

LOESS INTEGRATED LEARNING SCENARIO TEMPLATE

Introduction

In [LOESS](#), the acquisition of soil health knowledge is facilitated using integrated STEM teaching and learning, which is carried out via the [Biology Science Curriculum Study \(BSCS\) 5E Instructional Model](#) by Bybee and colleagues (Bybee et al. 2006) as well as the application of innovative [pedagogical approaches](#) (PBL, IBL, etc).

Keywords

Soil microorganisms, biodiversity, macronutrients, rhizosphere.

Title

Sustaining Our Invisible Life

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Summary

In this interdisciplinary learning scenario, students explore soil biodiversity through online inquiry, outdoor investigation, and hands-on experiments. They collect soil samples, observe organisms using Citizen Science apps, and build a Berlese funnel to discover invertebrates. Through collaborative discussions and reflections, they analyse their findings and create a digital mini encyclopaedia to present the organisms they discovered. The scenario integrates STEM education, inquiry-based learning, and creativity, fostering environmental awareness and digital literacy. It aligns with the UN Sustainable Development Goals, particularly those related to life on land, quality education, and climate action.

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Subjects

Biology, ICT, Engineering, English language

Real-life questions

- What types of living organisms exist in the soil beneath our feet?
- How do soil invertebrates and microorganisms contribute to a healthy ecosystem?
- How can we use technology (e.g., apps, digital tools) and citizen science to explore and protect soil biodiversity?
- Why is it important to monitor and preserve soil ecosystems for future generations?



Learning objectives

After the implementation of the learning scenario, students will be able to:

- identify and describe various soil organisms, including invertebrates and microorganisms.
- explain the ecological roles of soil organisms in maintaining soil health and supporting ecosystems.
- collect, observe, and classify soil samples using scientific methods and tools.
- use digital technologies (e.g., citizen science apps, tablets) to record, analyse, and present scientific information.
- construct and use a Berlese funnel to extract soil organisms, demonstrating understanding of basic engineering principles.
- compare data from different collection methods and reflect on biodiversity in various soil types and environments.
- collaborate in teams to create learning products showcasing their research and findings.
- communicate scientific observations clearly and creatively using digital storytelling tools.

Link to curriculum

This learning scenario aligns closely with the natural sciences curriculum by engaging students in the observation, classification, and analysis of living organisms found in the soil. It also integrates STEM skills such as scientific inquiry, information processing, problem-solving, engineering thinking (Berlese funnel), and the use of digital tools for research and communication. Collaboration, critical thinking, and creativity are fostered throughout the project. The scenario supports key UN Sustainable Development Goals (SDGs), including **SDG 4 (Quality Education)** by promoting inclusive, hands-on, and inquiry-based learning, **SDG 13 (Climate Action)** by encouraging awareness of human impact on ecosystems, and **SDG 15 (Life on Land)** by highlighting the importance of soil biodiversity and the need to protect it.

Age of students

Between 11 and 12 years old

Time

Preparation time (total): 4 hours

Biology & ICT: 3 hours – English language: 1 hour

Teaching time (total): ~6 hours

Lesson 1: 35 min Lesson 2: 50 min Lesson 3: 3 hours Lesson 4: 90 min

Teaching resources (materials & online tools)

Material for all lessons

- Computers/tablets.
- Internet connection.
- Interactive whiteboard or projector

Materials for Lesson 2

- Paper



- Printer
- Scissor

Materials for Lesson 3

For the outdoor activity:

- Tablets
- Print-out of Worksheet ([Annex 4](#))
- pen or pencils
- latex gloves or similar
- shovels
- markers
- cardboard boxes

Additionally:

- Materials for the Berlese funnel experiment (see [Annex 5](#))
- magnifying glasses or simple microscopes.

Online tools:

Lesson 1: Brainstorming and discussion

- An image (photo collage) with various soil organisms such as <https://soilandsoulfarm.org/blogs/news/the-soil-community>
- "Soil is Alive!" a video by SciShow Kids https://youtu.be/Q-J2FErZHuA?si=wEV8eTB_UHVzT2Q
- Useful links for teachers:
<https://www.dpi.nsw.gov.au/agriculture/soils/soil-testing-and-analysis/plant-nutrients> (NPK nutrients)
<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-organism> (soil organisms)

Lesson 1: Preparation for the next lesson

- Why soil is one of the most amazing things on Earth (BBC video) <https://www.youtube.com/watch?v=OILITHMVcRw>
- An image about the nutrients in soil (NPK) such as <https://greenplanetnutrients.com/blog/tips-advice/understanding-plant-nutrition/>
- The online game "A-Maze-ing Underground" by Nutrien https://leara-elearning.com/projects/nutrien/amazing_underground/

Lesson 2. Exploring Soil's Microscopic Communities

- An image of the rhizosphere such as <https://magazine.caltech.edu/post/changhuei-yang-soil-camera>
- A collaborative digital idea-sharing tool such as Padlet (<https://padlet.com>), Lino (<https://en.linoit.com/>) or DigiPad (<https://digipad.app/>)
- Online repositories for soil organisms research such as iNaturalist (<https://www.inaturalist.org/observations>), animalia.bio (<https://animalia.bio/>), Soils4Teachers (<https://www.soils4teachers.org/biology-life-soil>),



Frontiers for Young minds

(<https://kids.frontiersin.org/articles/10.3389/frym.2021.604096>),

National Geographic (<https://www.nationalgeographic.com/magazine/article/meet-the-marvelous-creatures-that-bring-soil-to-life-feature>),

Kids gardening (<https://kidsgardening.org/>)

- The card game “The Hidden Life of Soils” by Gessol research programme
https://esdac.jrc.ec.europa.eu/Awareness/Documents/Material/planche_cartes_GES_SOL.pdf

Lesson 3. Let’s become Citizen Scientists

- The Citizen Science app iNaturalist
<https://www.inaturalist.org>

Lesson 4. Creating a digital guide to the invisible biodiversity

- A digital storytelling platform such as Canva (<https://www.canva.com>), Book Creator (<https://bookcreator.com/>), WriteReader (<https://www.writereader.com/>), StoryJumper (<https://www.storyjumper.com/>).

