing a graph. Students might require a lesson on graphing if they have not recently engaged with graphs.
- This lesson involves measuring 500 mL of water. Students might require a lesson on measuring volume if they have not recently engaged with this skill.
- Place the four class soil solutions on display (see Lesson 2, Session 2).
- Enlarge a copy of 'Weathering investigation planner' (Resource sheet 3).
- *Optional:* Display the mystery map and the 'Information note for parents' (Resource sheet 1) on an interactive whiteboard or on a computer connected to a projector. Check the PrimaryConnections website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections
- Fill a plastic bottle to the brim with water, screw the lid on and freeze it. The expanding ice will damage the bottle which simulates similar processes that can happen in rocks.
- Ensure students are provided with jars that do not break easily when shaken with rocks inside. An added precaution is to first wrap glass jars in a cloth bag so students are not directly holding the glass or alternatively use plastic jars.



Lesson steps



- 1 Review the previous session using the class science journal, TWLH chart and word wall.
- 2 Introduce the frozen bottle and ask students to describe what they think happened. Ask questions such as:
 - Why do you think this happened?
 - What do you think would happen if water got into rock crevices and froze?
 - Can you think of other ways that water might wear away at things?



- 3 Ask students to describe rocks they have seen in rivers. Ask what things might affect how smooth river rocks become over time (how fast the river flows, the hardness of the rocks, the size of the rocks, how long the rocks have been in the river, what the rocks are made of, the temperature of the water).
- 4 Explain that students will be working in collaborative learning teams to investigate what happens to a rock when water flows over it in a stream.
- 5 Introduce the balls of dried clay-sand. Explain that the dried ball will be used as a model of a soft rock for the investigation, and shaking it in a bottle of water will be used to simulate water flowing over the rock. Discuss the importance of using models in a scientific investigation. For example, if the system being investigated is too large and/or the processes are too slow, then models can be used as a simulation. Discuss the limitations of using models.



- 6 Ask what things might affect the clay-sand ball if it is shaken with water. Use students' answers to make a list in the class science journal, for example:

- the size of the ball
- what the ball is made of
- the hardness of the ball
- the amount of water
- the type of liquid
- the size of the jar
- how hard it is shaken
- how long it is shaken.

- 7 Introduce the term 'variables' and discuss that in an investigation these are the things that can be changed, measured or kept the same. Ask students why it is important to keep some things the same when measuring the changes (to make the test fair, and so we know what caused the observed changes). Explain that when a variable is kept the same it is said to be 'controlled'.



- 8 Introduce students to the process of writing questions for investigation. Model how to develop a question, for example:

- What happens to the size of a clay-sand ball when we change what the ball is made of?
- What happens to the size of a clay-sand ball when we change how hard we shake it?
- What happens to the size of a clay-sand ball when we change the time we shake it?



- 9 Introduce the enlarged copy of 'Weathering investigation planner' (Resource sheet 3). Explain that students will be investigating the question:

'What happens to the size of a clay-sand ball when we change the time we shake it?'

Model how to record this on the planner.

- 10 Ask students to predict what they think will happen, and indicate where they will record this in the planner. Ask them to include a scientific explanation for their opinion after discussion with their team mates.



- 11 Ask questions such as:

- What would happen if we used different-sized balls in the different jars?
- What would happen if we had water in some jars and not others?
- What would happen if we put different amounts of water in the jars?

- 12 Ask students how they will manage the variables in the investigation to make it a fair test. Indicate where they will record this on the planner. If students haven't conducted fair tests before, conduct a class brainstorm and record on the enlarged planner that teams will:

- **Change:** the time of shaking
- **Measure/Observe:** the size of the clay-sand ball after shaking
- **Keep the same:** the size of the ball, what the ball is made of, the hardness of the ball, how hard it is shaken, the type of liquid, how much water is used, the size of the jar.



13 Read through the remaining steps on the investigation planner and model where appropriate. Ask question such as:

- Why compare the shaken clay-sand ball to a clay-sand ball that was immersed in water without shaking? (To check it is the shaking in water and not the water alone that caused the change.)
- How will we measure the ball? (Use a tape measure and measure the diameter or circumference.)



Ask students to gently shake the jars to mimic water washing over the rocks rather than shaking it violently which could break the glass.



14 Discuss the 'Recording results' section of the 'Weathering investigation planner' (Resource sheet 3) and discuss how to record measurements of the dried balls. Explain teams will also record observations of the water immediately after they have shaken the jar and then after it has been left to stand for some time.



15 Form teams and allocate roles. Ask Managers to collect team equipment. Allow time for students to conduct the investigation and record their results.



16 Share team findings with the class, discussing ways to represent the data in a way that communicates their findings clearly.

17 Model how to construct a graph to represent the information that teams recorded in the table of their copy of 'Weathering investigation planner' (Resource sheet 3).

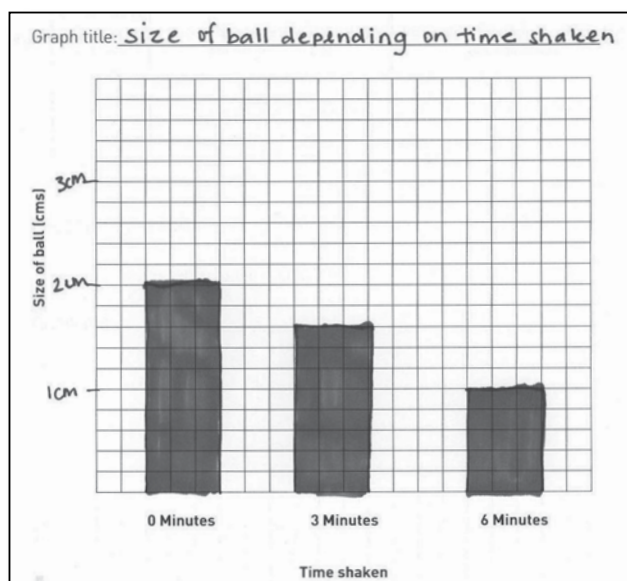
Literacy focus

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.



Sample of a column graph

Discuss with students the conventions of constructing a scientific graph. The vertical axis (Y axis) usually represents the thing (variable) we measure and the horizontal axis (X axis) the thing (variable) we change.

Note: As the data for both variables are continuous, a line graph would be the conventional method to represent the findings from this investigation. It is suggested, however, that students construct a column graph as this is appropriate for Year 4 students. You might produce a column and a line graph and discuss with students why a line graph would normally be used to represent the data.



- 18** Ask students to construct their graphs and observe what their water now looks like. Allow time for students to record measurements and observations,

- What changes can you see?
- How was the water different after you shook the jar?
- How has the size of the ball changed?
- What can you see in the bottom of the jar?



- 19** Invite each team to share their observations and results. Ask students in the audience to use the 'Science question starters' (see Appendix 5) to ask each team about their investigation.



- 20** As a class discuss what conclusions can be drawn from the collected results, asking questions such as:

- What did we learn about what happens to dried balls when shaken in water?
- How did each team measure their clay-sand ball? Can we compare results from each team? Why/Why not?
- What do you think this simulation might help explain about real-life weathering?
- Why do you think scientists use models to gather information? Can you think of any jobs in the workforce where models or simulations are used?



- 21** Review the investigation as a class, asking questions such as:

- What can we conclude about the effect of water on rocks?
- What challenges did you experience doing this investigation?
- How might you overcome them?

- 22** Introduce the class soil solutions and compare them to the jars of water with settled particles of clay-sand. Ask students questions such as:

- What is similar about these jars?
- Where do you think the minerals in soils might come from?



- 23** Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

- 24** Update the word wall with words and images.

Optional: Provide opportunities for students to investigate the alternative questions for investigation that they posed in Lesson step 8.

Weathering investigation planner

Name: _____ Date: _____

Team members' names: _____

What are you going to investigate?		What do you think will happen? Explain why.
What happens to _____? when we change _____?		
Can you write it as a question?		Give scientific explanations for your prediction.
To make the test fair, 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?
Describe how you will set up your investigation.		

Question for investigation

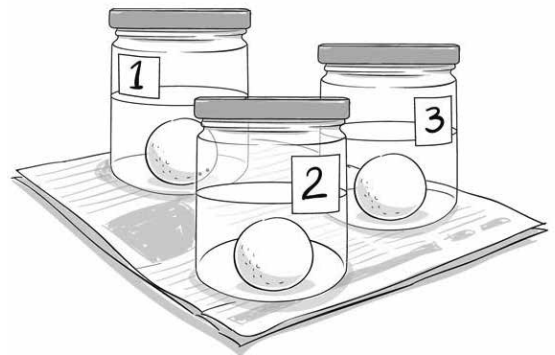
What happens to the size of the ball when we change the time it is shaken?

What equipment does the team need?

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- tape measure
- 3 screw-top jars
- 3 dried clay-sand balls
- 1 spoon to scoop out the ball of clay/sand
- 500 mL water
- 1 stopwatch or wristwatch with second hand
- newspaper to protect the working surface

What will we do?

- 1 Put one ball of dried clay-sand in each jar.
- 2 Label the jars '1', '2' and '3'.
- 3 Half fill the jars with water.
- 4 Screw the lid of the jars on tightly.
- 5 Leave jar number 1 without shaking it.
- 6 Take turns to **gently** shake jar number 2 for 1 minute each.
- 7 Take turns to **gently** shake jar number 3 for 2 minutes each.
- 8 Record what the water in the jars looks like.
- 9 Scoop out the balls from the water with the spoon.
- 10 Measure the size of each ball and record in the 'Recording results' section of the planner.



