Year 6

Science

Agriculture in Education:
an educational resource for Year 6 Science

Saving our Soils

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AGRIFOOD SKILLS AUSTRALIA

Saving our Soils

Year 6 Science

Content Description	
The growth and survival of living things are affected by physical conditions of their environment	*ACSSU094*
With guidance, pose clarifying questions and make predictions about scientific investigations	*ACSIS232*

Source: Australian Curriculum v8.1
http://www.australiancurriculum.edu.au/science/curriculum/f-10?layout=1 - level4

learn

Learning Outcomes

At the end of the unit, students will have a greater understanding of:

- the characteristics of soil;
- the role of soil in supporting life on Earth;
- the three main soil types;
- how soil quality can be improved;
- the effect of soil nutrients and soil texture on plant growth;
- the interrelationship between soils and agriculture; and
- the role of groundcover and water management in preventing soil loss.

Description

This resource is designed to increase students' understanding of the importance of soil and its fundamental role in supporting plant and animal life. The activities lead students through a progression of investigations and simple experiments on how soils form, different soil types and how levels of nutrients, soil texture and soil pH affect the ability of soils to support plant growth and resist erosion.

Throughout the unit, students consider the impact of agriculture on soils and the role of farmers today in managing their soil resource to prevent soil and nutrient loss. Students investigate the relationship between soils and plant growth and the effect of nutrients and organic matter on the quality and water holding capacity of soils.

Background information for teachers is included for reference throughout the unit. Activity sheets include background material for students. Website links and suggested references are included where appropriate.

It is suggested that teachers commence this unit by undertaking the introductory discussion unit - *Is Soil Dirt*.

Pre-preparation is required for Student investigations 1, 2 and 6.

Introduction:	Is Soil Dirt?
Activity 1:	Nutrients and Plant Growth + assessment
Activity 2:	Soil Types - Texture Testing
Activity 3:	Optional Extension - Word Search
Activity 4:	Mineral Nutrients
Activity 5:	Soil Erosion and Water Management
Activity 6:	Reflection

Teacher Background Information

Definition

Soil is the loose top layer of the Earth's surface, consisting of rock and mineral particles mixed with decayed organic matter (humus). It is vital to life on earth, providing nutrients for plants and supporting a wide range of biotic communities.

Importance of Soils

Soil is a habitat for the myriad of insects and organisms that live in it. Soil:

- supports the web of life that connects all ecosystems;
- provides us with food and the nutrition we need;
- recycles nutrients;
- is the base for growing food, fibres, feed for animals and some biofuels;
- provides plants with nitrogen from the air through a process of nitrogen fixation;
- filters and purifies water and also stores, releases and absorbs water;
- provides building, ornamental and engineering materials;
- holds clues to past cultures and civilisations;
- contains microbes from which we have made medicines;
- helps prevent many diseases.

Everything we have contact with is related in some way with soil. Soil plays a vital role in supporting life on Earth.

Role of Soils in Food and Fibre Production

Healthy soils enable pastures and crops to take up both nutrients and moisture efficiently. This enables farmers to grow more nutritious food.

Healthy soils also reduce water run-off and erosion and lessen the amount of water that might otherwise penetrate well below the root zone in a process called deep drainage. Deep drainage is a natural process providing the groundwater and springs that replenish rivers and creeks. However, too much deep drainage can cause dryland salinity - a build-up of salt in non-irrigated soils, that seriously affects soil and water quality, native vegetation, biodiversity, crops and pastures.

Well managed soils can store large amounts of atmospheric carbon dioxide. This improves pasture productivity through nutrient retention, as well as helping to moderate carbon dioxide emissions.

Groundcover - grasses and shrubs hold the soil together, allow water to penetrate and protect the soil from erosion. Good groundcover management is of vital importance to farmers.

Without effective management of both soils and groundcover, loss of soil by wind and water erosion puts the livelihood of Australian farmers at risk.

Improving Soil Quality

All soils require nutrients and organic matter. Organisms in the soil such as bacteria and fungi, worms, beetles, ants and termites help create nutrients and maintain soil balance.

Nutrient elements that are essential for plant growth can be divided into three groups:

- Major Elements - nitrogen (N), phosphorous (P), and potassium (K);
- Secondary Elements - calcium (C), magnesium (Mg), Sulphur (S);
- Trace elements - iron (Fe), copper (Cu), boron (B), manganese (Mn), molybdenum (Mo), zinc (Zn).

There are three main types of soil – sand, silt and clay, can be improved in different ways:

- Sandy soils do not retain nutrients well and need to be supplied with plenty of organic matter;
- Silty and loam soils are most suitable for plant growth and require less added materials;
- Clay soils lack aeration (the ability for water and air to pass between the soil particles) and also lack the crumbly structure needed for growing. They need lots of compost.

Encouraging Living Organisms – Humus and Compost

Many people confuse humus and compost. Both improve soil quality.

Humus is decayed plant and animal matter. It improves soil structure making it crumbly and aerated, improves water holding ability and supports plant growth.

Humus is the organic, non-cellular, long-lasting component of soil - organic because it contains mostly stable carbon compounds with no phosphorus and little or no nitrogen. Its nutritive qualities include trace elements and several important organic acids.