Assessment session:

- A digital tool for creating quizzes such as Kahoot (<https://kahoot.com/>), Quizizz (<https://quizizz.com>), Blooket (<https://www.blooket.com/>) or Mentimeter (<https://www.mentimeter.com/>)

STEM Strategy Criteria

Developing the LOESS learning scenario will help you and your school comply with the [STEM School Label criteria](#). Please find below which STEM School Label criteria this learning scenario fulfils.

Elements and criteria	How is this criterion addressed in the learning scenario?
Instruction	
Problem and project-based learning (PBL)	Students are introduced to a real-world environmental issue: the lack of awareness and threats to soil biodiversity. Through investigation, experimentation (e.g. Berlese funnel), and discussion, students analyse the problem, make observations, and draw conclusions based on evidence. The creation of a digital encyclopaedia as a final product represents the core of the project-based learning element.
Inquiry-Based Science Education (IBSE)	The scenario follows the BSCS 5E model (Engage, Explore, Explain, Elaborate, Evaluate), guiding students through a structured inquiry process. All the activities promote observation, hypothesis testing, collaboration, and scientific reasoning.
Curriculum implementation	The scenario aligns with curriculum goals in natural sciences (ecosystems, biodiversity), digital literacy (use of educational apps and tools), and cross-curricular skills like communication and environmental education. It provides meaningful, hands-on learning that connects classroom content with real-world problems, helping students meet learning objectives while remaining actively engaged.



Elements and criteria	How is this criterion addressed in the learning scenario?
Emphasis on STEM topics and competencies	
Interdisciplinary instruction	<p>The scenario integrates multiple subjects to create a holistic learning experience:</p> <ul style="list-style-type: none"> ○ Science: Study of soil biodiversity and living organisms. ○ Technology: Use of tablets, digital tools and Citizen Science apps ○ Engineering: Construction and use of the Berlese funnel to investigate invertebrates. ○ Language: Students write and present findings in collaborative digital learning products, enhancing writing and communication skills.
Contextualisation of STEM teaching	<p>The scenario is rooted in a real-world context, the exploration and preservation of soil biodiversity. Students investigate problems in their local environment, apply STEM skills to find solutions, and reflect on broader sustainability issues.</p>
Assessment	
Continuous assessment	<p>Assessment is embedded throughout all phases of the scenario through info posters, digital “wall”, observation worksheets, class discussions and digital Soil Hidden Life encyclopaedia.</p>
Personalized assessment	<p>Students receive feedback specific to their performance and understanding of soil biodiversity after each activity and the summative assessment quiz.</p>
Professionalization of staff	
Highly qualified professionals	<p>The different sessions are taught by specialists in each subject (Biology, ICT, Engineering and Language).</p>
Existence of supporting (pedagogical) staff	<p>Supportive staff helps ensure inclusive practices and helps adapt activities for students with special educational needs.</p>
Professional development	<p>The scenario offers educators opportunities to learn about interdisciplinary methods and the use of real-world, problem-based approaches in the classroom.</p>
School leadership and culture	
School leadership	<p>School leadership is committed to facilitate resource allocation, ensure time for interdisciplinary collaboration, and promote participation in professional development opportunities aligned with the scenario’s goals.</p>
High level of cooperation among staff	<p>The implementation of the scenario requires collaboration between science, ICT, environmental education, and language teachers in a way that enhances the quality of teaching and models teamwork for students.</p>
Inclusive culture	<p>Group work fosters a supportive learning environment where every student can contribute according to their strengths.</p>
Connections	
With universities and/or research centers	<p>iNaturalist is a global citizen science platform supported by research institutions (e.g., California Academy of Sciences and National Geographic Society). Students contribute to real scientific databases, supporting biodiversity research and engaging directly with the scientific community.</p>
School infrastructure	



Elements and criteria	How is this criterion addressed in the learning scenario?
Access to technology and equipment	Students use tablets or mobile devices to access the iNaturalist app, supporting real-time organism identification and direct contributions to a global citizen science database. Also, they use the ICT lab's computers to create their digital learning products.
High quality instruction classroom materials	Students work with a detailed observation worksheet, detailed manual for the Berlese funnel experiment, reflection questions, and guided inquiry prompts, which scaffold learning and support scientific thinking.