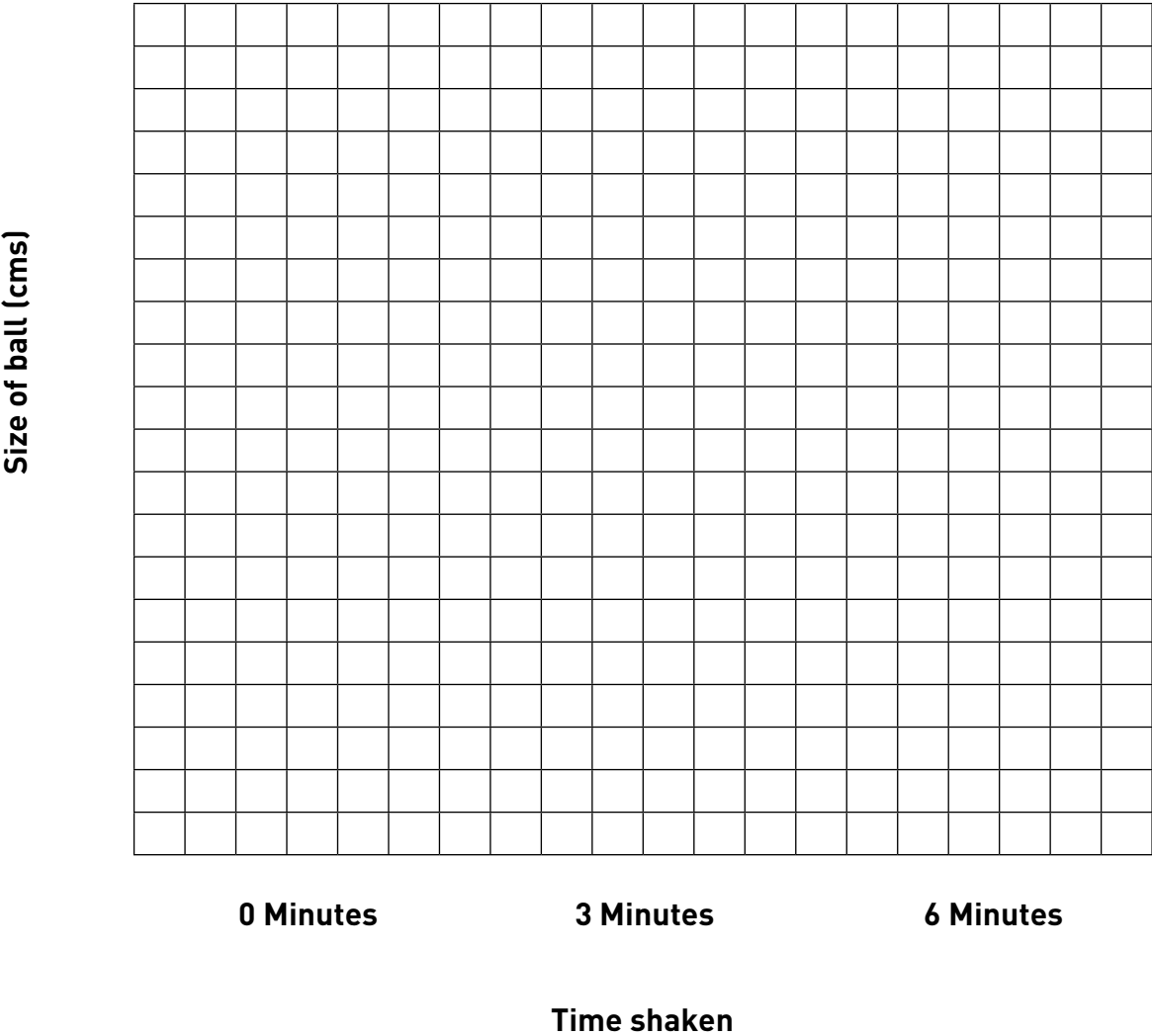
Recording results

Jar	Measurement of ball after removed from water	Description of water immediately after removal of ball	Description of water ____ mins after removal of ball

Presenting results

Can you show your results in a graph?

Graph title: _____



Lesson 5 Modelling mountains

AT A GLANCE

To provide hands-on, shared experiences of how features of the landscape change over time.

Students:

- investigate the effect of water erosion on the landscape through the use of models
- discuss how water erosion could affect landscapes.

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 Earth's surface changes over time due to natural processes.

Key lesson outcomes

Students will be able to:
<ul style="list-style-type: none">• work in teams to follow a procedural text
<ul style="list-style-type: none">• investigate what happens to models of landscapes when water is poured over them
<ul style="list-style-type: none">• record their observations using an annotated diagram
<ul style="list-style-type: none">• contribute to discussions about water erosion, how it shapes and impacts landscapes and how it can be influenced by human impact.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

Erosion

Erosion is the removal and transport of rocks and weathered material, for example, soil. It helps to shape landscapes. Erosion is a natural process that can be affected by human activity. Erosion, especially in Australia, is a serious concern given the slow-forming ancient soils prevalent in this country. Farmers are particularly concerned about erosion if it removes the soil required for crop growth. Living things, for example, plants both help and hinder erosion. Plant roots bind soil, reducing wind erosion, but can also help weather rocks. Farmers in windy areas often plant rows of trees between their fields. This slows down the wind at ground level, which reduces the amount of soil lost to erosion.

The structure of the Earth's surface

There are three main layers at the surface of the Earth: topsoil, subsoil and bedrock. Topsoil contains decomposed remains of living things (mostly plants) mixed with fine particles of broken down rocks. Subsoil contains larger rock particles and usually little or no plant material. The bedrock is the parent material which, when broken down, forms large and small rocks and when further broken down forms the bulk of the soil. These layers can often be seen in road cuttings.

The use of scientific models

The physical world is a complex ecosystem with millions of variables. Scientists use models to help engage with a concept or to produce testable hypotheses. Often the model is a simplified version of reality, and the ability of the model to fit the actual observations tells scientists whether their simplifications were justified or not. Models can be expressed physically, for example, creating the model of a mountain in a tray; by the written word, for example, saying that 'DNA is like a computer program'; by a mathematical formula; or by a combination of these. These models are all expressions of a current theory to be tested.

Models have limitations to their power of explanation and representation. For example, sand does not model soil erosion completely or soil may have plant roots which help stop erosion. A scientist will acknowledge and describe the limitations of any scientific model devised. Information gathered from experiments can support or discredit a scientific model.

Using scientific models to represent scientific phenomena can assist students to develop their understanding. Effective teaching includes discussion of the way in which models represent a concept and ways in which they might not.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team roles chart
- team skills chart
- enlarged copy of 'Procedure: Exploring water erosion' (Resource sheet 4)
- images of cut-away hillsides (see 'Preparation')
- source of water
- *optional*: camera

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- copy of 'Procedure: Exploring water erosion' (Resource sheet 4)
- 1 large disposable aluminium tray
- sand
- rocks, plastic containers or building blocks (see 'Preparation')
- 1x 500 mL bottle
- 1 bucket
- 1 thick book, wrapped in plastic
- scissors

Preparation

- Locate an area for the students to complete this activity with no electricity sources, such as a wet area or a veranda.
- In this activity, students will be modelling landscapes which are composed of bedrock and soil. Students will first build the landscape with rocks or something that models rocks, for example, plastic containers or wooden building blocks. Collect enough for teams to create different rock formations.
- Collect photos of exposed hillsides and rock faces, for example, using websites such as www.commonswikimedia.org
- Enlarge a copy of 'Procedure: Exploring water erosion' (Resource sheet 4).
- *Optional*: Display 'Procedure: Exploring water erosion' (Resource sheet 4) on an interactive whiteboard or on a computer connected to a projector. Check the **PrimaryConnections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

- 1 Review the previous lessons referring to the class science journal and the word wall. Draw students' attention to the first two columns of the TWLH chart and discuss what they thought they knew about landscapes and landscape formation and how their ideas are changing.
- 2 Ask students to think about what they would encounter if they dug a hole as big as a skyscraper below a grassed area in the schoolyard. Ask students to draw an annotated diagram in their science journal of what they think is below their feet for that distance. Discuss the purpose and features of an annotated diagram.



Literacy focus

Why do we use an annotated diagram?

We use an **annotated diagram** to show the parts of an object and what they do.

What does an annotated diagram include?

An **annotated diagram** might include an accurate drawing, a title, a date and a few words about each of the parts. A line or arrow joins the words to the part.



- 3** Ask students if they have seen areas where hills have been cut for a road to go through, or where deep digging has occurred. Introduce the photos (see 'Preparation') and ask questions such as:

- Did you see a lot of rock in those cut layers?
- How does this information fit with what you think you know?
- What questions do you have?

Explain that scientists have found that we stand on a relatively thin amount of soil under which is a solid layer of rocks that extends for kilometres.



- 4** Ask students how they think landscapes can change over time, asking questions such as:

- What parts of the landscape might change?
- How might these changes occur?
- Can rocks and soil change? How?
- How might we investigate how landscapes change?

Discuss the term 'erosion' and add a description to the class science journal. Discuss how human activity can impact on erosion and how the impact of erosion caused by water is a serious concern for farmers.

Optional: Visit local sites in the school grounds or surrounding areas where erosion is visible.



- 5** Explain that students will be working in collaborative learning teams to explore how water erosion can affect the landscape. Form teams and allocate roles. Ask students to brainstorm ways to explore water erosion.

If students are experienced in student-focused investigations, allow teams to carry out their proposed tests or ask all teams to conduct the same tests collaboratively agreed on by the class. Alternatively, use the following procedure to assist students to learn ways to conduct investigations using models.