Compost: Organic matter that has been broken down by bacteria and recycled to increase the nutrient content of soil. Compost is beneficial as a soil conditioner, fertilizer and as a natural pesticide for soil. Once fully decomposed, organic matter is known as humus.

Composting organisms require four important ingredients to work effectively:

- *Carbon* - for energy - the microbial oxidation of carbon produces heat. Examples - shredded paper/cardboard, dry brown leaves, ash, sawdust, hay and straw;
- *Nitrogen* - to grow and produce more organisms to oxidise the carbon. Examples include fresh green materials, grass, weeds, fruit and vegetable waste and prunings from trees and shrubs;
- *Oxygen* - for oxidising the carbon, enabling the decomposition process;
- *Water* - in the right amounts to maintain activity without causing anaerobic conditions *http://www.abc.net.au/gardening/stories/s2683832.htm*

Factors Influencing the Development of Soil

- *Parent material* - the mineral and organic material from which new soil forms from. Minerals come from sediments and weathered rocks and helps determine the soil type and the time it will take to form.
- *Climate* - Temperature, moisture, rainfall and wind influence the breakdown of mineral material and the production of organic matter. In warm and moist climates, plants grow faster and more consistently than in cool and dry climates. This creates soils with more organic matter, but this organic matter also breaks down faster, so there is less accumulation in the soil.
- *Biological influences* - Plants, animals, bacteria and fungi impact on soil formation. Plants help recycle nutrients by decaying and taking up nutrients. Plants also put down roots into the soil and this helps anchor the soil in place and prevent erosion. There are millions of microscopic organisms in the soil. These help mix the soil and recycle nutrients.
- *Topography* - Landforms influence soil development. On steeper land runoff from rainfall erodes and carries away rocks, minerals and organic material, depositing them in flatter areas.
- *Time* - Soil forms very slowly - sometimes taking a thousand years or more.

Soil Horizons

As soil slowly forms, it becomes sorted onto layers with distinct characteristics. These horizons, from the surface to the bedrock, make up the soil profile. Soil scientists study soil profiles.

The three main horizons in a soil profile are:

- Humus or organic matter such as decaying leaves in a layer of variable depth.
- Topsoil which is mainly minerals from parent material and incorporated organic matter, providing the habitat for plants and other organisms.
- Subsoil which is rich in minerals that have accumulated or leached down from layers above

Soil Situation Today – Soil Erosion

Less than 30% of the world's topsoil remains in a fair or acceptable condition today and despite our increasing knowledge about soils, soil is still being lost and depleted of nutrients and beneficial properties. Soil forms very slowly especially in Australia. In many areas the rate of soil loss greatly exceeds that of soil production.

Soil is easily eroded by wind, water, people and animals.

Soil erosion happens when soil particles are dislodged and removed from their original position. It is a natural process and has shaped the Australian landscape. Places like the Kimberley Ranges attract visitors to view the effects of erosion that have taken place over long periods of time.

Human activities have greatly accelerated the rates of soil erosion as too, have past agricultural practices.

Erosion is a natural process, but the accelerated erosion of topsoil that is high in organic matter and nutrients results in productivity losses and environmental degradation. It is no surprise that soil erosion is a major issue for Australian agriculture and for water catchment management.

discuss

Setting the Scene - Soil is our life support system

Introduce this unit by encouraging students to think about what soil is and how we use it.

> *Many people use the terms soil and dirt interchangeably. Soil is the upper layer of the earth's surface in which plants grow. It contains rock and mineral particles mixed with micro-organisms and decaying organic matter. Dirt is soil that has lost the characteristics that enable it to support life.*

1. Think about instances when you use the terms soil and dirt.
   a. What is the difference between soil and dirt?
   b. Where do we find soil? Where do we find dirt?
   c. In what ways should we use the terms soil and dirt correctly?

The PowerPoint presentation - Soil is not Dirt provides further questions for class discussion
https://www.soils.org/files/lessons/teachersguide/soil-is-not-dirt.pptx

2. Divide the class into two groups, giving each group one of the statements below. Students brainstorm and compile a list of examples to support their statement.

   Statement 1: Everything we do has some link to soil. (Why are soils so important?)

   Statement 2: Many people earn their living directly by working with soil. (Jobs, professions, hobbies)

3. From early times humans have recognised and written about the importance of soil. Explain that the following was written over 4,000 years ago.

   "***To be a successful farmer one must first know the nature of the soil***." - Xenophon, Oeconomicus, 400 B.C.[1]

Soil forms very slowly but it can be eroded and washed away very quickly. The rate of soil loss throughout the world today exceeds the rate of soil production. We all have a responsibility to make sure our actions do not destroy the nutrient value of soils or cause soil to be lost through erosion. Soil is a farmer's most important resource. Farmers have a particular responsibility to manage their soil.

4. Soil is our life support system. Display this statement in a prominent position in the classroom and have students suggest answers to the following:
   a. Who needs soil?
   b. Are our soils under threat? If so why?
   c. Is there a connection between healthy soils and healthy people?

[1] Xenophon was a Greek historian and soldier from Athens. He lived from c.430-354BC and was a student of the famous philosopher Socrates.