Description of activities

Name of activity	Procedure	Time
1st Lesson		
5E Phase	Engage, Explore	
Brainstorming and discussion	<p>The teacher starts the lesson by posing the questions:</p> <ul style="list-style-type: none"> • Is soil alive? • What do you think lives in the soil? • What would happen if soil disappeared? <p>to intrigue and spark students' curiosity. At the same time the teacher shows images of soil organisms on the classroom interactive whiteboard and asks students if they recognize them (see Annex 6). Students engage in a brainstorming discussion and the teacher assesses their prior knowledge about soil as a living thing.</p> <p>After the brainstorming session, the teacher shows the video "Soil is Alive!" by SciShow Kids (https://youtu.be/Q-J2FeRzHuA?si=wEV8eTB_UHVzT2Q) that demonstrates the presence of microorganisms, insects, and organic activity within the soil, proving that it is, in fact, alive (Explore phase).</p> <p>The aim of this activity is to stimulate students' curiosity about soil's hidden life, challenge misconceptions regarding the fact that soil is teeming with life, introduce soil biodiversity and develop inquiry skills by prompting students to observe, think critically, and generate questions for further exploration.</p>	15 minutes
Discussion and preparation for the next lesson	<p>To introduce the basic concepts that students need to understand soluble soil nutrients, the teacher presents the picture "Plant Nutrients in Soil" (see Annex 1) and initiates a discussion about the essential elements that plants absorb from the soil. The teacher focuses on the three primary macronutrients: Nitrogen (N), Phosphorus (P), and Potassium (K), commonly known as the NPK trio.</p> <p>Students, using mobile devices (tablets, phones) or the ICT lab's computers, play the game "A-Maze-ing Underground" by Nutrien (https://leara-elearning.com/projects/nutrien/amazing_underground/) where they become Pedologists and create the right balance of water and nutrients in the soil that crop needs. While playing on their underground journey, students encounter soil organisms such as worms, shrews, protozoa, mites, and springtails, which they take pictures and then display in the photo lab at the end of the game.</p>	20 minutes



Name of activity	Procedure	Time
	<p>Flipped Classroom: The teacher suggests that students watch the video Why soil is one of the most amazing things on Earth as a homework assignment to deepen their understanding of the living organisms that enrich the soil and their invaluable role. Students should focus on the first 4 minutes of the video and create an info-poster on the role of bacteria, fungi, and earthworms in the healthy soil with short information and simple drawings.</p>	
Learning products	Information posters with students' drawings regarding the invaluable role of soil organisms.	
2nd Lesson		
5E Phase	Explore and elaborate	
Subjects	Biology, ICT	
Exploring Soil's Microscopic Communities	<p>To reinforce students' understanding after having gained knowledge about soil biodiversity and its living organisms, the teacher presents an image in the classroom depicting the complex ecosystem beneath our feet, known as the rhizosphere (see Annex 2). Students observe that soil microorganisms can be classified into three categories: Arthropods/Invertebrates, Bacteria, and Fungi.</p> <p>To engage students in a self-directed online inquiry and collaborative knowledge construction, the teacher assigns students to groups, each researching on the Internet one of the three categories presented (names, information, images, and role in soil health). Then, the teacher invites students to showcase their findings on a Padlet (https://padlet.com/), Lino (https://en.linoit.com/), or DigiPad (https://digipad.app/). The teacher acts as a facilitator, suggesting reliable websites for students to conduct their online research such as:</p> <ul style="list-style-type: none"> • iNaturalist (https://www.inaturalist.org/observations), • Soils4 Teachers (https://www.soils4teachers.org/biology-life-soil), • Frontiers for Young Minds (https://kids.frontiersin.org/articles/10.3389/frym.2021.604096), • National Geographic (https://www.nationalgeographic.com/magazine/article/meet-the-marvelous-creatures-that-bring-soil-to-life-feature), or • Kids Gardening (https://kidsgardening.org/). <p>Once the activity is completed, the digital 'wall' is presented to the whole class to enhance communication and teamwork skills. Each group presents their findings on the category they researched and curated, specifically providing information about the role of these microorganisms in the soil ecosystem. The teacher provides clarifications and answers any group questions.</p>	30 minutes
Playing with... microorganisms	<p>To apply their acquired knowledge in an interactive way and strengthen memory retention, the student groups play the card game "The Hidden Life of _____ Soils" (https://esdac.jrc.ec.europa.eu/Awareness/Documents/Material/planche_cartes_GESSOL.pdf) (also in Annex 3) by Gessol research programme. The teacher introduces students to this engaging, hands-on approach and explains its procedure. By applying the gamification approach, the</p>	20 minutes



