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 Biodiversity, Plant Growth, Soil Erosion, Sustainability, Field Study

Title

From Soil to Sustainability: A STEM Journey Across Disciplines

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Summary

This interdisciplinary learning scenario focuses on exploring soil as a living system through Biology, Geography, and Mathematics. Students investigate soil biodiversity, analyse local soil types, and apply mathematical calculations to real data. Both indoor and outdoor activities promote inquiry, observation, and problem-solving skills. Through experiments, data collection, and group projects, learners understand how soil supports ecosystems and human life. The scenario encourages environmental awareness, sustainability, and STEM-based thinking while connecting classroom learning with real-world experiences.

Licenses

Subject (s)

Biology, Geography, Mathematics

Real-life questions

1. ***Biology***
   - *How do soil organisms like earthworms or bacteria help plants grow?*
   - *What happens to plants when the soil becomes polluted or too dry?*
   - *Why is soil biodiversity important for a healthy ecosystem?*

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2. ***Geography***

   • How does soil erosion or pollution affect the local environment and human life?
   • What can our community do to protect soil and prevent erosion?
   • How do climate and land use influence the quality of soil in different areas?

3. ***Mathematics***

   • How can we calculate the amount of water or nutrients in different soil types?
   • How much compost is needed to enrich a school garden of a given size?
   • How can data and percentages help us compare soil quality from different locations?

Learning objectives

Biology:

- Students will be able to identify living organisms found in soil and explain their roles in maintaining soil health.
- Students will be able to describe how soil properties affect plant growth.
- Students will design and observe a mini soil ecosystem to understand the interactions between soil, plants, and organisms.

Geography:

- Students will be able to classify different soil types and explain how climate and land use affect them.
- Students will analyze the causes and effects of soil erosion and pollution in their local environment.
- Students will suggest sustainable actions to protect and preserve soil.

Mathematics:

- Students will be able to collect and interpret numerical data related to soil properties (mass, moisture, water percentage).
- Students will perform calculations to compare soil samples and evaluate changes in soil composition.
- Students will apply mathematical reasoning to real-life soil problems, such as estimating compost or water needs.

Link to curriculum

This interdisciplinary learning scenario aligns with the curriculum in Biology, Geography, and Mathematics. Students explore soil biodiversity, investigate local soil conditions, and apply mathematical analysis to real-world data. The activities strengthen key STEM skills such as observation, data collection, critical thinking, and problem-solving. Both indoor and outdoor tasks connect theoretical knowledge with practical experience, fostering environmental awareness and sustainability. The scenario supports the UN Sustainable Development Goals ***SDG 4 (Quality Education)****,* ***SDG 13 (Climate Action)****, and* ***SDG 15 (Life on Land)*** *by helping students understand the vital role of soil in ecosystems, agriculture, and climate balance. Through inquiry and collaboration, learners develop scientific literacy and responsibility for sustainable living.*

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Age of students

Between 11 to 15 years old.

Time

Preparation time:
*Approximately **2–3 hours** for teachers to prepare materials, set up indoor and outdoor stations, collect or label soil samples, print annex worksheets, and test online tools (videos, quizzes, and websites).*
Teaching time:
Total of 150 minutes (3 lessons × 50 minutes)
Biology Lesson: 50 minutes – Soil & Living Organisms
Geography Lesson: 50 minutes – Soil & Environment
Mathematics: 50 minutes – Soil Data & Calculations:

Teaching resources (materials & online tools)

Teaching Resources (Materials & Online Tools – Indoor & Outdoor)

Materials for All Lessons

- *Computers or tablets*
- *Internet connection*
- *Projector / interactive whiteboard*
- *Notebooks and pens*
- *Annex worksheets for data collection*

Biology Lesson – Soil & Living Organisms
Indoor Materials

- *Annex 1 – Observation worksheet*
- *Magnifying glasses / simple microscopes*
- *Transparent jars or containers for mini-ecosystems*
- *Gloves for handling soil samples*

Outdoor Materials

- *Soil samples collected from different areas (garden soil, clay, sand, loam)*
- *Zip bags for soil collection*
- *Clipboards for field notes*

Geography Lesson – Soil & Environment
Indoor Materials

- *Annex 2 – Soil comparison data sheet*
- *Poster paper, markers, colored pencils (for group work)*
- *Reference maps and atlases*

Outdoor Materials

- *Different soil samples (sandy, clay, loamy)*
- *Rulers and thermometers for measuring soil properties*
- *Clipboards for outdoor data collection*
- *Camera or mobile phone for documentation*

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Mathematics Lesson – Soil Data & Calculations
Indoor Materials

- *Annex 3 – Data recording sheet for calculations*
- *Laboratory scale for weighing soil*
- *Measuring containers (cups, beakers)*
- *Calculators for problem solving*

Outdoor Materials

- *Soil samples (wet and dry) for measurement*
- *Buckets or small containers for soil collection*
- *Measuring tape for field-based math activities*

Online Tools
For Biology Lesson

- *Soil is Alive! (SciShow Kids video)* *https://www.youtube.com/watch?v=Q-J2FErZHuA*
- *Soils4Kids – Interactive activities and facts* *https://www.soils4kids.org*

For Geography Lesson

- *FAO Soils Portal – Global soil information* *https://www.fao.org/soils-portal/en/*
- *PBS Science Trek – Soil video* *https://www.pbs.org/video/science-trek-soil/*

For Mathematics Lesson

- *SoilWeb – Virtual soil science data and maps* *https://soilweb.ca*
- *Kahoot! / Quizizz – Interactive quizzes for soil-related math problems*

STEM Strategy Criteria

Developing the LOESS learning scenario will help you and your school comply with the STEM School Label criteria. The criteria fulfilled by this learning scenario are presented below.