Activity 1: Nutrients and Plant Growth

Teacher Background Information

Activities 1 and 2 in this unit enable students to investigate two main characteristics that scientists use to describe soil – organic content and texture.

We often refer to soils as good, poor or bad; fertile or infertile; light or heavy and even sweet or sour. Scientists describe soils according to nine characteristics - colour, compaction, moisture content, organic content, pH, profile, structure, temperature and texture. **Of these, organic content, pH and texture are the most important**.

The basic requirements for plant growth, are water, soil and sunshine. Australia has lots of sunshine, but it is a dry continent and our soils are not very fertile. Despite this, Australia is an important producer and exporter of food and fibre. This is largely due to the ability of farmers to understand the limitations of their soils, to manage them, prevent soil erosion and conserve water. Mistakes were made previously, but we have learnt from them.

Soil is made up of:

- Minerals (from rocks);
- Air (emits and absorbs gases and dust);
- Water (dissolves nutrients making them accessible to plant roots); and
- Organic matter (dead tissue of plants and countless organisms).

The organic content of soil greatly influences the plant, animal and micro-organisms in the soil. As organic material decomposes, it provides many of the necessary nutrients for these soil inhabitants. All soils need periodic additions of organic matter to remain fertile.

Many people confuse humus and compost. Both improve soil quality.

Humus: The dark, stable remnant of decayed plant and animal matter. It is the organic, non-cellular, long-lasting component of soil - organic because it contains mostly stable carbon compounds with no phosphorus and little or no nitrogen. It improves soil structure, making it crumbly and aerated, increases its ability to hold water and supports plant growth. Its nutritive qualities include trace elements and several important organic acids.

Compost: Organic matter that has been broken down by bacteria. It increases the nutrient content of soil, is beneficial as a soil conditioner, fertilizer and as a natural pesticide for soil. Once fully decomposed, organic matter is known as humus.

Composting organisms require four important ingredients to work effectively:

- *Carbon* - for energy - the microbial oxidation of carbon produces heat. Examples - shredded paper/cardboard, dry brown leaves, ash, sawdust, hay and straw;
- *Nitrogen* - to grow and produce more organisms to oxidise the carbon. Examples include fresh green materials, grass, weeds, fruit and vegetable waste and prunings from trees and shrubs;
- *Oxygen* - to oxidise the carbon, enabling the decomposition process;
- *Water* - to maintain activity without causing anaerobic conditions - namely, moist but not saturated.

Teacher Preparation

This investigation can be done in a school garden or in pots in the classroom. It requires pre-preparation of two soil samples per group. In scheduling the activity, allow sufficient days for seeds to germinate and results to be observed. This may take a couple of weeks depending on the time of year (if using outdoor soil plots).

As students will be handling compost, teachers will need to exercise discretion in selecting appropriate compost, ensuring students wear gloves when handling it and washing their hands afterwards.

Equipment Needed per group for Activity 1

- Photocopies of Student Activity 1: Nutrients and plant growth.
- Access to part of a school garden or 2 x 20cm plastic garden pots.
- Small garden trowel or fork
- Plastic gloves for each group member who handles soil and compost.
- Soil for pots and access to a compost supply.
- 6 bean seeds - 3 seeds per sample.
- Watering can or hose access (if outside).

What to do

1. Decide where the soil samples will be set up - either in a section of the school vegetable garden or in pots in the classroom. If using pots, ensure the soil is sourced from the one area.

2. Collect the necessary materials - soils, compost, pots, seeds and gloves.

3. Introduce the activity by asking students if they have a vegetable garden at home and what additives (fertilisers, compost, grass cuttings and leaf mulch) are used to increase the soil fertility.

4. Divide the class into workable groups - the size and number will depend upon whether the activity uses the school garden or is done within the classroom. (Six groups are suggested for Activities 2 and 3).

5. Each group prepares two soil samples – if working outside, group plots will need to be clearly marked.

6. Before planting their seeds, encourage students to consider:
   a. The amount of compost to add;
   b. How they will ensure their seeds germinate;
   c. The rate and quantity of watering;
   d. The amount and intensity of light available to their samples; and
   e. A suitable way to measure plant growth (hint: bury a ruler in each plot after planting).

7. While waiting for the seeds to germinate, students will need to:
   a. Identify key risks to their investigation;
   b. Determine when and how they will make and record their observations; and
   c. Predict the outcome.

8. It is suggested that teachers show the video below, after the seeds have sprouted sufficiently for students' investigations to get under way. The video presents the fundamental but engaging concept of soil as the "life support system" for plants. It describes what soil is and what lives within it.

   Soil: Healthy Dirt makes Healthy Plants. The Life in Dirt - 5 minutes Scootle M015603
   http://splash.abc.net.au/home - !/media/104056/soil-healthy-dirt-makes-healthy-plants

   The last section explains how to build a worm farm. Teachers may choose to stop the video at this point if students have already had experience with worm farms.