Name of activity	Procedure	Time
	teacher solidifies students' understanding before moving on to the next phase.	
Learning products	<p>The learning product of this activity is a collaborative digital wall (Padlet, Lino, or DigiPad) where students present their research findings on soil microorganisms. Each group contributes text, images, and key information about their assigned category (Arthropods/Invertebrates, Bacteria, or Fungi), highlighting their role in soil health.</p> <p>Additionally, students deliver an oral presentation to the class, explaining their findings and engaging in discussions. This activity results in a shared knowledge repository, fostering peer learning and digital literacy skills.</p>	
3rd Lesson		
5E Phase	Explore, Elaborate, Evaluate	
Subject 2	Biology, ICT, Engineering	
Let's become Citizen scientists	<p>To participate in real-world scientific research by contributing data to a global database, the students in groups visit the surrounding area of the school (schoolyard, nearby park, vacant lot, etc.). They examine the soil and attempt to discover soil microorganisms that are visible to the naked eye. Using tablets and the citizen science app "iNaturalist" (https://www.inaturalist.org/), the students become scientists, trying to identify the species of the living organism they discovered and record it in the application's database.</p> <p>To develop observation and data collection skills through hands-on soil exploration, on a dedicated worksheet ("The Soil Detectives" – see Annex 4), students document their findings, including the location they investigated and the name of the organism they identified through the iNaturalist app.</p> <p>Next, using shovels, they collect various types of soil in small cardboard boxes in a sufficient quantity, as well as a mixture of dried and moist leaves. The teacher advises the students to collect soil samples by digging a whole and not from the surface. Using a marker, students label the box with the location where they collected the soil or leaf pulp. Students will use the soil samples in the school laboratory to isolate and study other microorganisms that are present in the samples but not easily visible. Their findings will enrich their outdoor research worksheets.</p>	90 minutes
Uncovering the Invisible with a Berlese Funnel	<p>In this hands-on extension of the outdoor soil exploration, students in teams build and use a "Berlese funnel" (see Annex 5) to extract and study soil invertebrates that are not easily visible to the naked eye. Through this activity, students understand scientific tools and methods, and practice scientific inquiry.</p> <p>Using the soil samples they previously collected from the schoolyard, nearby park, or other local environments, students, under the guidance of the teacher, assemble simple Berlese funnels using everyday materials (e.g., plastic bottles, mesh, and lamps). The heat and light source from the lamp will gradually drive soil invertebrates downward through the soil and into a container of ethanol or water placed at the bottom of the funnel. Then, students monitor and collect these microorganisms.</p>	45 minutes (Day 1) 30 minutes (Day 2)



Name of activity	Procedure	Time
	<p>Once the process is complete (next day), students observe the collected invertebrates using magnifying glasses or simple microscopes. To develop data recording skills, they document their findings, identify organisms using the iNaturalist app, and add their results to their worksheet and to the app's database.</p>	
Discussion	<p>After completing both the outdoor soil exploration and the Berlese funnel experiment, students engage in a class discussion to analyze their findings. They compare the organisms found in the field with those extracted using the Berlese funnel, discussing how different collection methods reveal different aspects of soil biodiversity.</p> <p>Using the reflection questions as a guide, students share their observations, highlight surprising discoveries, and explore the ecological roles of these organisms. This discussion helps students synthesize their knowledge and consider the broader implications of soil health and conservation.</p> <p><u>Reflection questions:</u> <i>What differences did you notice between the organisms found during the outdoor activity and those collected using the Berlese funnel?</i> <i>How do the invertebrates found in the Berlese funnel contribute to soil health?</i> <i>Were there any unexpected findings? What surprised you the most?</i> <i>What challenges did you face in identifying the organisms, and how did the iNaturalist app help?</i> <i>How might human activities impact the diversity of soil organisms?</i></p>	30 minutes
Learning products	<p>The two soil exploration activities lead meaningful learning products that reflect student understanding, creativity, and scientific inquiry:</p> <ul style="list-style-type: none"> ○ A completed observation worksheet ○ iNaturalist contributions ○ The Berlese funnel construction 	
4th Lesson		
5E Phase	Elaborate, Evaluate.	
Subject 3	Biology, ICT, English language	
Creating a digital guide to the invisible biodiversity	<p>To apply what they learned in a new context and transform observations into educational content (Elaborate phase), students work in same groups to create a digital mini-encyclopedia (e-book) featuring the living soil organisms they discovered throughout the previous activities (online inquiry-Padlet, outdoor investigation and the Berlese funnel experiment-observation worksheet).</p> <p>Using tools like Canva (https://www.canva.com/), BookCreator (https://bookcreator.com/), WriteReader (https://www.writereader.com/), StoryJumper (https://www.storyjumper.com/), or another suitable digital storytelling platform, students collaboratively organize, synthesize, and present their research in a creative and informative way. Each group focuses on a set of organisms (Arthropods/Earthworms, Bacteria, or Fungi), providing information, accurate descriptions, illustrations or photos, and ecological roles.</p>	90 minutes



Name of activity	Procedure	Time
	Their digital book serves not only as a showcase of what they learned but also as an educational resource for their peers, families, or even the school community. Through this culminating activity, students reflect on their learning, assess each other's work, and demonstrate understanding through creative expression (Evaluate phase).	
Learning products	A collaborative "Soil Life Encyclopaedia" with: <ul style="list-style-type: none"> • Title page and table of contents • Individual entries for each soil organism (name, image, role, etc.) • Bibliography or references (including iNaturalist links) 	

Initial assessment

The teacher assesses the students' prior knowledge about soil as a living thing by posing questions and engaging them in a brainstorming discussion.

Some of the brainstorming questions that teacher can pose are:

- Is soil alive?
- What do you think lives in the soil?
- What would happen if soil disappeared?

At the same time, the teacher shows images of soil organisms to the classroom's interactive whiteboard asking students if they recognise them (see [Annex 6](#)).

Formative evaluation

Throughout the scenario, the students' learning is constantly monitored through the learning products of each lesson: info-posters, the digital "wall" of the microorganism categories, the completed observation worksheet, the iNaturalist contributions, the Berlese funnel construction and the collaborative "Soil Life Encyclopaedia".

Final assessment

The final collaborative "Soil Life Encyclopaedia" can also be considered as a summative assessment.

