Digging into Soil Sciences (Level 3)

Description	Learners will explore the properties, types, and uses of soil found in their locality. They will test soil pH and create a compost bin to promote soil fertility. They will then choose the most suitable plant to grow in the soil available to them.
Leading question	How can I analyse and prepare the soil to grow my own plant?
Subjects covered	Science, Social Science, Art, English, Math
Total time required	40-60 minutes a day for 5 days
Resources required	Paper, pencil, different soil samples from the area, glass or transparent container, stones or small rocks, cloth, string, water, tray
Learning outcomes:	By the end of this project, learners will be able to: Knowledge-Based Outcomes: 1. Describe soil as a natural resource, the process of soil formation, and its different layers. 2. Differentiate between different types of soils based on soil particles. 3. Examine the properties of different types of soil. 4. Determines which crops grow in different types of soils. 5. Test the pH of the soil. 6. Make compost and describe its benefits. 21st Century Skill Outcomes: 1. Think creatively in designing their clay/soil models and using objects around them to mould and decorate their models. 2. Think critically by analysing soil samples to determine their type and making inferences during experiments. 3. Communicate effectively by providing feedback and presenting their findings through various visual media and speeches.
Previous Learning	- Meaning and causes of soil erosion - Meaning of pH, acidity, and alkalinity
Supervision required	Medium

Day 1 -

Today, you will learn about the importance of soil, discover how soil is formed through an experiment, and start thinking about what plants you could grow.

Time	Activity and Description

<table>
<tr><td>10 minutes</td><td>Introduction
What do you think would happen if the whole world was covered by water and there was no land? Would people survive? Why do you say so?

Tip: Help learners think of what people would eat, where they would live, and what would be a challenge. How long could they survive?

- Life would be extremely difficult without any land!
- List 10 things we get from land. (Food – grains, leaves, vegetables, fruit, meat; resources – wood, rocks, metals, etc.)
- Almost all the things we use in our daily lives have some parts that come to us from land.
- Can you think of something other than water that does not come from land?
- One of the most important parts of this land is its topmost layer – soil.
- Without soil, there would be no plants! Without plants, we cannot survive.</td></tr>
<tr><td>15 minutes</td><td>Weathering process
- In this project, we will be exploring the soil that is found in our region. We will collect samples from around our locality and study what they contain. We will then choose a soil that is suitable for our plants to grow in and create a compost pit to help them grow!
- Before we do that let us understand how soil is formed.
- How do you think soil is formed?

Note: Ask learners to make the following table in their notebooks and record their hypothesis. Once done, ask them to carry the experiment out based on the described method. Do not share observations and inferences with them, and ask learners to write them on their own.

<table>
<tr><td>Hypothesis:</td><td>Soil is formed by the process of weathering.</td></tr>
<tr><td>Materials Needed:</td><td>Steel glass/slim container, small pebbles, water, white or light-coloured cotton cloth, string/rubber band</td></tr>
<tr><td>Method:</td><td>1. Place 2-3 small stones or small pieces of bricks in the glass.
2. Fill half the glass with water.
3. Secure the cloth on the rim and tie it in place with the string like a lid.
4. Shake the glass vigorously for 3 to 4 minutes (you can take turns with your partner).
5. Once done, turn the glass upside down and let the water slowly drain through the cloth.
6. Carefully remove the cloth and examine what is left on it. (You can refer to the link in Appendix 1 to watch a video of</td></tr>
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<table>
<tr><td></td><td>
<table>
<tr><td></td><td>this experiment)</td></tr>
<tr><td>Observations:</td><td>Sample observations can include:
There are small particles or powder on the cloth.
Small pieces of the rock broke down and can be seen on the cloth.</td></tr>
<tr><td>Inferences:</td><td>Sample inferences can include:
Water and movement breaks down rocks into small particles.
Water weathers rock to form small particles.</td></tr>
</table>

Think and answer:
- Based on this experiment, how do you think soil is formed?
- Yes, soil is formed by the breaking down of rocks!
- This powdered rock then mixes with things like water, dead leaves, etc. to make the soil we see around us.
- Observe these images.
 