Generate follow-up discussion:

- Why is compost sometimes called a super soil?
- What role do microscopic bugs and bacteria play?
- Why are roots important to plants?
- Why do farmers and gardeners like having worms in their soil?
- Find out what soil biologists do and why their work and research is so important.

task

Student Activity 1: Nutrients and Plant Growth

One of the most important ways scientists describe soils is by their organic content. Soil is made up of:

- Minerals (from rocks);
- Air (emits and absorbs gases and dust);
- Water (dissolves nutrients so plant roots soak them up);
- Organic matter (insects, microscopic bugs and bacteria); and
- Decaying matter (broken down plant and animal matter in varying states of decay)

Healthy soils are vital for healthy plant growth. They enable plants to use water and nutrients in the soil and enable farmers to grow productive crops and pastures. Healthy soils also provide us with food.

Compost gives us healthy soils, but it can be tricky to make if you don't know how. Compost includes anything organic that can be consumed by worms, bacteria, microscopic bugs or fungi. You need the right environment for organisms to do their work and produce good compost. Good compost isn't smelly. It needs a balance of:

Carbon containing ingredients - BROWN, such as autumn leaves, pea-straw, lucerne hay, sugar-cane mulch, moistened cardboard, egg cartons and pizza bases and shredded newspaper.

Nitrogen containing ingredients - GREEN, such as lawn clippings, fresh garden prunings, green leaves, kitchen scraps, citrus peelings, egg shells, tea bags, coffee grinds.

Humus - the end product - fully decayed plant and animal matter. It improves soil structure and water holding ability.

Aim

Working in groups, your task is to compare the rate of germination and growth of plants in two soil samples, one with compost added and one without.

Materials

- Access to part of your school garden or 2 x 20cm plastic garden pots.
- Plastic gloves for handling compost and soil.
- Soil plus shovels and trowels.
- 6 bean seeds per group - 3 seeds per sample.
- Compost – an equal amount for each group.
- Measuring beaker or jug.

Method

1. Using gloves, prepare your two soil samples and remove any weeds.
2. If using pots, fill each one to a pre-determined height.
3. Label one sample A and the other sample B. Add compost to sample B
4. Plant 3 equally spaced seeds per sample.
5. Insert an appropriate measuring mechanism into the soil.
6. Water your seeds. Record when and how much water is given to each sample.
7. Decide and agree how your group will monitor and record your observations.

task

Student Activity 1: Nutrients and Plant Growth

Group Observation and Recording Sheet

Results

Students' Names:

Sample	Planting Date	Germination Date	Watering - Dates & Amount	Growth - Dates & Height
A				
B				

Discussion

1. Which seeds germinated first – those in Sample A or B?
2. What differences did your group observe?
3. Did one sample require more attention than the other? What was this?
4. What method did you use to determine whether your plants needed more frequent watering?
5. Did your group's results match your expectations?
6. What would your group change if you did the experiment again?

Reflect

We cannot live without soils. Think about this and start a list of reasons why soil is so important.

You can add to this list of reasons as you work through this unit.

assess

Assessment

This assessment task has two components.

1. From your observations and discussion, prepare a report on your findings.

Nutrients and Plant Growth

Name:

Sample A	Sample B
Days between planting and germination	Days between planting and germination
Number of seeds germinated	Number of seeds germinated
Rate of Watering	Rate of Watering
Average rate of growth of plants - show calculations	Average rate of growth of plants - show calculations
Description of the investigation	
Differences observed between the two samples - appearance and soil	
Why was that?	
What would you change next time?	

2. Prepare a graph that clearly shows the average rate of plant growth within each soil sample over the observation period. This can be a line graph or bar graph. Your graph needs to show:
   - Duration from planting to final measuring, using number of days.
   - The growth of the plants.
   - Think of a way to show some extra features such as when seeds germinated.
   - Put all the necessary labels on your graph.

Activity 2: Soil Types - Texture Testing

Teacher Preparation

This activity contains two experiments on soil texture - Test 1: Field Texturing and Test 2: The Shake Test.

These enable students to build on their understanding of soils by investigating soil texture and its effect on the ability of soils to retain water and nutrients.

Sufficient time needs to be allocated to enable students to make their observations and for undisturbed storage of the measuring cylinders or jars in Test 2.

Background

Ask students how we describe soils - good, poor or bad; fertile or infertile; sandy, loam or clay; light or heavy and perhaps even sweet or sour. Scientists describe soils according to nine characteristics - colour, compaction, moisture content, organic content, pH, profile, structure, temperature and texture.

Explain that of these, organic content, pH and texture are the most important.

Soil Texture

Soil texture is an estimate of the relative amounts of sand, silt and clay particles in a soil. The physical and chemical behavior of soil is influenced by soil texture. Soil texture varies according to:

- The type and mineral composition of the parent material from which it formed;
- The position of the soil in the landscape; and
- The physical and chemical weathering processes involved in its formation.

Soil texture affects the movement and availability of air, nutrients and water in a soil.

As no two soils are exactly the same, it is useful to be able to group them into three broad categories - sand, silt and clay. Most soils are a mix of all three and the relative size and amount of each determines the soil texture (how it looks and feels). Specifically:

Sandy soils are not able to hold water and dry out quickly because they have larger particles with larger spaces (pore spaces) between them. Clay soils have small particles and small pore spaces. They store water well (very often too well) but often this doesn't allow good drainage and aeration. All soils between sand and clay are called silt. Silt is a mix of coarse and fine particles – it is more porous and can absorb and hold water.