Additionally, the students participate in the following quiz, which has been created using Kahoot (<https://kahoot.com/>), Quizizz (<https://quizizz.com/>), or Blooket (<https://www.blooket.com/>):

Quiz Questions:

1. What does NPK stand for in relation to soil and plant nutrition?
 - a. Nitrogen, Phosphorus, and Krypton
 - b. Nickel, Potassium, and Phosphorus
 - c. Nitrogen, Phosphorus and Potassium.**
 - d. Neon, Phosphorus, and Keratin

2. What is the role of earthworms in the soil ecosystem?



- a. They eat plant roots
 - b. They create space for plant roots to grow**
 - c. They eat harmful insects
 - d. They absorb sunlight for energy
3. The Berlese funnel uses heat and light to drive soil organisms down into a container for collection.
True – False
4. What type of organisms are most likely to be found using the Berlese funnel?
- a. Birds and mammals
 - b. Aquatic animals
 - c. Tree-dwelling insects
 - d. Arthropods**
5. Which of the following tools helps us identify organisms and contribute to a citizen science database?
- a. iNaturalist**
 - b. WriteReader
 - c. Padlet
 - d. Scratch
6. Which of the following is NOT typically recorded in a scientific observation worksheet?
- a. Favorite color of the organism**
 - b. Name
 - c. Soil type
 - d. Size and appearance
7. What is the role of fungi in the soil ecosystem?
- a. They capture carbon dioxide
 - b. They create breathing holes
 - c. They give plants nutrients**
 - d. They are food for birds
8. Why is soil biodiversity important for the environment?
- a. It makes soil prettier
 - b. It helps plants grow, supports ecosystems, and recycles nutrients**
 - c. It keeps animals out of the garden
 - d. It pollutes the soil
9. All soil organisms are harmful to plants.
True – False
10. Soil is alive! **True – False**



Student feedback

To collect meaningful and student-friendly reflections on the learning scenario and its activities, the teacher can use an interactive quiz, such as a Mentimeter (<https://www.mentimeter.com/>) presentation, with the following questions:

1. **Word cloud** - What three words describe your experience in this project?
2. **Likert Question** (1–10 scale) - How much did you enjoy the outdoor exploration and soil investigation activities? (1 = Not at all, 10 = A lot)
3. **Multiple Choice (Single Answer)** - Which activity did you enjoy the most?
 - Drawing the info-poster
 - Creating the digital “wall”
 - Collecting soil outdoors
 - Using the Berlese funnel
 - Identifying organisms with iNaturalist
 - Completing the observation worksheet
 - Creating the digital encyclopaedia
 - Group discussions and reflections
4. **Multiple Choice (Single Answer)** - Which activity did you find more difficult?
 - Drawing the info-poster
 - Creating the digital “wall” Padlet
 - Collecting soil outdoors
 - Using the Berlese funnel
 - Identifying organisms with iNaturalist
 - Completing the observation worksheet
 - Creating the digital encyclopaedia
 - Group discussions and reflections
5. **Open-Ended** - What is one new thing you learned about soil?
6. **Open-Ended** - What would you change or improve in this project for next time?

Teacher feedback

A customized self-assessment table for teachers will be provided to help them reflect on the learning scenario’s effectiveness (see [Annex 7](#)).



Reflection on the development process

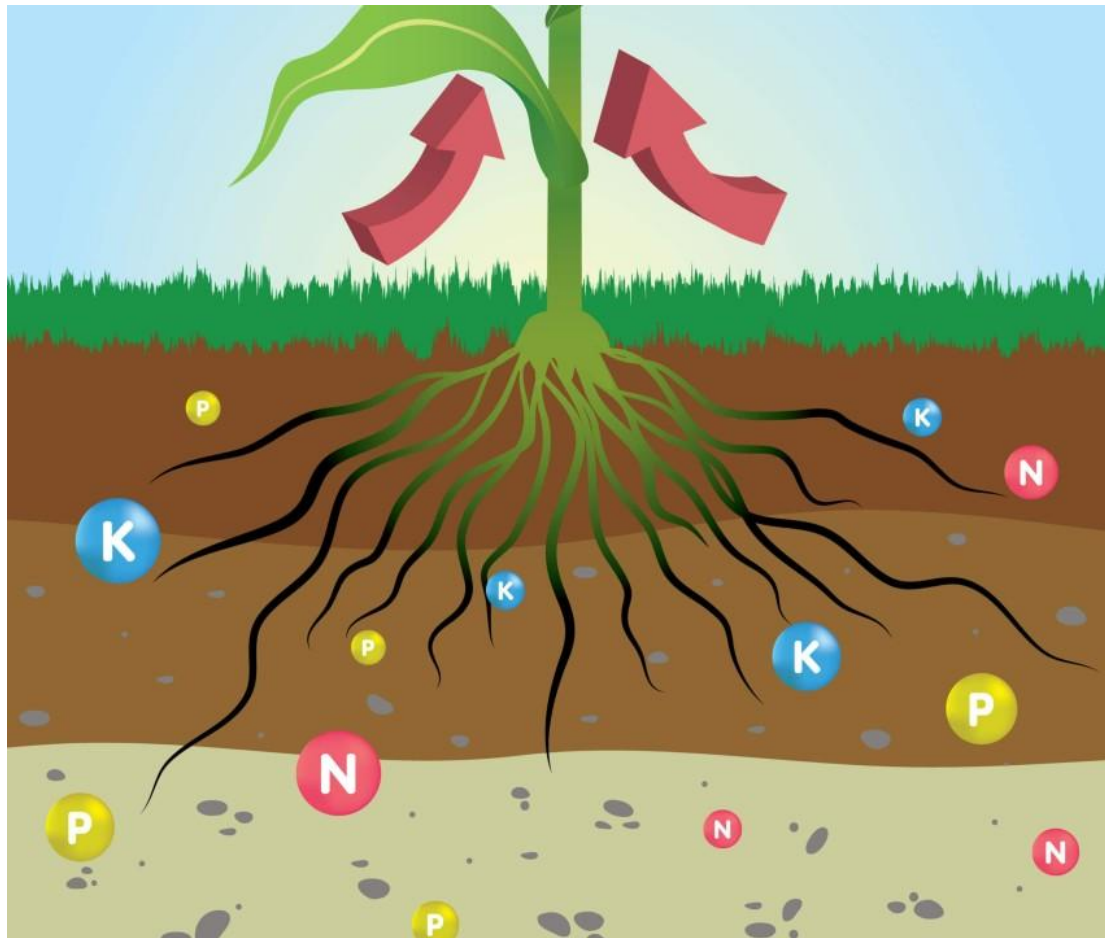
The initial idea for the learning scenario was inspired by my interest in environmental education, my leading role in the school environmental team and the need to help students connect with nature through STE(A)M. The theme of soil hidden biodiversity emerged after reflecting on how often the crucial life beneath our feet is overlooked, despite its importance to ecosystems and sustainability. I wanted to create a scenario that combines scientific inquiry, outdoor exploration, and digital creativity to foster curiosity and critical thinking.