- Now, can you imagine, in what ways would the soil created by these rocks look different?
- Depending on the composition of rocks, the soil created by them is different in colour, texture, and minerals. We will explore the idea of types of soil more in the coming days.</td></tr>
<tr><td>5 minutes</td><td>This process of soil formation takes many many years. Do you know it would take over 100 years to create just one centimetre of topsoil?

But it is very easy for us to damage and lose this top layer of soil.
Some of the biggest problems we face are:
1. Soil erosion: the washing away of the top layer of soil.
2. Soil contamination or pollution: mixing of harmful substances in soil, making it less suitable for plant growth.
3. Reduction in soil fertility: loss of nutrients in soil because of its overuse, overuse of chemicals in farming etc.</td></tr>
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<table>
<tr><td></td><td>We will examine some of these problems in more detail as we progress and add sections in our guide with tips on how we can prevent them.</td></tr>
<tr><td>10 minutes</td><td>Planning to Grow Your own Plant
We will now think about the plant that we want to grow! To do this:
- Come up with a list of plants you would you like to grow and why. Consider usefulness, beauty, availability of seeds, etc. while making this choice.
- Ensure that this is a plant and not a tree because trees take longer to grow and it would take us years to see any results!
- In addition to soil, make a list of things you will need to grow this plant and where you can get them from.

Note: Share the table below with learners to give them a format to record their notes.

<table><tr><td>What I need</td><td>Where I can find it</td></tr><tr><td>water</td><td>home</td></tr><tr><td>sunlight</td><td>open spaces</td></tr><tr><td>spade</td><td>neighbour</td></tr><tr><td>seeds</td><td>fruits at home/the market</td></tr></table>
As we analyse the soil samples available to us, you will choose one of these plants from your list based on the kind of soil it needs.

Note: Learners can take the help of an adult while trying to grow their plant. They can grow their plants in a pot if available.

In the next class, we will be analysing what soil contains and creating our own models from the soil!</td></tr>
<tr><td>At home activities</td><td>1. Ask family members for feedback on your plant list and the things needed for it to grow.
2. Start collecting 1-2 different soil samples from your area and keep a record of where each sample is from.
3. If possible, visit a garden or farmland and collect enough soil to fill half a small transparent glass or bottle.
4. Carry 2 cups of flour and half a cup of salt to mix with water to create clay to make a small clay model. (An alternative activity has been mentioned on day 2, if this is not possible)</td></tr>
</table>

Day 2

Today, you will identify the different components of soil and learn about the characteristics of different types of soil.

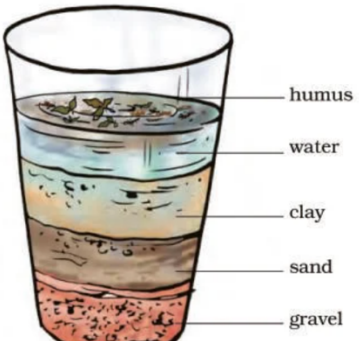
<table>
<tr><th>Time</th><th>Activity and Description</th></tr>
<tr><td>15 minutes</td><td>
Components of Soil Experiment
Note: Since settling of soil will take time, please carry out the experiment a day before and keep the tumbler showing layers of soil ready for learners to observe. They can follow the steps and wait for the soil to settle, meanwhile, use the sample you created for learners to observe.

- Yesterday, we saw that soil is created by the weathering of rocks.
- Apart from rock particles, what else do you think you will find in soil?
- So let us explore what our soil contains!