- *Sand* - comprises small particles of weathered rock – quartz and resistant primary minerals such as mica. It is fairly coarse and loose and the large grains allow water to drain easily. Sandy soil is not good for plant growth as it holds very little water and is unable hold onto nutrients like clay is able to.
- *Clay* - very fine-grained soil. Clays are made up of secondary clay minerals and oxides and of iron and aluminium. Clays do not drain well or enable plant roots to flourish as there is little space between the grains for air or water to circulate. Clay soils are able to store nutrients, but are not as good for farming as they are hard to work. Clay soils swell when wet and shrink as they dry.
- *Silt* - is a combination of sand, silt/loam and clay. Silts are typically composed of quartz and small mineral particles such as feldspar and mica. Farmers and gardeners prefer this type of soil as it is easy to work, can absorb and hold moisture, but also allows for good drainage.

Equipment Needed

Good samples of clay, silt and sand need to be obtained in advance. A four litre ice cream container of each of types should be sufficient. Six groups are an ideal number, enabling two groups to test each soil type inTest 2.

Per group:

1. Soil samples - 1 tablespoon of each type (Test 1)
2. Dish or paper towel to display worked samples (Test 1)
3. Beaker/jug for water (Tests 1 and 2)
4. Soil sample - to ½ fill a measuring cylinder with one type only (Test 2)
5. 1 measuring cylinder or jar (Test 2) – preferably with a lid
6. Labels and marker pen (Test 2)

What to do

Working in groups, students undertake two investigations. Instructions for the first test are provided and students test all three soil types. Students are provided with the materials for the second test - Shake Test. They select **one soil type only**. They then plan and conduct their own experiment.

1. In advance, collect three soil samples ranging from sand, silt, clay. Remove particles (>0.5cm).
2. Label each sample and set them aside.
3. Have a beakers or jugs of water handy.
4. Hand out Student Activity 2: Soil Types - Texture Testers Background.
5. Hand out Student Activity 2: Soil Types - Texture Testers Tests 1 and 2.

Discuss how the relative amounts of sand, silt and clay in soils affects their ability to support plant growth and their likelihood of being eroded by water and wind. Ask students which type would be best for growing vegetables and flowers in the home garden and for agriculture.

Test 1: 'Field Texturing'

1. Provide students with the task. They decide how to carry it out and record their observations.
2. Students select a soil sample (size of a golf ball) from one of their three different types. They moisten it with a small amount of water and knead it into a ball, continuing to work it and adding more soil and water if necessary, until it no longer sticks to their fingers.
3. With a clean and slightly damp hand, students place the ball between their thumb and forefinger and try to squeeze it into a ribbon with their thumb. This will be difficult for the sandy soil.
4. Students examine the sample – does it feel gritty or smooth and can it be rolled into a ball without crumbling? They repeat the demonstration with the other two samples.
5. Ask students how texture affects the ability of each to hold water, resist erosion and promote plant growth? The sand will feel course and gritty and won't hold its shape, the silt will be partly gritty and sticky, will roll into a ball, but will crumble easily. The clay will be smooth, sticky and a bit like plastic. It can be rolled into a ball. It forms ribbons when squeezed between the fingers.
6. Students compare their three samples and record their findings.

Test 2: The Shake Test

In their same group, provide students with the materials and the task. Each group tests one soil type. Ensure that all three soil types are tested – preferably two groups per soil type.

Students plan how they will conduct the experiment. Ideally they should:

1. Half fill the measuring cylinder or jar with soil, add water to about 1cm from the top and carefully shake it until all the soil particles are suspended. This breaks the soil aggregates apart and the soil separates into individual mineral particles. It is preferable to have a tight fitting lid.
2. Store their container where it can be observed, but not disturbed, for 2-3 days. All observations should be done without picking it up. An initial measurement can be taken after 1-2 minutes. This will be the sand.
3. Students will need some guidance here, as the next observation should be made after a further 2-3 hours. This will be the silt. It is preferable for the final observation (clay) to be done 2-3 days later when most of the sediment has settled and the water is clear.
4. After measuring and recording the thickness of the layers, students calculate the percentage of each in the sample. To calculate the percentage of sand, silt and clay:
   a. Depth of sand layer / total depth of soil x 100% = % clay
   b. Depth of silt layer / total depth of soil x 100% = % silt
   c. Depth of clay layer / total depth of soil x 100% = % sand

Students discuss and record their observations.

This experiment is modified from Camp Internet's Global Gardening Studies
https://www.rain.org/global-garden/soil-types-and-testing.htm

Expected Results and Explanations

Test 1: Depending on the soil samples, students should be able to describe the differences in feel and plasticity. They should be able to associate these differences with each soil type and suggest how this could affect the ability of each type of soil to support plant growth and resist erosion.

Test 2: After planning and conducting their experiment students should be able to describe the three different soil types within their sample, noting the order in which each settled out. Ideally, they should be able to calculate the % content of sand, silt and clay and use this data as a means of graphically representing their findings.

Explain and encourage discussion on other associated features - such as ability to hold moisture yet allow adequate drainage, ability to store nutrients, the role of soil texture in determining which soils are better for growing plants than others and the role of soil texture in maintaining soil health and quality, both on a larger scale as in farming and parks and on a smaller scale in gardens and vegetable plots.