- 6** Introduce the enlarged copy of 'Procedure: Exploring water erosion' (Resource sheet 4) and discuss it with the class. Explain that it is a procedural text and discuss its purpose and features.

Literacy focus

Why do we use a procedural text?

We use a **procedural text** to describe how something is done. We can read a **procedural text** to find out how to do things.

What does a procedural text include?

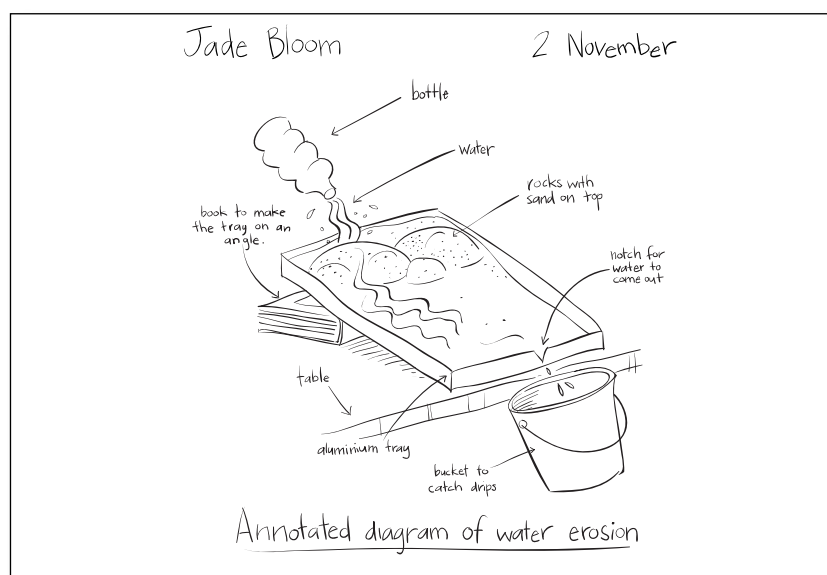
A **procedural text** includes a list of materials needed to do the task and a description of the sequence of steps used. It might include annotated diagrams.

- 7 Model building a landscape by piling rocks or similar and then heaping sand on top (see 'Preparation'). Discuss the limits of the model, ask questions such as:

- What does this represent?
- Is it an accurate representation?
- In what ways it is similar/different?
- How does this affect the conclusions we can make?
- Why do you think scientists use models in their work?

Record students' answers in the class science journal.

- 8 Explain that teams will model landscapes by piling bricks and blocks and covering them with sand. Discuss what each element represents. Discuss that the model will be of water erosion of soils. Remind students that weathering also occurs.
- 9 Explain that students will draw an annotated diagram of the landscapes they sculpt before they have poured water on them.



Sample of an annotated diagram

Model drawing an annotated diagram of a landscape in the class science journal. Explain that students can draw modifications to the landscape from water erosion in a different colour once the investigation is complete.

Optional: Ask students to take photographs of their landscapes before and after investigation.

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



11 Remind teams to complete the annotated drawing before pouring the water.



12 Remind students to pour the water at the top of the tray at a consistent rate for each test. Ask questions such as:

- What would happen if you only poured water on this spot?
- What would happen if you carved a path down the hill for the water before pouring?
- What would happen if the slope was different?

Ask students to record additional observations in their science journals.



13 Invite Speakers to share observations with the class. Ask students in the audience to use the 'Science question starters' (see Appendix 5) to ask each team about their investigation.



14 Discuss the results as a class, asking questions such as:

- What have we learned about how water erosion affects landscapes?
- Who might use this information in their work?
- What do you think this model helps us understand about real-life landscapes?
- What other elements does this model **not** take into account, for example, wind, plant life, weathering of rocks?



15 Discuss how hills gradually change shape but remain similar over the lifespan of a human. Discuss advantages of using different features of landscapes to mark something on a map, for example, sand dunes can easily change position and trees can fall down whereas rocks weather slowly. Ask questions such as:

- How do you think the water erosion could be reduced?
- How does human activity can impact on erosion of the landscape?



16 Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

17 Update the word wall with words and images.

Curriculum links

Maths

- Explore statistics of Australia's oldest landforms (ACMNA052), for example, by visiting www.ga.gov.au/education

Procedure: Exploring water erosion

Aim: To explore the effect of water erosion using a model

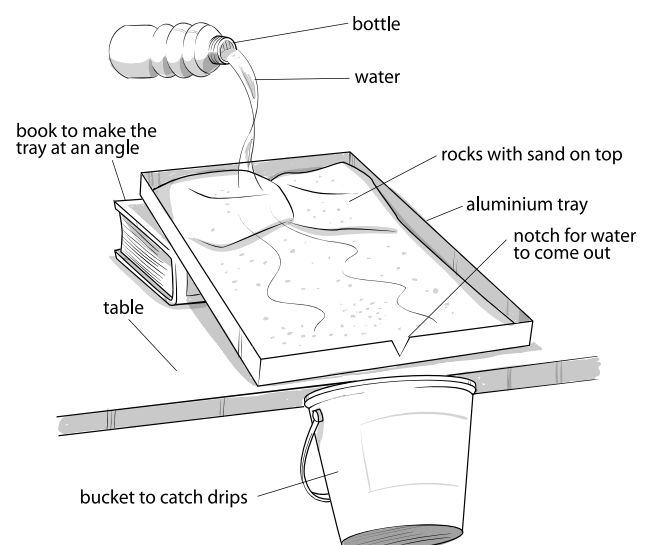
Equipment

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 large disposable aluminium tray
- sand
- rocks, plastic containers or building blocks
- 500 mL bottle
- 1 bucket
- 1 thick book
- plastic to cover the book
- scissors
- water

Activity steps

- 1 Cut a notch in one side of the aluminum tray for water to come out.
- 2 Pile the rocks or similar to create a landscape.
- 3 Pour sand over the rocks to simulate soil.
- 4 Draw an annotated diagram of the landscape in your science journal.
- 5 Prop up the end of the tray opposite the notch on the book to ensure the water flows downwards.
- 6 Hold the bucket under the notch to catch the overflow of sand and water.
- 7 Using the bottle, pour the water on a specific area of the landscape.
- 8 Observe how the water flowing interacts with features of the landscape.
- 9 On your annotated diagram, mark the areas where water was poured.
- 10 Using a different-coloured pen, on the annotated diagram draw how the water has affected the landscape.



Lesson 6 Fabulous formations

AT A GLANCE

To support students to represent and explain their understanding of soils, rocks and landscapes and how they change over time, and introduce current scientific views about how landscapes are formed over time.

Students:

- respond to pictures about landforms
- read and discuss a factual text about the origin of Uluru
- discuss theories of how a landscape might change in the future through erosion.

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 important 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 Earth's surface changes over time as a result of natural processes and human activity.

This allows you to provide feedback to help students further develop their understanding.

Key lesson outcomes

Students will be able to:
• contribute to discussions about how landforms are shaped by erosion
• read and interpret factual texts
• make claims about what a landscape might look like over time
• represent and communicate their ideas in a variety of ways.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

Rock formations

Some geologists study the composition of rocks and of rock layers and some use this information to try to understand how rock formations came to be. The founding principles of studying rock layers were recorded in the 17th century and are still used today but with more understanding of the exceptions to the principles. The three main principles are those of superposition—that sedimentary layers are deposited in a time sequence, with the oldest on the bottom and the youngest on top; original horizontality—that sediments are originally deposited in horizontal layers; and lateral continuity—that layers of sediment are originally deposited in continuous layers. However, there are many exceptions to these principles.

As with all scientists, geologists believe that the principles at work today have worked in much the same way in the past (principle of uniformitarianism). As a rule of thumb for developing hypotheses, scientists use the principle of Occam's razor, or that the theory with the least new assumptions is more likely to have the best explanatory power. Therefore, if one idea works well within existing ideas and another requires many very special conditions and exceptions to the rule, then scientists will prefer the first. However, this is not a measure of truth, rather it is a practical method of guessing the probability of a scenario.

Erosion and landscapes

Erosion is the transport of particles from one place to another, for example, soils and particles that are produced when a rock is weathered (is broken down through natural elements into smaller particles). The combination of weathering and erosion wears down exposed rocks, making molehills out of mountains. This is counteracted by the uplift of landscapes through tectonics and volcanism. Australia is a particularly flat island continent since its landscapes have been exposed for a long time with no recent tectonic activity.

Erosion takes particles away but they are eventually deposited somewhere. Many particles end up in the sea or in lakes where they accumulate and form sediments that can eventually become new rocks. Human activity affects erosion by exposing landscapes to more weathering and erosion, for example, by removing soil cover and roots that bind the soil, but also by stopping erosion through building dams and shoring up cliff faces.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team roles chart
- team skills chart
- mystery map with associated soil and rock samples (see Lesson 1)
- 1 enlarged copy of 'Red rock rising' (Resource sheet 5)
- *optional*: collection of multimedia resources (see 'Preparation')
- images (landmarks by erosion)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Red rock rising' (Resource sheet 5) per team member
- 1 copy of the mystery map
- *optional*: material to create multimedia presentations

Preparation

- Gather images of landmarks shaped by erosion. Australian examples include: 'The Twelve Apostles', 'Wave Rock' and 'Uluru'. Use websites such as:
www.commonswikimedia.org
www.sciencera.com/earth-sciences/geology/worlds-most-impressive-rock-formations
- *Optional*: Identify multimedia resources, including books, photos and videos to help students access the science of erosion and the formation of landscapes. Useful websites include:
www.parkweb.vic.gov.au
www.qwiki.com
www.mrsciguy.com/weathering.html
www.teacher.scholastic.com/dirtrep/index.htm
www.thelearningfederation.edu.au
www.minerals.org.au/primary
 Scope: Earth and space TV series (9 episodes available through Enhance TV).
- Prepare an enlarged copy of 'Red rock rising' (Resource sheet 5)
- *Optional*: Display the collected photos and videos, and the enlarged copy of 'Red rock rising' (Resource sheet 5) on an interactive whiteboard or on a computer connected to a projector. Check the PrimaryConnections website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

- 1 Review the previous lessons, referring to the class science journal, word wall and TWLH chart. Remind students of the mystery map and samples, asking questions such as:

- Have we found out which area we think the mystery map is from? What clues did we use?
- Did the landscape always look like that?
- Will it look the same tomorrow?
- Do you think it would look the same in thousands of years?