In developing the scenario, I reviewed educational materials on soil literacy, biodiversity, and citizen science, including resources from the BBC, and iNaturalist. I was particularly influenced by the BSCS 5E model, which helped structure the activities into a meaningful learning journey. I also explored various digital tools like Padlet and WriteReader to ensure students can creatively synthesize their findings.

Throughout this process, I learned how powerful cross-curricular planning can be by combining science, technology, and environmental education that leads to engaging, authentic learning. Designing this scenario made me more aware of the importance of guiding students to observe, question, and reflect. I also appreciated the value of integrating digital tools in a meaningful way that supports both collaboration and deeper learning.



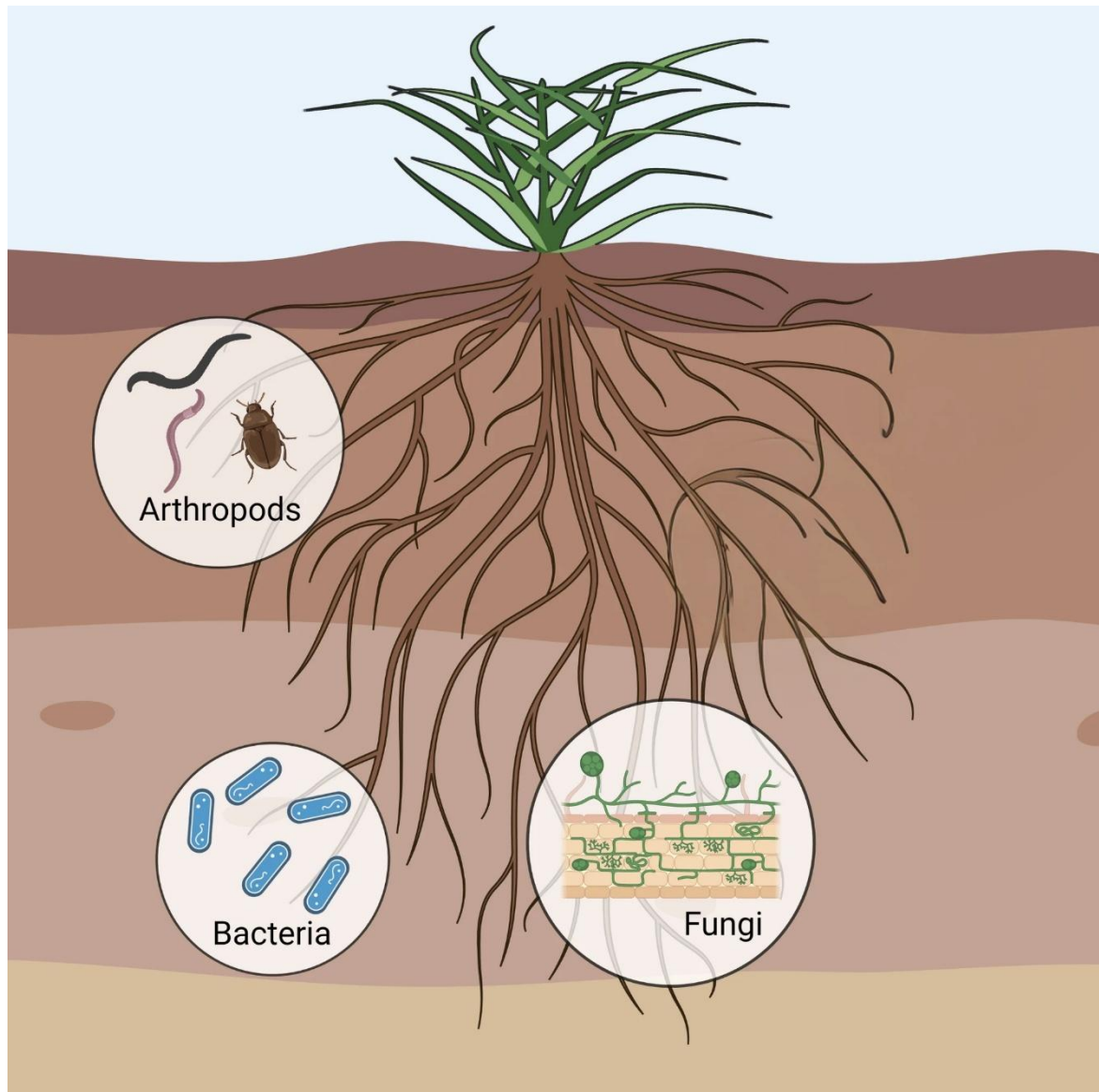
Annex 1 – Plant Nutrients in Soil



Source: <https://greenplanetnutrients.com/blog/tips-advice/understanding-plant-nutrition/>