Further information can be accessed via the link below.

Penn State Extension – Soil Quality – Introduction to Soils
http://extension.psu.edu/business/start-farming/soils-and-soil-management/soil-quality-introduction-to-soils-fact-sheet

task

Student Activity 2: Soil Types - Texture Testers

Background

In this task you will be investigating soil texture. This is one of the most important ways scientists describe soils.

The three main types of soil are sand, silt and clay.

Soil texture is an estimate of the relative amounts of sand, silt and clay particles in a soil. Soil texture varies according to:

- How it was formed;
- Where it is in the landscape; and
- The weathering processes that changed it.

You can feel soil texture when you rub a small moist sample between your thumb and forefinger. Some soils are sticky, others don't stick together at all, while others feel "doughy" or "spongey."

One of the main differences between sand, silt and clay is the relative size of the soil particles. This plays a large part in the movement and availability of air, nutrients and water in a soil.

Have you ever walked in soil that sticks to your shoes when it's wet? People often call this type of soil a heavy soil? Which of the three types of soil do you think it is?

Which of the three types of soil might some people describe as a light soil?

An idea for a quick class survey:

Question: Which type of soil - clay, silt, or sand is best for agriculture and growing vegetables and flowers in the home garden?

You have one 'vote' each. Have someone record the numbers for each and keep the scores so the class can readily access them again.

Once you have finished your investigations, make sure your teacher asks this question again and record how the answers have changed. You may be surprised.

task

Student Activity 2: Soil Types – Texture Testers

Test 1: Field Texturing

Aim

To investigate the differences in the feel of samples of clay, silt and sand.

Materials

Your group needs:

- 3 soil samples – one each of sand, silt and clay (1 tablespoon per sample)
- beaker/jug for water
- Dish or paper towel to display your worked sample
- Marker pen

Method

1. One person the group takes a small amount (about the size of a golf ball) of the sand sample.
2. Another student labels a sheet of paper ready to display the sample when finished.
3. Add a very small amount of water the soil sample and knead it into a ball until it no longer sticks to your fingers. Another group member may need to add more soil and water.
4. Give the sample to another member of the group. This person should have just washed his/her hands, leaving them slightly moist.
5. Place the ball between your thumb and forefinger and try to force into a ribbon.
6. Examine the sample – does it feel gritty or smooth and can it be rolled into a ball without crumbling?
7. Record your observations.
8. Repeat the demonstration with the other two samples.
9. Can they be rolled into a ball? What shape do they make when an attempt is made press each one of them between the thumb and forefinger?
10. Record and discuss your findings.

task

Student Activity 2: Soil Types - Texture Testers

Test 2: Clay Silt and Sand

Your group needs to design and carry out an experiment to determine the relative amounts of clay, silt and sand within a given soil sample when mixed with water. Make three observations over a period of two to three days.

Materials Provided per Group

- 1 soil sample - of clay, silt or sand to half fill the measuring cylinder
- 1 measuring cylinder of jar, preferably with a lid
- 1 beaker/jug for water
- Labels and marker pen

Plan your experiment – as a group decide and record:

1. The aim of your experiment.
2. What you expect will happen and why.
3. Your method - how you will separate the sand silt and clay.
4. What you will measure, when and how you will record your three observations.
5. What you expect the water to look like when you do the final observation.
6. Once you have finished your observations, calculate the percentage of each soil type below.
   a. Depth of soil = cm
   b. Depth of sand layer / total depth of soil x 100% = % clay
   c. Depth of silt layer / total depth of soil x 100% = % silt
   d. Depth of clay layer / total depth of soil x 100% = % sand
7. Discuss and record your findings. Were the results as expected?
8. Allocate one group member to report. Groups that tested the same soil type could present their results together. The percentage data needs to be recorded so all students can access it.
9. What do the combined class results show for each soil type?

discuss

Soil Characteristics - Reflection

Encourage students to reflect on their learnings from the two soil texture tests and add to their understanding of the characteristics and importance of soils. This could be done with each group deliberating and agreeing on a group answer. One member of the group provides the group response.

Ask students the following questions:

1. In test 1, which soil type was unable to hold it shape when rolled into a ball? Why was this?
2. In test 2, was your group able to name each layer correctly as it settled out? How could you tell?
3. Which soil type has the largest particle size? Which has the smallest?
4. The pore size is the space between the particles. Which type has the largest poor space?
5. How does pore size affect the ability of soil to hold water?
6. Clay soils have small particles and small pore spaces. How does this affect their drainage and aeration?
7. Silt has a mixture of larger and smaller particles. Why do farmers and gardeners prefer this type of soil?
8. Why are sandy soils more likely to be eroded by water and wind erosion?
9. Suggest how the following sentence could be completed.

   Soil texture is important because ……..

   Encourage students to think back to Activity 1 where they compared the rate of plant growth in two soil samples – one with added compost (organic matter).

10. Which types of soil would benefit most from the addition of compost? Why?

Reminder:

The following question was asked at the beginning of activity 2. Ask it again. Students vote by a show of hands.

Which type of soil is best for agriculture and for growing vegetables and flowers in the home garden?