<table>
<tr><td>Hypothesis:</td><td>Soil contains many different types of materials</td></tr>
<tr><td>Materials Needed:</td><td>Half a cup of soil, transparent glass/tumbler/bottle, water</td></tr>
<tr><td>Method:</td><td>1. Break any big lumps in the garden/farm soil collected.
2. Fill half of the transparent container with soil.
3. Add water till the container is 3/4th full.
4. Use a stick/ spoon to mix the soil in well.
5. Leave the container to sit undisturbed for 30 minutes.</td></tr>
<tr><td>Observations:</td><td>Sample observations can include:
Different layers have been created.
We can see some particles floating at the top.
Heavy components like small stones have settled at the bottom.
The middle layers appear to contain fine particles.</td></tr>
<tr><td>Inferences:</td><td>Sample inferences can include:
Soil is made up of different types of components.</td></tr>
</table>

Note: Ask learners to fill out the method, observation and inferences.

Conclusion:
- It is clear that soil has many different components in it.
- The particles have settled into layers based on their weight in water.



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</table>

	- The topmost layer in the glass is **humus**, which refers to the dead remains of plants and animals that mix with soil. High humus content makes the soil more fertile, or better for plants to grow in. - Below that is the layer of water. This tells us that humus is lighter than water and, hence, floats on it. - Below the layer of water is clay. Clay particles absorb water. - Below that is the layer of silt. Silt contains all the important minerals that plants need to grow. - And lastly, there is gravel (small stones).
20 minutes	**Types of Soil** - We already know that based on the rocks that broke down to form it, the soil has different properties. Now, let us understand the different types of soil. - Now, based on the size of particles in the soil, it can be of three main types – sandy, loamy and clayey.  - Clayey soil has the smallest particles. - Sandy soil has the largest particles. - Loamy soil has a mixture of sand and clay. - Clay is the easiest to mould and stretch! That is why people use clay to make pots and statues! **Option 1:** **Moulding Clay Activity** (*if clayey soil/dough is easily available, if not use option 2*): - Today we will become sculptors and create our own models from clay! - You will use water and clay to create a work of art! - You can make multiple small models or one large one, be as creative as you can. - We will present these works of art with our final plants!  ***Note:*** *While learners are working, you can mention how clay particles are so fine, that they can hold more water and have less air in them. This makes it easier for clay to stay in shape. In contrast, sand particles are large and have gaps for air and therefore, break apart easily.*

	The dough created is a lot like clayey soil and thus can be moulded easily. **Option 2:** **Soil Castle Activity** (*can be done in any outdoor space where there is sand or mud that can be used to make structures*) **Note:** *Bring some homemade clay if possible and have learners compare the texture and moldability with the soil they use to create the models.* - Today we will become sculptors and create our own sculptures using soil! - You will use water, and things in our surroundings like sticks and leaves, create a model of anything you like – it could be a building, a house, a person or vehicle, etc. - Be as creative as you can. ***Note:*** *Please monitor learners closely as soil can have worms and other hazardous objects in it. Also, ensure learners wash their hands thoroughly with soap after the activity.* 
5 minutes	**Reflection:** - Was it easy to create this model? - Would it have been easier to do this project with a different type of soil? - How well did the soil hold water? Do you think such soil would be good for plants to grow in?
At home activities	1. Take a look at the soil samples in your glass/tumbler that you kept undisturbed at the beginning of this class. Do you see the layers form? Add any additional observations to your table. 2. Place your soil samples in the heat for a few hours to let the water evaporate from them. 3. Bring a sheet of newspaper or any hard paper to use as a funnel. 4. Ask elders in the community about which plants grow in which kind of soil and which plants grow well in our region. Make a note of their answers to discuss.
Optional Literacy Activities	**Ratios:** - Have the learners create the play dough in class. - Give them instructions to mix the water, salt, and flour in the ratio 1:1:2. - Explain that ratios show quantities in relation to each other. Each number in the ratio is related to a different thing. (*in this case water, salt, and flour*) - So if we put 1 spoon of water, we should add 1 spoon of salt but 2 spoons of flour. - Have learners determine quantities of salt and flour if they have to add 2 or 3 spoons of water.

Day 3 –

Today, you will analyse the properties of soil with respect to water absorption. You will then explore which crops grow well in which soil type and then choose which plant they would like to grow.