Annex 2 – The rhizosphere



Source: <https://magazine.caltech.edu/post/changhuei-yang-soil-camera> (Oumeng Zhang / Biorender)



Soil Family

<p>Soil family Organic matter</p> <p>Organic matter Sand Silt Clay Water</p> <p>Organic matter is a mixture of living and dead organisms that may be decomposed to different extents and incorporated by the soil.</p>	<p>Soil family Sand</p> <p>Organic matter Sand Silt Clay Water</p> <p>A grain of sand is a mineral particle derived from rock erosion. Sandy soils do not retain much water.</p> <p>Grain size 0.05 mm-2 mm</p>	<p>Soil family Silt</p> <p>Organic matter Sand Silt Clay Water</p> <p>Silt is made up of mineral particles often carried by water or the wind. Silty soils erode easily.</p> <p>Particle size 0.002-0.075 mm</p>
<p>Soil family Clay</p> <p>Organic matter Sand Silt Clay Water</p> <p>Clay consists of the finest soil mineral particles. Clay soils absorb water and retain organic matter.</p> <p>Particle size <0.002 mm</p>	<p>Soil family Air</p> <p>Organic matter Sand Silt Clay Water Air</p> <p>Air provides the oxygen necessary for soil organisms, which in turn release carbon dioxide (CO₂).</p>	<p>Soil family Water</p> <p>Organic matter Sand Silt Clay Water</p> <p>Water is necessary for life in soils. Microorganisms and microfauna move around by floating in soil water.</p>

The Hidden Life of soils

MicroFauna Family

<p>Microfauna & Microorganism Family Fungi</p> <p>Fungi Protozoa Bacteria Nematode Amoeba Ciliate</p> <p>Soil fungi are in the form of white filaments. Like bacteria, they decompose organic matter.</p> <p>Actual diameter 0.300 mm</p>	<p>Microfauna & Microorganism Family Nematode</p> <p>Fungi Protozoa Bacteria Nematode Amoeba Ciliate</p> <p>A nematode may be a plant parasite or a predator of bacteria, fungi or other nematodes.</p> <p>Actual size 0.2 mm</p>	<p>Microfauna & Microorganism Family Bacteria</p> <p>Fungi Protozoa Bacteria Nematode Amoeba Ciliate</p> <p>Bacteria are spherical in shape. They transform organic matter into nutrients that help plants.</p> <p>Actual size 0.003 mm</p>
<p>Microfauna & Microorganism Family Rotifer</p> <p>Fungi Protozoa Bacteria Nematode Amoeba Ciliate</p> <p>A rotifer lives in soil water and feeds on bacteria and protozoans.</p> <p>Actual size 0.3 mm</p>	<p>Microfauna & Microorganism Family Amoeba</p> <p>Fungi Protozoa Bacteria Nematode Amoeba Ciliate</p> <p>An amoeba is a protozoan that feeds mainly on bacteria and organic matter in the soil.</p>	<p>Microfauna & Microorganism Family Ciliate</p> <p>Fungi Protozoa Bacteria Nematode Amoeba Ciliate</p> <p>A ciliate, like all protozoans, is a unicellular organism. It feeds on fungus filaments.</p> <p>Actual size 0.003 mm</p>

The Hidden Life of soils

MesoFauna Family

<p>Mesofauna family Tardigrade</p> <p>Tardigrade Enchytraeid Proturan Collembola Mite Dipluran</p> <p>A tardigrade, also called a water bear, has eight legs, nematodes and protozoans.</p> <p>Actual size 0.5 mm</p>	<p>Mesofauna family Enchytraeid</p> <p>Tardigrade Enchytraeid Proturan Collembola Mite Dipluran</p> <p>An enchytraeid (left on the photo) is related to the earthworm (right on the photo). It feeds on dead matter.</p> <p>Actual diameter 0.2 mm (photo)</p>	<p>Mesofauna family Proturan</p> <p>Tardigrade Enchytraeid Proturan Collembola Mite Dipluran</p> <p>A proturan has 6 legs, but no wings, eyes or antennae. It feeds on microorganisms.</p>
<p>Mesofauna family Collembola</p> <p>Tardigrade Enchytraeid Proturan Collembola Mite Dipluran</p> <p>A collembola lives mainly in litter. It feeds on fungi and bacteria.</p> <p>Actual size 0.5 mm</p>	<p>Mesofauna family Mite</p> <p>Tardigrade Enchytraeid Proturan Collembola Mite Dipluran</p> <p>Mites are related to spiders. They generally feed on plant debris, but are also omnivorous predators.</p>	<p>Mesofauna family Dipluran</p> <p>Tardigrade Enchytraeid Proturan Collembola Mite Dipluran</p> <p>A dipluran is a predator. It hunts mites and collembolans using its mandibles.</p>