Record students' answers in the class science journal.



- 2 Introduce photos of strongly eroded landscapes (see 'Preparation') and ask questions such as:

- Do you recognise this landform?
- Why do you think it looks like this?
- What might it have looked like a long time ago?

- 3 Ask students, as a class or individually, to read through the factual text 'Red rock rising' (Resource sheet 5), highlighting any key words, dates or names that might be relevant and/or important in explaining the origin of Uluru. 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.

- 4 Discuss the terms that students have highlighted in 'Red rock rising' (Resource sheet 5). Add each word with a brief description if necessary to the word wall.
- 5 Discuss the model of what the area around Uluru might have looked like millions of years ago. Review the use of models in science as a useful way of thinking about complex things (see Teacher background information, Lesson 4). Discuss whether it would be possible to be sure of exactly what happened.
- 6 Remind students of the mystery map and samples from Lesson 1. Explain that students will be working in collaborative learning teams to create an annotated diagram of what the landscape of the map might look like 100 years after the map was drawn and then millions of years in the future.



- 7 Introduce the collected multimedia resource (see 'Preparation') and explain that teams can consult it while thinking about the possible changes to the landscape.

Optional: Provide students with access to the internet so they can conduct web searches on erosion and landscapes.



- 8** Ask students to provide reasons and explanations for why they think changes might happen.

Optional: Ask students to create a multimedia presentation, such as a series of slides, a poster or a video to present their ideas.

- 9** Form teams and allocate roles.



- 10** Allow time for teams to discuss their ideas. Invite team members to discuss each other's ideas by asking questions such as:

- That's interesting, what about ...?
- I think Does that fit with your idea?



- 11** Ask Speakers to share their ideas with the class. Ask students in the audience to use the 'Science question starters' (see Appendix 5) to ask each team about their investigation.



- 12** Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

Optional: For each unanswered question on the class science chat-board, discuss with students whether the question is relevant to the topic and feasible to investigate. If it is, discuss a plan of action for how to find that information, for example, through secondary sources such as credible books or websites.



- 13** Review the third and fourth columns of the TWLH chart and add any further contributions.

- 14** Update the word wall with words and images.

Curriculum links



English

- Read stories and discuss creation myths and legends from different cultures, including Dreaming stories, Christian bible, Norse legends, Chinese tales and Native American stories.



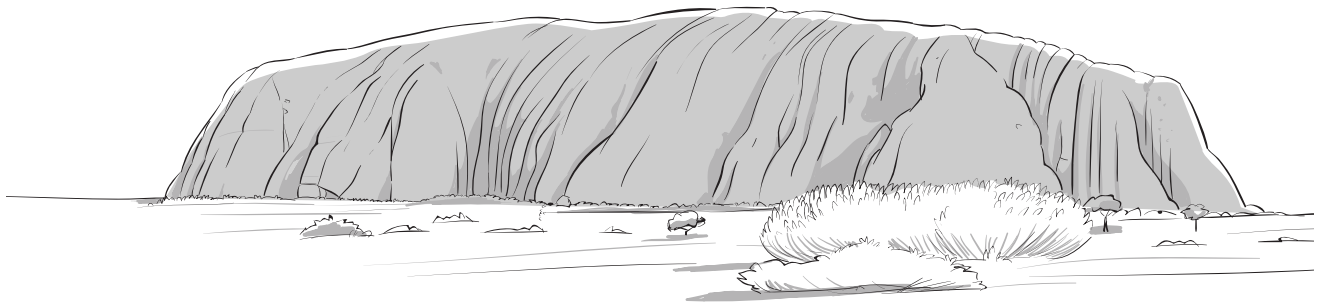
Indigenous perspectives

- Western scientists seek to understand the features of the landscape through geological processes such as erosion and weathering over long periods of time. Indigenous people may have their own way of explaining the features of the landscape (see page 6). Contact local Indigenous community members and/or Indigenous Education Officers to access relevant, local Indigenous knowledge. Protocols are available on the website: www.science.org.au/primaryconnections/indigenous

Red rock rising

Name: _____ Date: _____

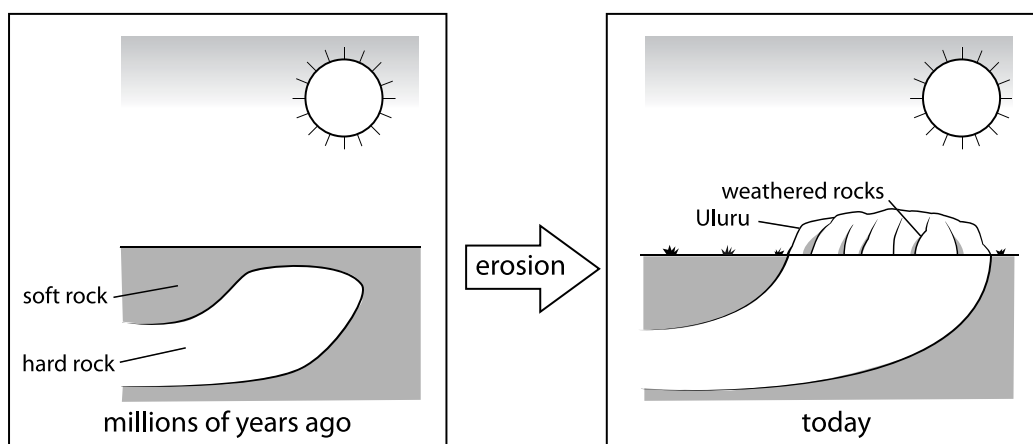
Uluru is located in the Uluru-Kata Tjuta National Park in the Northern Territory, Australia. The Anangu people are recognised as the traditional owners of that land. It is world famous for being a large red-orange rock in the middle of a very flat land.



Have you ever wondered where it came from?

The origin of Uluru is explained differently by Anangu people and by scientists. Here the origin is explained by a geologist.

'Uluru is like the tip of an iceberg. It is part of a massive rock that stretches underground for many kilometres. Millions of years ago, there was a layer of hard rock between two softer rocks. The land tilted slightly. Over the years the rocks around Uluru eroded away, leaving Uluru standing in a flat plain.'



Have you ever wondered why it looks like that?

'The orange colour of Uluru is due to grains of iron in the rock. When exposed to air, these grains rust like nails do when left out in the rain. If a piece of rock breaks away the rock underneath is grey until it rusts.'

Lesson 7 Examining erosion



AT A GLANCE

To support students to plan and conduct an investigation of factors that influence water erosion of soils.

Students:

- discuss variables that might affect soil erosion
- work in collaborative learning teams to plan and conduct an investigation to determine the effect of a chosen variable on the erosion of soils
- observe, record and share the results of their 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' understanding and skills.

Assessment focus



Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase. Rubrics are available on the website to help you monitor students' inquiry skills.

Key lesson outcomes

Students will be able to:

- with support, formulate a question for investigation and make predictions about how a chosen variable will affect the erosion of soils
- work in teams to identify and safely use appropriate equipment to test their investigation question
- record their observations, measure how much soil is eroded and present results in a table
- discuss and compare their results with the class to form common understandings
- analyse the investigation to make evidence-based claims about the water erosion of soils
- reflect on the investigation.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team roles chart
- team skills chart
- mystery map (see Lesson 1)
- enlarged copy of 'Procedure: Exploring water erosion' (Resource sheet 4, see Lesson 5)
- 1 enlarged copy of 'Water erosion investigation planner' (Resource sheet 6)
- 1 disposable aluminium tray (from Lesson 5)
- soil or sand
- 2 thick books, each wrapped in plastic
- 1 x 1.25 L bottle
- 1 permanent marker
- 1 ruler
- source of water


FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Water erosion investigation planner' (Resource sheet 6)
- 1 disposable aluminium tray (from Lesson 5)
- soil or sand
- 2 thick books, each wrapped in plastic
- 1 x 1.25 L bottle
- 1 bucket
- 1 permanent marker
- 1 ruler


Preparation



- Locate an area for the students to complete this activity with no electricity sources, such as the one used for Lesson 5. The investigation in this lesson is messy and might be best conducted outside or in a wet area.
- Read 'How to facilitate evidence-based discussions (Appendix 5).
- Read 'How to write questions for investigation' (Appendix 6).
- Prepare an enlarged copy of 'Water erosion investigation planner' (Resource sheet 6).
- *Optional:* Display the 'Water erosion investigation planner' (Resource sheet 6) on an interactive whiteboard or on a computer connected to a projector. Check the PrimaryConnections website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

- 1 Review previous lessons using the class science journal, word wall and TWLH chart.
- 2  Review the mystery map and annotated diagrams from Lesson 1. Discuss the use of maps to find buried things, for example, a pirate's treasure map. Ask questions such as:
 - What things does a map need on it?
 - If the pirate buried the treasure 1 m down would it always stay at the same depth?
 - What might change over time?