- Which type of soil scored the highest this time? What percentage of the class nominated this type?
- Which soil type showed the greatest shift?

Suggest some more reasons to support the statement below that was introduced at the beginning of Activity 1: Nutrients and Plants Growth.

We cannot live without soils.

assess

Assessment: Investigation Report - Soil Texture

Student Name:
Other Group Members:

Soil Type	General Characteristics - Test 1		Labelled Diagram - Test 2 Results	Bar Graph - Test 2 Results
	Description	Behaviour	Your Soil Type:	Depth/Time
Sand				
Silt				
Clay				

What conclusions can you draw from your investigations and the comparison of findings with other groups:

What would you do differently, if you did the texture tests again?

Student Activity 3: Soil Word Search — Optional Extension

Read each of the words below and think about their meaning in the context of your work so far on soils.

Group A	Group B	Group C
Soil	Mulch	Mulch
Water	Wind	Wind
Trees	Leaves	Leaves
Organic	Manure	Manure
Nutrients	Growth	Growth

1. Find each one in the word puzzle. Circle the word after you have found it.

   Note: SOME WORDS MAY BE PRESENTED BACKWARDS

X	V	V	B	B	V	L	Z	L	S	N	R	J	Z
O	R	G	A	N	I	C	E	T	J	M	W	D	Q
N	B	V	G	O	R	A	N	M	A	N	U	R	E
L	O	P	S	O	V	E	M	B	P	H	D	L	Q
T	D	I	C	E	I	Q	H	Y	C	T	M	Q	J
P	S	K	S	R	O	T	G	L	S	E	E	R	T
L	S	O	T	O	W	X	U	D	N	I	W	M	Q
A	P	U	P	O	R	M	Y	W	A	T	E	R	V
N	N	B	R	M	J	E	T	G	N	T	M	L	N
T	Y	G	T	W	O	T	L	Z	E	G	N	B	L
S	D	N	Y	J	Z	C	T	T	T	N	X	R	Q

2. Select one word from each of the three groups, A B and C and include it in a sentence about soils.

   Group A_____

   Group B_____

   Group C_____

task

Student Activity 4: Mineral Nutrients

Read and discuss the following facts:

- Soil provides the food, water and oxygen needed for healthy plant growth, but in order to do this, it also needs feeding and watering.
- Plants get carbon, hydrogen and oxygen from the atmosphere. Soils also need carbon, hydrogen and oxygen.
- Bacteria in the soil also enables plants to get nitrogen from the atmosphere.

You already know that decomposed organic matter improves soil quality and plant growth.

Mineral elements in the soil are also an important ingredient - they are essential for plant growth.

Mineral elements can be divided into three groups:

- The primary or major elements. These are the most important for healthy plant growth.
- The secondary elements are also needed. In most soils, these are required in lesser amounts.
- The trace elements. These are only required in very small amounts.

1. Research the symbol for each one. Write it in the spaces provided. Next time you visit a plant nursery, find as many of these symbols as you can amongst the products on sale.

Primary Elements

Nitrogen		Phosphorus		Potassium	

Secondary Elements

Sulphur		Magnesium		Calcium	

Trace Elements

Iron		Boron		Manganese	
Zinc		Molybdenum		Copper	

2. If time permits, watch the video - Soils Support Health Soil - Science Society of America.
https://www.youtube.com/watch?v=LXUnGntFahE

- Describe how these mineral elements end up in our food.
- Soil is full of life. It is often said that a handful of soil has more living organisms than there are people on planet Earth. Soils are the stomach of the earth, consuming, digesting, and cycling nutrients and organisms. Provide some examples to support this.

Activity 5: Soil Erosion and Water Management

Teacher Preparation

This class demonstration introduces the important role of groundcover in protecting soil from erosion.

Students observe the effect of water being poured onto three soil samples with different types and amounts of groundcover. One soil sample has no cover, another is covered with dry leaves and the third is covered by grass that has dried out for a few days ahead of the experiment.

Students predict what will happen once water is poured onto the samples - appearance and amount of water that flows out and the time taken for water to start draining out.

Equipment needed

- Copies of Activity
- 3 clear 1.25l plastic soft drink bottles
- Soil - enough to half fill each bottle
- Quick growing grass seed or a thick section of turf
- 3 clear plastic tumblers/measuring containers
- Tray
- One measuring jug and a supply of water
- Dried leaves – enough to cover one soil sample
- Stop-watches

What to do

Set aside enough time to allow a thick cover of grass to grow to 3-5 cm in height in one of the soil samples. Let the grassed sample dry out for a few days, before undertaking the experiment.

To save time, you could obtain a thick section of turf.

It is suggested that teachers view the following video before undertaking this activity.

Fun Science demos

https://www.youtube.com/watch?v=im4HVXMGI68

Preparation – to be carried out in advance

- Leaving caps on, cut away a 14cm x 7cm section along the side of each bottle below the neck.
- Place each bottle on its side and fill with an equal amount of soil up to the level of the neck.
- Keep each bottle on its side once filled.
- Leave the soil in one bottle bare and cover the other with a 2cm layer of dried leaves.
- Plant quick growing grass seeds in the third and keep moist till the seeds germinate and the plants are cm high.