The Hidden Life of soils

Scientific Family


<p>Scientific family Berlese funnel</p> <p>Berlese funnel Charles Darwin Solman Waksman Peter E. Muller Microscope Auger</p> <p>A Berlese funnel is used to extract soil mesofauna to be able to observe and study these small organisms (less than 2 mm).</p> <p>Actual size 0.2 mm</p>	<p>Scientific family Charles DARWIN</p> <p>Berlese funnel Charles Darwin Solman Waksman Peter E. Muller Microscope Auger</p> <p>Charles DARWIN (1809-1882) was the first scientist to highlight the importance of soilfauna in enhancing the fertility and structure of soils.</p>	<p>Scientific family Solman WAKSMAN</p> <p>Berlese funnel Charles Darwin Solman Waksman Peter E. Muller Microscope Auger</p> <p>Solman WAKSMAN (1888-1953) studied soil microorganisms. He found many antibiotics that are now widely used to treat diseases.</p>
<p>Scientific family Peter E. MULLER</p> <p>Berlese funnel Charles Darwin Solman Waksman Peter E. Muller Microscope Auger</p> <p>Peter E. MULLER (1868-1930) demonstrated that soil organisms participate in soil formation.</p>	<p>Scientific family Microscope</p> <p>Berlese funnel Charles Darwin Solman Waksman Peter E. Muller Microscope Auger</p> <p>A microscope magnifies minute organisms (about 1 mm) to facilitate their observation.</p>	<p>Scientific family Auger</p> <p>Berlese funnel Charles Darwin Solman Waksman Peter E. Muller Microscope Auger</p> <p>An auger is used to collect soil samples at different depths. Just turn it and push down on the handle.</p>

The Hidden Life of soils



7


Happy Families




PLAYING RULES

The object of the game is to collect as many sets of families as possible.


One player shuffles and deals 7 cards to each player. The remaining cards are placed faced down to form the stock. The player to the dealer's left plays first by asking any player for a specific card from a family that he/she is collecting, but the player must already have at least one other card from that family. The aim is to collect the complete family. For example, the asking player can say, "In the Macrofauna family, do you have the earthworm?" The 6 members of the family are listed at the top of each card. The asked player must hand over the card if he/she has it. If the asking player obtains the requested card then he/she can play again, but if not the top card of the stock must be drawn. If the requested card is drawn, then the player says "good draw" and plays again, otherwise the next player takes the turn. Once a player collects a complete family, it is set on the table and the player plays again. The player who has the most complete family sets at the end wins.




The Hidden Life of soils




Microfauna




Mesofauna




Macrofauna




Megafauna



Soil



Plant



Scientific



Annex 5 – The Berlese Funnel

Materials Needed (per group):

- Plastic bottle or funnel
- Fine mesh or gauze
- Soil samples
- Lamp or light source
- Collection jar with ethanol, isopropyl alcohol, or soapy water
- Tape, scissors, and support stand (optional)
- Worksheet and tablet with iNaturalist app

Steps:

1. Cut the plastic bottle in half and invert the top to form a funnel.
2. Place mesh or gauze at the narrow end to prevent soil from falling into the jar.
3. Fill the funnel with the collected soil sample.
4. Place a collection jar with liquid underneath the funnel.
5. Position a light source above the funnel to gradually dry the soil.
6. Leave the funnel undisturbed for 24–72 hours.
7. Collect and observe the organisms that migrated into the jar.
8. Use magnifiers/microscopes and the iNaturalist app to observe and identify them.
9. Record findings on the worksheet and reflect on biodiversity and soil health.



The Berlese Funnel

Image created by the authors using Canva

Annex 6 – Initial assessment



Image source: <https://soilandsoulfarm.org/blogs/news/the-soil-community>



Annex 7 – Self assessment tool for teachers

Focus Area	Reflection Questions	Rating (1–5)	Comments / Observations
Student Engagement	Were students actively involved during the scenario’s activities?		
Understanding of Soil Biodiversity	Did students demonstrate understanding of soil organisms and their role in the ecosystem?		
Use of Digital Tools	How effectively did students use the digital tools of the scenario (e.g., iNaturalist, Padlet, digital storytelling tool)?		
Collaboration & Group Work	How well did students collaborate during data collection, discussion, and the creation of the learning products?		
Scientific Inquiry Skills	Did the activities (especially the outdoor one and the Berlese funnel) support students in developing observation, recording, and identification skills?		
Achievement of Learning Objectives	Were the planned learning goals successfully met?		
Creativity & Communication	Did students express information clearly and creatively in their final learning product (digital encyclopaedia)?		
Suggestions for Improvement	What changes would you recommend for future implementation?		

Table explanation:

- **Student engagement (1–5)** – Rate how engaged students were in the activity, with 1 being not engaged and 5 being very engaged.
- **Understanding of Soil Biodiversity (1–5)** – Rate the level of understanding demonstrated by students, with 1 being minimal and 5 being deep understanding.



- **Use of Digital Tools (1-5)** – Rate the effectiveness of the digital tools used for each lesson.
- **Collaboration & Group work (1-5)** – Rate how well students worked together in their groups.
- **Scientific Inquiry Skills (1-5)** – Rate how supported were the digital tools to the development of inquiry skills.
- **Achievement of Learning Objectives (1-5)** – Rate the level of achievement of the scenario's learning goals.
- **Creativity & Communication (1-5)** – Rate how well the students communicated during the creation of the final learning product.
- **Suggestions for Improvement** – Teachers can suggest any changes or improvements to the learning scenario's activities.