Record students' answers in the class science journal.

- 3 Discuss how erosion might change the depth of something buried, for example, by removing soil from on top of it or by depositing soil on top.
- 4  Ask students what things might affect the erosion of soil. Revise the term 'variables' introduced in Lesson 4. Brainstorm possible variables, such as the type of soil, the angle of the surface, the amount of soil, the amount of water/wind, how the water/wind falls on the slope, the presence of plants. Record students' answers in the class science journal.

- 5   Explain that students will be working in collaborative learning teams to investigate the water erosion of soil. Introduce the enlarged copy of 'Water erosion investigation planner' (Resource sheet 6). Explain that each team will choose one variable to investigate from the list of variables and write their question for investigation on their planner. If students need support, model recording a question for investigation, for example:

- What happens to the water erosion of soil when we change the angle of the slope?
- What happens to the water erosion of soil when we change the type of soil?
- What happens to the water erosion of soil when we change how the water falls on the slope?



- 6 Review the fair testing that students have completed throughout the unit and ask students how they will ensure that they conduct a fair test. Model how to set up one possible inquiry, for example:

‘What happens to the erosion of soil when we change the angle of the slope?’

Identify that teams will:

- **Change:** the angle of the slope
- **Measure/Observe:** the amount of erosion (the depth of soil moved by the water)
- **Keep the same:** the type of soil, the angle of the surface, the amount of soil, the amount of water/wind, how the water/wind falls on the slope, the presence of plants.

- 7 Explain that students will need to plan how they will conduct their investigation. Introduce the enlarged copy of ‘Procedure: Exploring water erosion’ (Resource sheet 4) used in Lesson 5 and explain that teams can modify the steps to fit their question for investigation.

Using the permanent marker, draw a level in the foil tray to which the soil will be filled, for example, 3 cm deep. Fill the tray to that level, even out the surface and then prop the tray on a book covered with plastic. This demonstration could also be done outside on sloping ground. Make sure the end with the notch is at the lower end and place the bucket underneath it. Pour water across the top of the tray evenly until the bottle is empty, catching excess water in the bucket. Measure the new depth of soil both at the top (the end of the tray elevated the highest) and at the bottom (end of the tray with the notch).

Record the revised procedural text in the class science journal.

Note: If not much soil accumulates using one bottle of water, pour another bottle of water over the tray. It is only essential that the quantity of water remain the same between tests.



- 8 Form teams and allocate roles. Provide teams with time to develop a question for investigation and complete the first page of the investigation planner.



- 9 Discuss the ‘Recording results’ section of the ‘Water erosion investigation planner’ (Resource sheet 6) and explain that teams will record measurements of the depth as well as observations of the water that flows into the bucket at the end. Add new vocabulary, for example, ‘depth’, to the word wall.



- 10 Ask Managers to collect team equipment and allow time for students to conduct the investigation and record results. This is a messy activity and might best be conducted outside or in a wet area.



- 11 Ask students to use their results in the table to construct a graph to display their results. Review the purpose and features of a graph (see Lesson 4), and discuss how to construct a graph to represent their recorded results.



12 Ask students to analyse and compare graphs and look for patterns and relationships, asking questions such as:

- What is the story of your graph?
- Where did the soil erode the most? The least?
- Using the data from the graph, what can you tell us about the relationship between the amount of erosion and the variable you chose to investigate?



13 Ask speakers to share their teams' findings with the class. Encourage students to question each other using the 'Science question starters' (see Appendix 5).



14 Discuss what claims the class can now make about soil erosion and record in the class science journal along with students' evidence and the science reasoning that students have used to come to these conclusions.



15 Ask students to complete the 'Explaining results' section of the investigation planner.

16 Review the investigation as a class, asking questions such as:

- What went well with our investigation?
- What didn't go well? How could we have done it better?
- What ideas do you have for another investigation about erosion?

17 Ask students to reflect on the investigation in the last section of the planner 'Evaluating the investigation'.

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

Curriculum links

Science

- Investigate how human activities, such as clearing trees and changing slopes, affects erosion.

Water erosion investigation planner

Name: _____ **Date:** _____

Team members' names: _____

What are you going to investigate?		What do you think will happen? Explain why.	
To make the test fair, what things (variables) are you going to:			
Change?	Measure/Observe?	Keep the same?	
<small>Change only one thing.</small>	<small>What would the change affect?</small>	<small>Which variables will you control?</small>	
How will you set up your investigation?		What equipment will you need?	
<small>Use drawings if necessary.</small>		<small>Use dot points.</small>	

Recording results

Depth of soil at the start at the top end: _____

Depth of soil at the start at the bottom end: _____

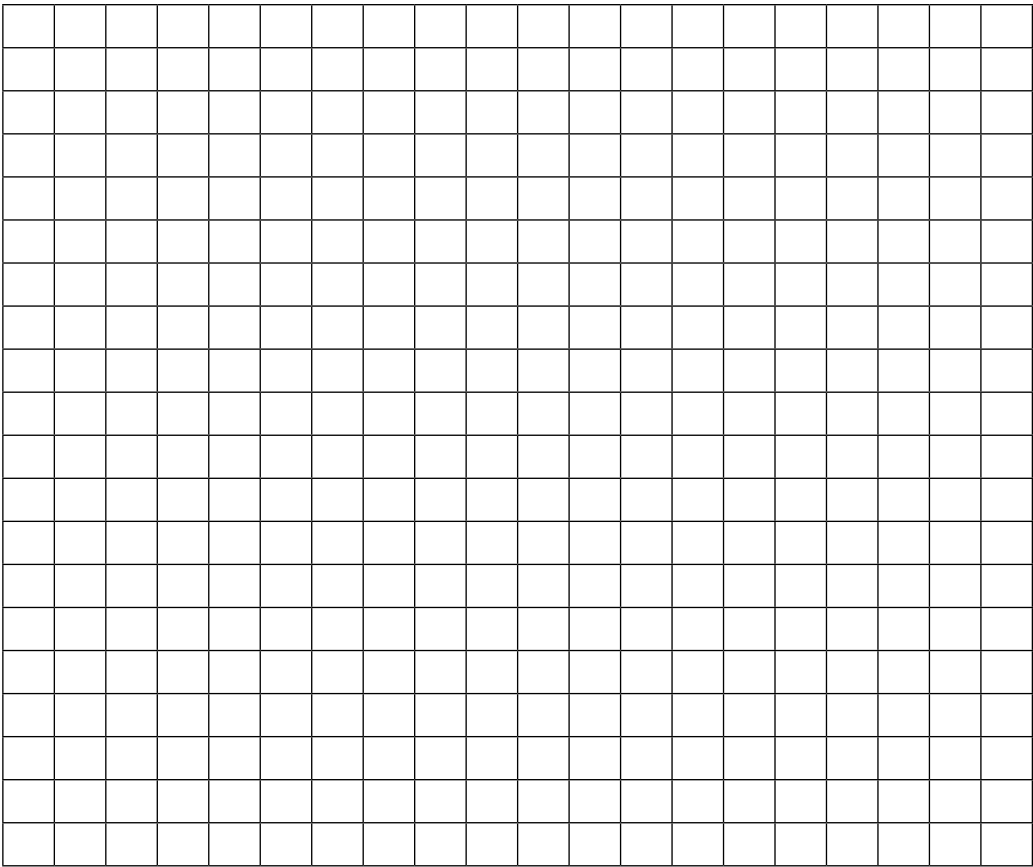
Depth of the soil

Trial	Top end	Bottom end (near notch)	Observation of the water in the bucket

Presenting results

Can you show your results in a graph?

Title of my graph: _____



Explaining results

When you changed the slope of the soil, what happened to the amount of erosion?

What is the story of your graph?

Evaluating the investigation

What challenges did you experience doing this investigation?

How did you, or could you, overcome them?

How could you improve this investigation (fairness, accuracy)?

Lesson 8 Meticulous maps

AT A GLANCE

To provide opportunities for students to represent what they know about erosion and how soils, rocks and landscapes change over time, and to reflect on their learning during the unit.

Students:

- draw a map of where they would bury a time capsule
- describe how the landscape might change over time
- 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 Earth's surface changes over time as a result of natural processes and human activity.

Literacy products in this lesson provide useful work samples for assessment using the rubrics provided on the PrimaryConnections website.

Key lesson outcomes

Students will be able to:

- identify things that cause landscapes to change, including weathering, erosion and human activity
- create a map and explain their choice of location to bury a time capsule
- contribute to discussions and express their opinions about their learning journey.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart


FOR EACH STUDENT

- science journal
- 1 book containing maps (see 'Preparation')

Preparation

- Write the questions for students to answer (see Lesson step 6) on a large piece of paper so they can refer to it.
- Gather some books with maps and pictures of scenery for students to imagine where they might bury a time capsule.
- *Optional:* Organise for students to visit an area to investigate where to bury a time capsule. Prepare a map of the area to have a model for students to design their own map.
- *Optional:* Display the questions and maps on an interactive whiteboard or on a computer connected to a projector. Check the **PrimaryConnections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

- 1 Review the unit using the class science journal, word wall and TWLH chart. Ask questions such as:
 - What did we learn about soils? Do they change over time? How do we know?
 - What did we learn about rocks? Do they change over time? How do we know?
 - What did we learn about landscapes? Do they change over time? How do we know?
 - What did we learn about erosion?
- 2 Ask students to share their ideas about what a time capsule is. Explain that time capsules are sometimes made by people and buried so that in the far distant future people will retrieve them and learn about life as it is today. Discuss some things that are commonly included in time capsules, for example, newspapers.
- 3  Explain that students are going to think about where they would put a time capsule so that it might be easily found in a thousand years.
- 4 Introduce the available resources for students to plan where they would bury a time capsule (see 'Preparation').
- 5 Ask students to carefully consider what features of the landscape they would record on a map to show where the time capsule is. Review the purpose and features of a map (see Lesson 1).