<table>
<tr><th>Time</th><th>Activity and Description</th></tr>
<tr><td>5 minutes</td><td>Recap
Let us revise what we learned yesterday. How are sandy, loamy, and clayey soils different from each other?
- Clayey soil has the smallest particles and absorbs the most amount of water.
- Sandy soil has the largest particles and absorbs the least amount of water.
- Loamy soil has a mixture of sand and clay and absorbs a moderate amount of water.</td></tr>
<tr><td>15 minutes</td><td>Water Absorption Experiment
Today we will analyse our soil samples to determine whether they are more sandy, loamy, or clayey. Based on this, we can choose which soil we wish to use to grow our plants!

<table>
<tr><td>Hypothesis:</td><td>Different types of soil absorb different amounts of water.</td></tr>
<tr><td>Materials Needed:</td><td>Different soil samples, water, filter paper/newspaper/think paper, water cup, 2 glass or transparent plastic cups/water bottles, and spoon</td></tr>
<tr><td>Method:</td><td>1. Choose 4 different soil samples from all the samples collected.
2. Use the newspaper or paper to create a funnel by folding it into a cone.
3. Place the funnel on the top of the cup or bottle.
4. Take a standard quantity of soil from the first sample – say 2 spoons and place it inside the funnel.
5. Take a standard quantity of water – say 10 spoons.
6. Pour water drop by drop into the funnel, ensuring that you don’t pour it all in only one spot. Keep pouring it until the water starts to drip.
7. Check how many spoons of water drip out of the soil and subtract it from your initial quantity. This is the amount of water retained by the soil.
For example, if 4 spoons drip into the cup, the water retained by the soil is 10 - 4 = 6 spoons.
8. Repeat the steps for each soil sample and compare.
9. Determine which soil has more clayey, sandy, or loamy particles based on the water absorption levels.</td></tr>
<tr><td>Observations:</td><td>Sample observations can include:
Sample 1 absorbed the most water, 8 spoons.
Sample 2 absorbed the least amount, 3 spoons.
Sample 3 absorbed 5 spoons.
Sample 4 absorbed 6 spoons.</td></tr>
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</table>

	Inferences: — ***Sample inferences can include:*** *Sample 1, collected from the garden seems to have the maximum water retention and therefore has more clayey properties than the other samples. Samples 3 and 4 had an average water absorption capacity and seemed to be more loamy.* *Sample 2 from the construction site absorbed the least water and seems to have the most sandy particles.*
10 minutes	**Plants that Grow in Different Types of Soil:** ***Note:*** *Ask learners to draw this table in their notebook.*

Crop	Conditions Needed	Recommended Soil Type
Wheat	Needs soil that is good at retaining water	
Rice/Paddy	Needs soil that holds the largest amount of water since it is a water-intensive crop	
Lentils and Pulses	Need soil that drains water easily. They do not grow well if the soil is too water-logged	
Cotton	Needs soil that drains water easily and holds a lot of air	

Crops Discussion:

- Take a look at the table. Based on your understanding of sandy, loamy, and clayey soil, can you recommend which type of soil would be useful for each crop?
- Also share the information you collected from elders and farmers on which crops grow well in our region.

Once done, discuss:

- Wheat grows well in clayey and loamy soil as it needs some level of water retention.
- Rice grows best in clayey soil as it has the highest water retention capacity.
- Lentils and pulses cannot grow in clayey soil as it is more waterlogged; loamy soil is suitable for these crops.
- Cotton grows well in sandier soil as it needs soil that holds a lot of air.

10 minutes	**Choosing Your Plant:** - Now, based on the soil sample test and the discussion you had with your community members, look back at your list of plants from day 1 and identify one plant you would like to grow based on the type of soil. - Note down the reasons for your choice as well.

	- Determine how you are going to get the seeds for this plant. *Once they are done, share:* - In the next class, we are going to think about one important aspect of soil - fertility. We will also think of a solution to improve soil fertility.
At home activities	- Ask parents or community members about soil-related problems in our region. Ask them to also share ways in which we can improve soil fertility. - Prepare the pot for your plant and acquire the seeds needed for it. - Bring the following to class: 4 spoons of the soil you plan to use to grow the plant, any small container or bowl, half a cup of baking soda, and half a cup of vinegar.