An option would be to show students this video instead of doing the experiment. The video could be the stimulus for students to complete Activity 6: Soil Erosion and Water Management).

task

Student Activity 5: Soil Erosion and Water Management

Background

Soil quality and quantity can be improved by:

- encouraging living organisms in the soil;
- slowing the flow of water across land; and
- ensuring sufficient nutrients and pH levels in the soil.

Students observe this class demonstration and assist as required.

Aim

To explore the effect of running water on different soil surfaces.

Materials

The soil samples have been set up in advance. The soil in the 1st sample is bare, the 2nd sample is covered with 2-3cm of dried leaves and the 3rd is covered by a thick matting of grass.

Method

1. Position the three sample bottles of soil so each can be clearly observed by the class.
2. Place a tumbler under the opening of each bottle to catch the run-off. Remove the bottle top.
3. Two students are selected as timers - one to advise when three minutes are up and another to record when the water first starts to drain out.
4. Another student is selected to pour water at a constant rate, onto the bare soil sample. Observe what happens. Repeat with the other two samples.
5. Observe what happens.
6. Record the results in terms of time, appearance of the water and amount of water run-off.
7. Repeat with the other two samples.
8. Record the results in terms of time, appearance of the water and amount of water run-off.

Results

9. Using the Soil Erosion and Water Management Results Sheet, draw an annotated sketch of each soil sample.
10. Record your observations.

Discussion

11. Were the results as expected?
12. What happened when the grassed sample was squeezed? Why was this?
13. Explain the role that plant roots in this demonstration.
14. Explain the role that groundcover can play in improving soil quality and amount.
15. Why is it so important that we all do what we can to limit soil erosion.

task

Student Activity 5: Soil Erosion and Water Management

Results Sheet

Name:

Sample	Annotated sketch	Observations

task

Activity 6: Reflection

Think about what you have discovered in the previous activities. If time permits, ask your teacher if you can watch the following videos.

Soils Protect The Natural Environment:
https://www.youtube.com/watch?v=hpMG43oFin4&feature=youtu.be

Published 24 August 2015. Soil Science Society of America. 2:32 minutes. Explains the role of soils in protecting the environment - in this instance from an obvious American perspective.

Soils Support Health: Soil Science Society of America
https://www.youtube.com/watch?v=LXUnGntFahE

Working in small groups or with a partner, reflect on your learning about soils:

1. Discuss some examples of how soils support life.
2. In Activities 1 and 2 you were asked to record your thinking about the statement - *We cannot live without soils*. Share your previous thoughts on this statement.
3. How would you now answer the question - *Why are healthy soils so important?*
4. Is there a link between the quality of food we eat and the quality of soil? What might this be?

assess

Assessment

"**Soil is our life support system**" - Do you agree with this statement?

From what you have discovered from the activities and experiments in this unit of work, prepare a two minute presentation explaining your answer and demonstrating the relationship between soiils, food and people.

Think up a catchy title or slogan that supports this statement and your presentation..

web

Online Teacher Support Resources

1. Soil: Healthy Dirt makes Healthy Plants. The Life in Dirt ABC Splash. Kids in the Garden
   http://splash.abc.net.au/home - !/media/104056/
   TLF ID M01560

2. Soil is Not Dirt - Soil Science Society of America.
   http://www.soils4teachers.org/lessons-and-activities

3. Fact sheet. How to make and manage perfect compost Gardening Australia
   http://www.abc.net.au/gardening/stories/s2683832.htm

4. The Dirt on Soil
   http://school.discoveryeducation.com/schooladventures/soil/down_dirty.html
   Discovery Education - Teacher Guide, information activities

5. Soils Protect The Natural Environment Soil Science Society of America
   https://www.youtube.com/watch?v=hpMG43oFin4&feature= youtu.be

6. Soils Support Health Soil Science Society of America
   https://www.youtube.com/watch?v=LXUnGntFahE

7. Understanding Soil pH Frances Michaels
   https://www.greenharvest.com.au/GreenGardenNotes/UnderstandingSoilpH.html
   Understanding Soil pH

8. Soil Quality - Introduction to Soils- Penn State Extension
   http://extension.psu.edu/business/start-farming/soils-and-soil-management/soil-quality-introduction-to-soils-fact-sheet

9. The Biodiversty of Living Soil - CSIRO
   http://www.scootle.edu.au/ec/viewing/R11831/index.html

10. Acid Soil Action - NSW Department of Agriculture
    http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/167187/soil-ph.pdf

11. Soil Erosion – Frank Fenner Association
    http://www.natsoc.org.au/our-projects/biosensitivefutures/part-4-facts-and-principles/ecological-issues/soils-erosion

12. Green Harvest
    https://www.greenharvest.com.au/GreenGardenNotes/UnderstandingSoilpH.html

13. Australian Native Plants
    http://www.australianplants.com/plants.aspx?filter=true&key=soil&value=11

14. Soils a Hidden Resource - Food and Agricultural Organisation (FAO)
    https://www.youtube.com/watch?v=YdBpLfhuZuk&list=PLyv2sudQhZoPHV7KUZ6HaUkhuynEXqNn3&index=35

15. Who loves soil? Tim does! ABC Splash
    http://splash.abc.net.au/home - !/media/528019/

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