6 Explain that students will be recording their map and their reasoning for where they would choose to bury their time capsule in their science journal. Ask students to answer the following questions:

- Would you bury your time capsule near a river? Why/Why not?
- Would you bury your time capsule in soil on top of a mountain? Why/Why not?
- Would you bury your time capsule under a boulder made of hard materials? Why/Why not?

7 Invite students to use sentence starters such as the following:

- The landscape where I would bury the time capsule is...
- I chose to bury it here because...
- The landscape might change in several ways, for example,...

8 Allow students time to complete their science journal entries and maps.



9 Invite students to share their maps and explanations with the class. Ask questions such as:

- Why did you choose to bury it there?
- Do you think people will be able to find it? Why?

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

- I really enjoyed...
- I learned a lot about...
- I could improve...
- I'm still wondering about...
- Next time we work in teams I will...
- In the future I would like to...

Curriculum links

Mathematics

- Use simple scales, legends and directions to interpret information contained in basic maps.

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 multi-modal 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.

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 learn to work 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, the 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 colour-coded peg, badge or wristband. 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 members 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

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

PrimaryConnections 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.

The development of these team skills aligns to descriptions in the Australian Curriculum: English. See page 7.



Supporting equity

In science lessons, there can be a tendency for boys to manipulate materials and girls to record results. PrimaryConnections 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 SKILLS

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

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

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.

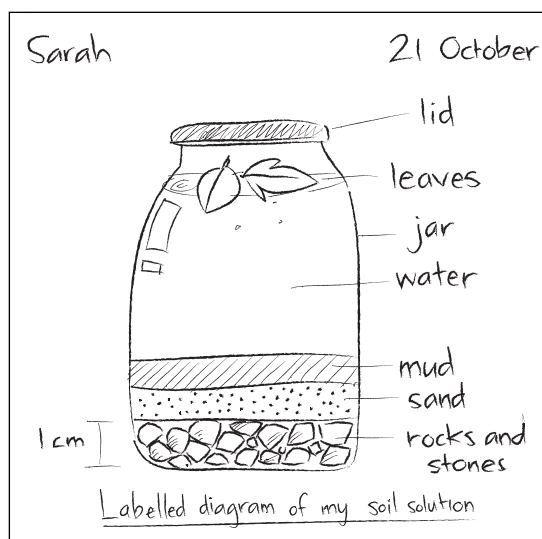
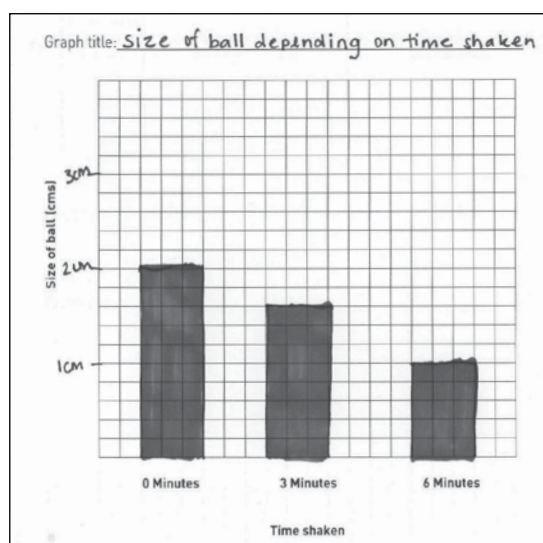
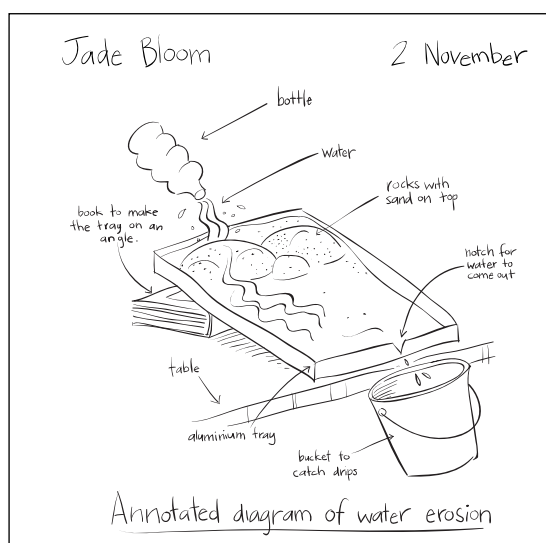
Representing their ideas in a science journal gives students a purposeful task for writing and reading in English. For additional information on how to help students who are learners of English as an additional language or dialect, please see the Australian Curriculum resources.

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.

Beneath our feet science journal entries



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.

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

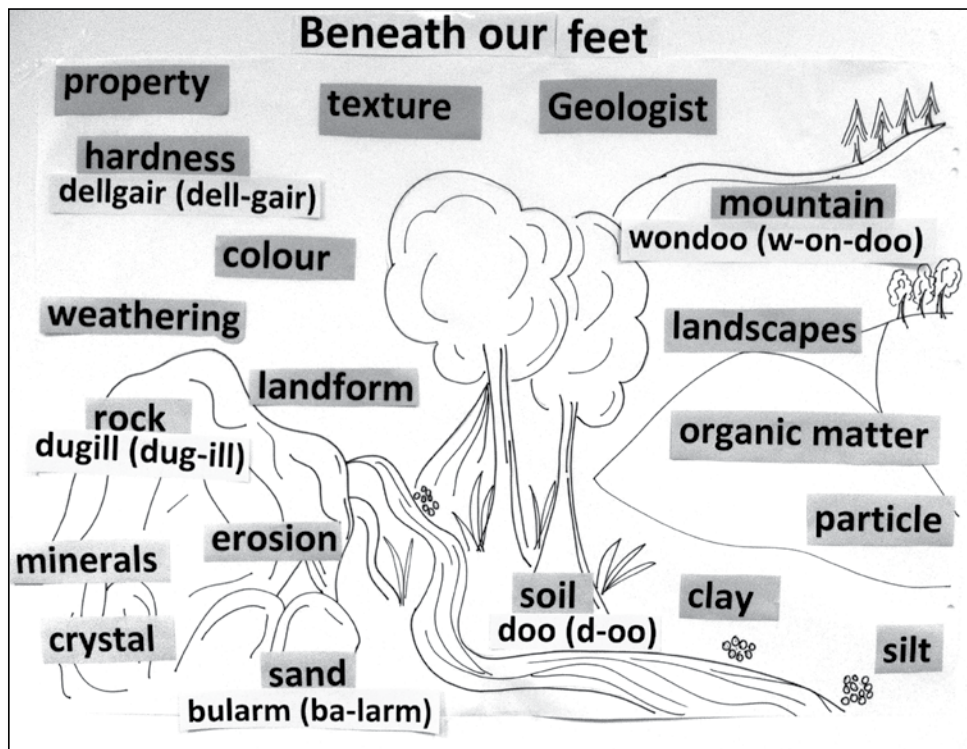
Position the word wall so that students have easy access to the words. They need to be able to see, remove and return word cards to the wall. A classroom could have one main word wall and two or three smaller ones, each with a different focus, for example, high-frequency words.

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-fastening 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 animal silhouette for an animal characteristics 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.

Invite students to contribute words from different languages to the word wall. Group words about the same thing, for example, different names of the same animal, on the word wall so that students can make the connections. Identify the different languages used, for example, by using different-coloured cards or pens to record the words.



Beneath our feet 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.

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.

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.

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

Topic	What we think we know	What we want to learn	What we learned (What are our claims?)	How we know (What is our evidence?)
Rocks	We think that all rocks are hard. <div>→</div>	If rocks can be harder than glass. <div>→</div>	Some rocks are soft and crumbly. Some rocks can be harder than glass. <div>→</div>	We investigated characteristics of rocks. We used them to scratch a glass sheet so they must be harder.

Appendix 5

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.
- Discuss all ideas before selecting one.

Question, 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 the size of clay-sand balls when we shake them in a jar of water?'

C – The **claim**. For example, 'Clay-sand balls reduce in size when we shake them in a jar of water. The longer you shake the jar the smaller they become.'

E – The **evidence**. For example, 'The ball size was ____cm when without shaking, reduced to ____cm after 3 minutes and ____cm after 6 minutes.'

R – The **reasoning**. For example, 'We conducted a fair test so it was the shaking of the clay-sand balls in water that made them smaller. These results also explain why rocks in streams would tend to be smoother through the process of weathering.'

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 how 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 *The PrimaryConnections 5Es DVD*, Chapter 5).

Science question starters

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

DISCUSSION SKILLS

- 1 Listen when others speak**
- 2 Ask questions of each other**
- 3 Criticise ideas not people**
- 4 Discuss all ideas before selecting one**

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 in *Beneath our feet* 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, measured 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 *Beneath our feet* refers to two variables and the relationship between them, for example, an investigation of the variables that affect the size of a model rock ball. The question for investigation might be:

Q1: What happens to the water erosion of soil when we change the angle of the slope?

In this question, *the water erosion of soil* depends on *the angle of the slope*. The *angle of the slope* is the thing that is **changed** (independent variable) and the *water erosion of soil* is the thing that is **measured or observed** (dependent variable).

Q2: What happens to the water erosion of soil when we change the type of soil?