Day 4 –

Today, you will explore the issues around soil fertility, test the soil's pH, and reflect on the advantages of composting.

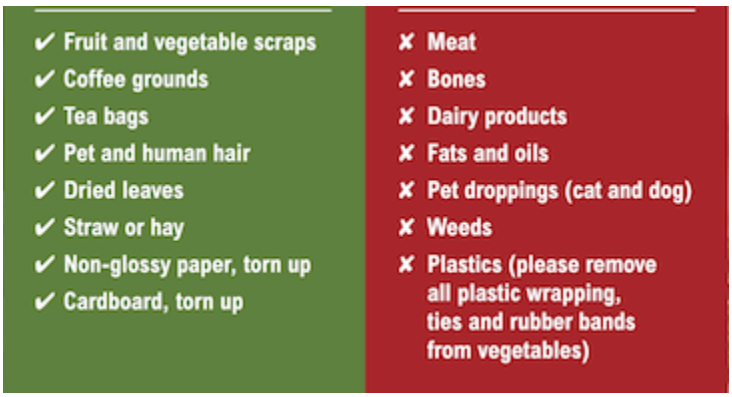
Time	Activity and Description
10 minutes	**Causes and Effects of Soil Erosion:** - Can you recall some human activities that increase the rate of soil erosion? *(Deforestation and other activities like overgrazing, bad farming practices, etc. have caused an increase in the rates of soil erosion. This means that the most fertile top layer of soil gets washed away.)* - Now, based on whatever we have learned, can you list at least 5 effects of soil erosion? ***Note:*** *After learners are done, take responses and collate them. Then close the loop by sharing:* Some critical effects of soil erosion include: - Loss of fertile land - Desertification - Pollution of water bodies - Increased flooding (as the soil can no longer absorb as much water) - Makes soil acidic (as it washes away many microbes that maintain the pH of the soil. One common concern today is that soil has become too acidic or basic for crops to grow. Ideal soil should have a neutral pH - between 6.5 and 7.5. Today, we will test our soil and then learn how we can help restore soil pH!
15 minutes	**Testing the pH of Your Soil:** ***Note:*** *Ask learners to draw the table and write down the hypothesis and materials needed for this experiment. Once done, take them through the method and ask them to write down their observation and inferences.*

<table>
<tr><td></td><td>
<table>
<tr><td>Hypothesis:</td><td>My plant can/can not grow in the soil I collected.</td></tr>
<tr><td>Materials Needed:</td><td>4 spoons of the soil, any small container or bowl, half a cup of baking soda, and half a cup of vinegar</td></tr>
<tr><td>Method:</td><td>1. Take 2 spoons of the soil in a bowl.
2. Add a few drops of drinking water till the soil feels like mud.
3. Add half a cup of baking soda.
4. If the soil fizzes, it is acidic.
5. Repeat steps 1 and 2 with a new sample.
6. Add half a cup of vinegar.
7. If the soil fizzes, it is basic.</td></tr>
<tr><td>Observations:</td><td></td></tr>
<tr><td>Inferences:</td><td></td></tr>
</table>

Note: Take responses from learners after they complete the table.
- The pH level of the soil is a crucial factor that influences the growth of plants.
- However, different plants have different preferences for soil acidity or basicity. Generally, most plants prefer a slightly acidic to neutral pH range.

Optional Reflection:
Can you guess why the acidic soil would fizz when baking soda is added and why alkaline soil would fizz with vinegar? (Recall neutralisation and what the reaction produces)</td></tr>
<tr><td>15 minutes</td><td>Composting:
- It is possible that our soil is acidic or basic instead of neutral. Acidic or basic soils are less fertile than neutral soils. This is because plants absorb the nutrients present in the soil the best if it is neutral.
- We all asked our family and community members about ways to improve soil fertility.
- What were some methods that were suggested?
Note: Collate the ideas as learners share. (Ideas could include using fertiliser, adding natural manure like cow dung, crop rotation, etc.)