In this question, *the water erosion of soil* depends on *the type of soil*. The *type of soil* is the thing that is **changed** (independent variable) and *water erosion of soil* is the thing that is **measured or observed** (dependent variable).

Developing questions for investigation

The process of developing questions for investigation in *Beneath our feet* 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 the water erosion of soil?'

- Use questioning to elicit the things (**independent variables**) students think could affect the (**dependent variable**). For example, the angle of the slope, the type of soil, the amount of soil, how the water falls on the slope, the presence of plants).
- By using questions, elicit the things that students can investigate, such as the angle of the slope and the type of soil. 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.
- 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 *Beneath our feet* students investigate:

- variables that affect the weathering of a rock
- variables that affect the erosion of a landscape.

These investigations are used to answer questions for inquiry about where soils come from and how landscapes change over time.

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.

‘Cows **Moo Softly**’ 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) and

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

To answer the inquiry question ‘Does frozen water always cause a bottle to explode?’ students could investigate whether the amount of water in the bottle affects whether the bottle explodes. Students could:

CHANGE	the amount of water in the bottle	Independent variable
MEASURE/OBSERVE	whether the bottle explodes	Dependent variable
KEEP THE SAME	the type of bottle, the initial temperature of the water, the shape of the bottle, the colour of the bottle, the temperature of the freezer in which the bottle is put, how long the bottles are put in the freezer	Controlled variables

Note: When choosing variables to ‘keep the **Same**’ we sometimes make decisions on variables that we think will affect the outcome as it is not always feasible to keep everything the same. For example, scientists might prioritise keeping the temperature of and duration of time in the freezer over having bottles that are the same colour or have the same writing on them.

Appendix 8

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.

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 Australian Curriculum: Mathematics describes data representation and interpretation for Year 4 as follows:

- Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values.
- Evaluate the effectiveness of different displays in illustrating data features including variability.

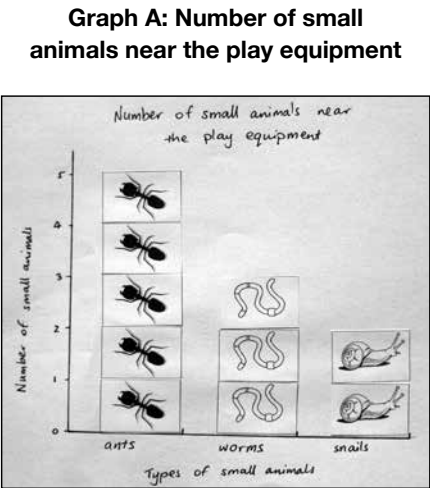
Picture graph

Picture graphs support students in the transition from using physical representations to representing information using symbols or pictures in columns. The symbols or pictures must be the same size.

Table A shows the results recorded for an investigation of the types of small animals found in different environments. This information is represented in Graph A by using one small picture for each animal in Table A.

Table A: Number of small animals near the play equipment	
Types of small animals	Number of small animals
ant	5
worm	3
snail	2

In the graph to the right, each picture might also represent a number of animals, for example, 1 picture = 5 animals found.



Column graph

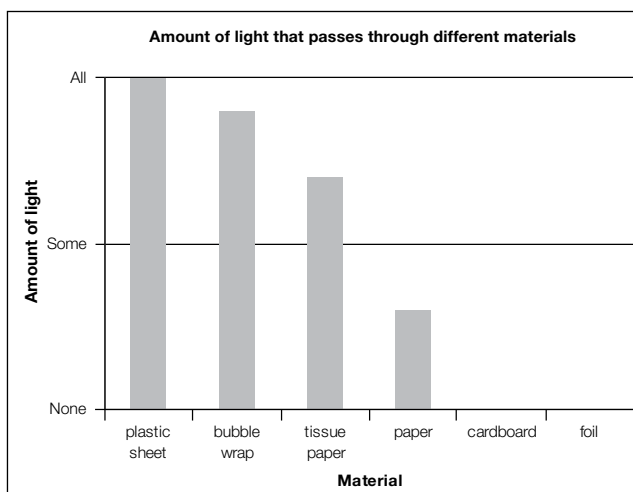
Where data for one of the variables are in **categories** (that is, we use **words** to describe it, for example, earthquake location) a **column graph** is used.

Graph A below shows how the results of an investigation of the effect of material type on the amount of light that passes through it (**data in categories**) have been constructed as a **column graph**.

Table B: The effect of material on the amount of light that passes through

Material	Amount of light
plastic sheet	all
bubble wrap	almost all
tissue paper	most
paper	not much
cardboard	none
foil	none

Graph B: The effect of material on the amount of light that passes through



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 material on the amount of light that passes through.'

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. For example:

- 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 A shows that different numbers of small animals were found near the play equipment. Students could compare graphs of different environments to determine which environments suit which animals. For example, if lots of ants were found in the garden, near the play equipment and in the lunch area students might conclude that ants can live in lots of places in the schoolyard. If ants were only found in the garden, students might conclude that the ants prefer a garden habitat because they aren't found in other places.

Analysis of Graph B shows that the amount of light that passes through materials changes according to the type of material. This is because the more transparent or translucent the material is, the more light can pass through it.

Appendix 9

Beneath our feet equipment list

EQUIPMENT ITEM	QUANTITIES	LESSON		1	2	2	3	4	5	6	7	8
		SESSION	1									
Equipment and materials												
A4 paper	3 per team											
book of maps	1 per student				●		●	●				
books (thick)	1 per team lesson 5, 2 in lesson 7								●		●	
books (thick)	1 per class lesson 5, 2 in lesson 7										●	
bottle (500 mL)	1 per team								●			
bottle (1.25 mL)	1 per class											
bottle (1.25 mL)	1 per team										●	
bucket	1 per team								●		●	
camera (optional)	1 per class								●			
cards/paper strips	at least 4 per student			●								
clay (to prepare dried balls for lesson 4)	3 balls per team			●								
clay-sand balls	3 balls per team							●				
cups (clear plastic)	2 per team			●								
cups (clear plastic)	3 per team				●							
frozen water in plastic bottle	1 per class							●				
glass (old) for scratching on (optional)	1 per team						●					
gloves (disposable or gardening)	1 pair per student			●								
images (cut-away hillsides) – see preparation	1 set per class				●				●			
images (landmarks by erosion)	1 set per class									●		
jar – transparent screw-top with sample of soil from home (from Lesson 1)	1 per team											
jars with lids	4 per class				●							
jars with lids (to hold at least 400 mL)	1 per student				●							
jars with lids	3 per team							●				
labels	4 per class				●							
labels	1 per student				●							
magnifying glass	1 per student or per team				●	●	●					
marker (permanent)	1 per class				●						●	
marker (permanent)	1 per team				●							●

EQUIPMENT ITEM	QUANTITIES	LESSON		1	2	2	3	4	5	6	7	8
		SESSION	1									
Equipment and materials (continued)												
mystery map	1 per class			●							●	
mystery map and soil samples (add rock samples for lesson 6)	1 per class			●						●		
mystery map	1 per team									●		
newspaper to protect working surface	per team							●				
paper towel	3 pieces per team						●					
plastic bags	4 per class			●								
plastic bags	1 per student			●								
rock samples	assorted per class						●					
rock samples	assorted per team			●			●					
rocks, blocks, plastic containers etc for building	1 set per team								●			
ruler	1 per team					●					●	
ruler	1 per class										●	
sand (to prepare dried balls for lesson 4)	3 balls per team			●								
soil or sand (½ aluminium tray)	1 per team								●		●	
soil or sand (½ aluminium tray)	1 per class										●	
scales (optional) (for measuring very small masses)	1 per class							●				
scissors	1 per team								●			
sieve (optional)	1 per team			●								
soil samples	1 per class			●								
soil samples	3 per team			●								
soil samples	1 per team			●								
soil solutions (from lesson 2, session1)	1 per student					●						
soil solutions	4 per class					●	●	●				
spoon	1 per team			●				●				
stopwatch/wristwatch (with second hand)	1 per team							●				
tape (self-adhesive)	1 per class			●								
tape (self-adhesive)	1 per team			●								
tape measure	1 per team									●		
tray (aluminium disposable)	1 per class										●	
tray (aluminium disposable)	1 per team								●			

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7	8
		SESSION		1	2						
Equipment and materials (continued)											
vinegar	½ cup per team					●					
water	varying amounts – check each lesson		●				●	●		●	
Resource sheets											
'Information note for families (RS1)'	1 per student		●								
'Information note for families (RS1), enlarged'	1 per class		●								
'Exploring soil samples (RS2)'	1 per team			●							
'Exploring soil samples (RS2) enlarged'	1 per class			●							
'Weathering investigation planner (RS3)'	1 per team						●				
'Weathering investigation planner (RS3) enlarged'	1 per class						●				
'Procedure exploring water erosion (RS4)'	1 per team							●		●	
'Procedure exploring water erosion (RS4) enlarged'	1 per class							●		●	
'Red rock rising (RS5)'	1 per student								●		
'Red rock rising (RS5) enlarged'	1 per class								●		
'Water erosion investigation planner (RS6)'	1 per team									●	
'Water erosion investigation planner (RS6) enlarged'	1 per class									●	
Teaching tools											
class science journal	1 per class		●	●	●	●	●	●	●	●	●
TWLH chart	1 per class		●	●	●	●	●	●	●	●	●
student science journal	1 per student		●	●	●	●	●	●	●	●	●
word wall	1 per class		●	●	●	●	●	●	●	●	●
team roles chart	1 per class		●	●	●	●	●	●	●	●	
team skills chart	1 per class		●	●	●	●	●	●	●	●	
role wristbands or badges	1 set per team		●	●	●	●	●	●	●	●	
Multimedia											
resource materials	assorted per team										

Appendix 10

Beneath our feet unit overview

LESSON SUMMARY		LESSON OUTCOMES *		ASSESSMENT OPPORTUNITIES
Students:		Students will be able to represent their current understandings as they:		
ENGAGE	Lesson 1 Lost location	<ul style="list-style-type: none">• discuss a map and what features of the landscape change over time• explore soil and rock samples• record their ideas and questions on a TWLH chart.	<ul style="list-style-type: none">• describe landscape features on a map• create a journal entry to represent and communicate their ideas• identify possible questions for investigation on a TWLH chart• contribute to a class word wall• contribute to discussions about soils, rocks and landscapes and their features.	Diagnostic assessment <ul style="list-style-type: none">• Science journal entries• Class discussions• Science word wall and TWLH contributions.
	Lesson 2 Studying soils	<ul style="list-style-type: none">• explore and describe the features of different soils• discuss different components of soils• draw an annotated diagram of their soil solutions• discuss what components of soils could change over time.	<ul style="list-style-type: none">• contribute to discussions about different soils and how this knowledge might help communities• work in teams to safely use appropriate materials to observe features of soils• record observations of the characteristics of soils in a table and a labelled diagram• draw conclusions about how soils change• review their investigation and suggest improvements, for example, in data collection• represent and communicate ideas and findings in a variety of ways, including a table.	Formative assessment <ul style="list-style-type: none">• Science journal entries• Class discussions• Science word wall and TWLH contributions• Labelled diagrams• Tables• 'Exploring soil samples' (Resource sheet 2).
EXPLORE				

* These outcomes are linked to relevant descriptors of the Australian Curriculum: Science and are provided at the beginning of each lesson.

EXPLORE	LESSON SUMMARY		LESSON OUTCOMES*		ASSESSMENT OPPORTUNITIES
	Students:		Students will be able to:		
Lesson 3 Rock hard?	<ul style="list-style-type: none">work in teams to examine the features of different rocksdescribe rocks using a game of 'Twenty questions'discuss how to choose rocks for a purpose based on their features.		<ul style="list-style-type: none">contribute to discussions about rocks, their features and how this knowledge can be used in communitiesdiscuss what types of data to collect about rockswork in teams to safely use appropriate materials to observe different features of rocksrecord their observations, including using an accurate labelled diagramidentify how features of rocks can be used to help with scientific classificationsrepresent their ideas about features of rocks in their science journal.		Formative assessment <ul style="list-style-type: none">Science journal entriesClass discussionsScience word wall and TWLH contributionsLabelled diagramsFormulating questions for a questioning game about rocks.

* These outcomes are linked to relevant descriptors of the Australian Curriculum: Science and are provided at the beginning of each lesson.

LESSON SUMMARY		LESSON OUTCOMES *		ASSESSMENT OPPORTUNITIES
EXPLORE	<p>Students:</p> <ul style="list-style-type: none"> Investigate a model of the physical weathering of rocks discuss how rocks might change over time. 	<p>Students will be able to:</p> <ul style="list-style-type: none"> identify the features that made their investigation a fair test and why scientists use models in their work follow a procedural text to investigate a model of the weathering of a rock in a stream work in teams to identify and safely use appropriate equipment to test whether water weathers rocks record their measurements and observations and present their results in a table discuss and compare their results with the class to form common understandings reflect on their investigation represent their ideas about characteristics of rocks in their science journal. 	<p>Formative assessment</p> <ul style="list-style-type: none"> Science journal entries Class discussions Science word wall and TWLH contributions Table Graph 'Weathering investigation planner' (Resource sheet 3). 	
	<p>Lesson 4 Rollin' rock</p>			
EXPLORE	<ul style="list-style-type: none"> investigate the effect of water erosion on the landscape through the use of models discuss how water erosion could affect landscapes. 	<ul style="list-style-type: none"> work in teams to follow a procedural text investigate what happens to models of landscapes when water is poured over them record their observations using an annotated diagram contribute to discussions about water erosion, how it shapes and impacts landscapes and how it can be influenced by human impact. 	<p>Formative assessment</p> <ul style="list-style-type: none"> Science journal entries Class discussions Science word wall and TWLH contributions Reading and using 'Procedure: Exploring water erosion' (Resource sheet 4) Annotated diagrams. 	
	<p>Lesson 5 Modelling mountains</p>			

* These outcomes are linked to relevant descriptors of the Australian Curriculum: Science and are provided at the beginning of each lesson.

	LESSON SUMMARY		LESSON OUTCOMES*		ASSESSMENT OPPORTUNITIES
	Students:		Students will be able to:		
EXPLAIN	Lesson 6 Fabulous formations	<ul style="list-style-type: none"> respond to pictures about landforms read and discuss a factual text about the origin of Ulluru discuss theories of how a landscape might change in the future through erosion. 	<ul style="list-style-type: none"> contribute to discussions about how landforms are shaped by erosion read and interpret factual texts make claims about what a landscape might look like over time represent and communicate their ideas in a variety of ways. 	Formative assessment <ul style="list-style-type: none"> Science journal entries Class discussions Science word wall and TWLH contributions Reading and comprehending 'Red rock rising' (Resource sheet 5) Annotated diagrams. 	
ELABORATE	Lesson 7 Examining erosion	<ul style="list-style-type: none"> discuss variables that might affect soil erosion work in collaborative learning teams to plan and conduct an investigation to determine the effect of a chosen variable on the erosion of soils observe, record and share the results of their investigations. 	<ul style="list-style-type: none"> with support, formulate a question for investigation and make predictions about how a chosen variable will affect the erosion of soils work in teams to identify and safely use appropriate equipment to test their investigation question record their observations, measure how much soil is eroded and present results in a table discuss and compare their results with the class to form common understandings analyse the investigation to make evidence-based claims about the water erosion of soils reflect on the investigation. 	Summative assessment of Science Inquiry Skills <ul style="list-style-type: none"> Science journal entries Class and group discussions Science word wall and TWLH contributions 'Water erosion investigation planner' (Resource sheet 6) Table Graph. 	

* These outcomes are linked to relevant descriptors of the Australian Curriculum: Science and are provided at the beginning of each lesson.

LESSON SUMMARY		LESSON OUTCOMES *	ASSESSMENT OPPORTUNITIES
Students:			
Lesson 8 Meticulous maps	<ul style="list-style-type: none">draw a map of where they would bury a time capsuledescribe how the landscape might change over timereflect on their learning during the unit.	<p>Students will be able to:</p> <ul style="list-style-type: none">identify things that cause landscapes to change, including weathering, erosion and human activitycreate a map and explain their choice of location to bury a time capsulecontribute to discussions and express their opinions about their learning journey.	<p>Summative assessment</p> <p>of Science Understanding</p> <ul style="list-style-type: none">Science journal entriesClass discussionsScience word wall and TWLH contributionsMap.
	EVALUATE		

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Professional learning

PrimaryConnections: linking science with literacy is an innovative program linking the teaching of science with the teaching of literacy in primary schools. The program includes a professional learning component and curriculum units aligned to the Australian Curriculum: Science.

Research has shown that the professional learning component of the **PrimaryConnections** program significantly enhances the implementation of the curriculum units. Professional Learning Facilitators are available throughout Australia to conduct a variety of workshops. At the heart of the professional learning program is the Curriculum Leader Training Program.

PrimaryConnections Curriculum Leader Training Program

Held annually, this two-day workshop develops a comprehensive understanding of the **PrimaryConnections** program. Participants receive professional learning resources that can be used to train others in **PrimaryConnections**.

PrimaryConnections one-day Introduction to PrimaryConnections Program

This workshop develops knowledge and understanding of **PrimaryConnections**, and the benefits to enhance the teaching and learning of science and literacy.

The professional learning calendar, other workshops and booking forms can be found on the website: www.science.org.au/primaryconnections

Order your next unit at
www.science.org.au/primaryconnections

Year	Biological sciences	Chemical sciences	Earth and space sciences	Physical sciences
F	<i>Staying alive</i>	<i>What's it made of?</i>	<i>Weather in my world</i>	<i>On the move</i>
1	<i>Schoolyard safari</i>	<i>Spot the difference</i>	<i>Up, down and all around</i>	<i>Look! Listen!</i>
2	<i>Watch it grow!</i>	<i>All mixed up</i>	<i>Water works</i>	<i>Push pull</i>
3	<i>Feathers, fur or leaves?</i>	<i>Melting moments</i>	<i>Night and day</i>	<i>Heating up</i>
4	<i>Plants in action</i>	<i>Material world</i>	<i>Beneath our feet</i>	<i>Smooth moves</i>
	<i>Friends and foes</i>	<i>Package it better</i>		
5	<i>Desert survivors</i>	<i>What's the matter?</i>	<i>Earth's place in space</i>	<i>Light shows</i>
6	<i>Marvellous micro-organisms</i>	<i>Change detectives</i>	<i>Earthquake explorers</i>	<i>It's electrifying</i>
				<i>Essential energy</i>

PrimaryConnections: Linking science with literacy is an innovative program linking the teaching of science with the teaching of literacy in primary schools.

The program combines a sophisticated professional learning program with exemplary curriculum resources.

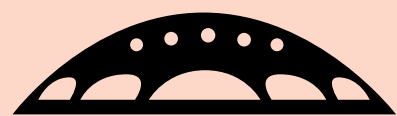
PrimaryConnections features an inquiry-based approach, embedded assessment and incorporates Indigenous perspectives.

The PrimaryConnections curriculum resources span Years F-6 of primary school.

www.science.org.au/primaryconnections



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