- One very easy and efficient way to improve soil fertility is composting!
- In addition to neutralising soil’s pH composting also makes it more fertile.
- Composting is a process by which we can recycle organic materials such as kitchen waste and paper to create natural fertiliser!
- In this process, we collect natural waste and put it in a bin with water and soil.
- We allow this matter to decompose, which makes humus and thus can be used as fertiliser.
- In the next class, we will be making our own compost!</td></tr>
</table>

	- Before we do that, let us think about all the things we can and cannot add to compost! - List some common household waste you can add to compost. *Once learners come up with their lists, share the following with them:*  *Optional: Ask learners to reflect on why the items in red are not suitable for composting. Ask them to reflect on why plastic especially is not suitable.* - Now, let us brainstorm and come up with the benefits of composting! ***Note:** Ask learners to reflect and share ideas, you can then collate them on the board. You can share or add their ideas:* - *Great way to recycle waste* - *Reduces pollution* - *Improves soil quality* - *Balances soil pH* - *Improves plant health*
At home activities	Bring the following to make your compost: 1. A jar (or a large soda bottle with the top cut off) 2. 3-4 cups of soil you wish to grow your plant in 3. Organic waste from home such as fruit and vegetable peels, dry leaves, and newspaper pieces. 4. Your plant pot and seeds

Day 5 -

Today, you will create your own compost, plant your seeds, and record all the steps they followed to pot your own plant to share with your family and friends.

Time	Activity and Description
10 minutes	**Compost Making** ***Note:** Ask learners to gather the materials needed and follow the steps to make compost.*

	Materials needed: A jar or large soda bottle with the top cut off, 3-4 handfuls of soil, organic waste such as fruit and vegetable peels, dry leaves, and newspaper pieces. Method: 1. For composting to work, you need a balance of browns and greens. Browns include soil, newspapers, cardboard, and dry leaves. Greens include fruits and vegetable scraps. 2. First fill 1/4th of the jar with the browns. 3. Then fill the other 1/4th with the greens. 4. Then add a little water to keep the mixture damp. 5. Cover the jar with a net or any other covering but make sure it is not airtight. 6. You can mix the contents in the jar every 2 to 3 days and add a little water. 7. Your compost will be ready in a few weeks when the mixture starts smelling like soil instead of rotting plants. 8. After it reaches this stage, you can transfer it out of the jar and it to the top of your plant pot.
10 minutes	**Planting Your Seeds:** - Now, bring out your pot to plant the seeds. - Make sure your plant pot has enough soil - 3/4th full. - Push the seeds into the soil at least 2 inches deep. - Water the soil and place the pot in an open area that gets sunlight. - Once our compost is ready in a few weeks, we can add it to the top of the soil or mix it in slightly without disturbing the growing plant.
20 minutes	**Recording Your Journey:** Now let us record the steps we followed to finally pot our plants. You can choose to draw pictures, write steps, or write a poem or speech explaining the following: 1. How did you choose the soil to grow your plant in? 2. How did you choose the plant to grow? 3. What steps did you follow to ensure the soil is fertile? 4. What will you do in the future to take care of the plant? *Make sure to check in on students' progress with their compost and their plants every month.*
At home activities	Present your journey, plant, and compost jar to your family and friends and share your learnings with them. You can also ask them for tips on how to better care for your plants.

Additional enrichment activities:	- Learners can work on creating a kitchen garden in their homes. - If learners have access to clay, they can create their own pots on day 2 and use them to plant their seeds.

Modifications for simplification	- The section on creating soil/clay models can be removed if it is logistically difficult to execute.

ASSESSMENT CRITERIA

A majority of my learners were able to:
☐ Describe the properties of different soil types.
☐ Create a compost bin.
☐ Choose appropriate plants to grow based on the soil available to them.
☐ Test the pH of the soil.
☐ Explain the meaning and causes of soil erosion.

APPENDIX 1

Video for Weathering Experiment -
https://www.youtube.com/watch?v=LG9rALeDK4s&ab_channel=Cassie