Elements and criteria	How is this criterion addressed in the learning scenario?
Instruction	
Personalisation of learning	***Biology Lesson – Soil & Living Organisms*** • *Students choose which soil samples to investigate (garden soil, clay, sand, loam) based on their curiosity.* • *Learners can work individually or in small groups to design mini-ecosystems, giving them ownership of their learning path.* • *Advanced students may explore microscopic organisms in more detail, while others focus on visible soil properties.* ***Geography Lesson – Soil & Environment***

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Elements and criteria	How is this criterion addressed in the learning scenario?
	• *Groups select local environmental issues (erosion, pollution, drought) to connect soil science with their community.* • *Students with artistic strengths can create visually attractive posters, while others focus on scientific accuracy and research.* • *Learners can integrate personal or family experiences with agriculture, gardening, or environmental observation.* ***Mathematics Lesson – Soil Data & Calculations*** • *Students work on soil-related problems with different levels of complexity (basic percentages vs. multi-step calculations).* • *Learners can collect their own soil data outdoors and apply mathematics to real samples instead of only textbook problems.* • *Fast learners may be challenged with advanced problems (e.g., scaling field data, calculating compost needs for larger areas).*
	Overall Strategy • *Students are encouraged to pursue **their own questions** about soil and ecosystems, promoting autonomy.* • *Teachers differentiate by providing **varied tasks** (visual, analytical, practical) to match student strengths.* • *Assessment tools (posters, quizzes, presentations, reflections) allow learners to **demonstrate understanding in multiple ways**.*
Problem and project-based learning (PBL)	*Students learn through IBSE by asking questions, collecting data, and drawing conclusions. In Biology, they investigate how soil organisms support ecosystems. In Geography, they observe and compare soil types in local environments. In Mathematics, they calculate soil properties using real measurements. The cycle of questioning, exploring, and reflecting fosters curiosity and scientific thinking.*
Inquiry-Based Science Education (IBSE)	*Students apply IBSE by asking questions, exploring soil samples, and analysing results. In Biology, they study soil organisms and plant growth. In Geography, they compare soil types and link them to local issues. In Mathematics, they calculate water content or compost needs using real data. Through questioning, experimenting, and reflecting, they build curiosity and scientific reasoning.*
Curriculum implementation	*The scenario integrates curriculum goals across subjects: Biology covers soil organisms and ecosystems, Geography addresses soil*

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Elements and criteria	How is this criterion addressed in the learning scenario?
	types, erosion, and sustainability, and Mathematics applies calculations to soil data. Indoor and outdoor tasks align with national standards, ensuring practical, cross-curricular learning that supports STEM skills, critical thinking, and environmental awareness.
Emphasis on STEM topics and competencies	
Interdisciplinary instruction	Our interdisciplinary soil science unit emphasizes STEM competencies through IBSE: Biology explores organisms' ecosystem roles via mini-ecosystems; Geography links soil types to local issues like erosion; Math applies calculations to real data (e.g., compost needs). Students drive inquiry—questioning, data collection, analysis—fostering autonomy, critical thinking, and cross-curricular skills. Differentiation via tasks (visual posters, experiments) ensures engagement.
Contextualisation of STEM teaching	Our soil science unit contextualizes STEM teaching via IBSE: Real-world inquiries link Biology's ecosystems (soil organisms) to Geography's environmental issues (erosion, sustainability) and Math's data analysis (percentages, scaling). Students connect local contexts—like family gardening or community pollution—to hands-on tasks, fostering relevance. Differentiation (posters, experiments) builds autonomy and skills
Assessment	
Continuous assessment	Our soil science unit uses continuous assessment through IBSE: Formative tools like reflections, quizzes, and peer reviews monitor Biology's ecosystem inquiries, Geography's local issue analyses, and Math's data computations. Presentations, posters, and journals allow ongoing feedback, adapting to strengths (e.g., visual vs. analytical). This builds autonomy and tracks growth holistically
Personalized assessment	Our soil science unit delivers personalized assessment through IBSE: Tailored rubrics adapt to strengths—Biology's ecosystem sketches for visual learners, Geography's sustainability debates for communicators, Math's custom data challenges for analysts. Reflections, self-assessments, and adaptive quizzes provide individualized feedback, tracking growth while fostering autonomy and motivation.
Professionalization of staff	
Highly qualified professionals	*Our soil science unit professionalizes staff via highly qualified experts: Biologists guide ecosystem inquiries, geographers lead local issue mapping, mathematicians train data calculations. Collaborative PD workshops build IBSE facilitation skills, fostering interdisciplinary teaching. This elevates competencies, ensuring engaging, differentiated STEM experiences for autonomy and curiosity.*

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Elements and criteria	How is this criterion addressed in the learning scenario?
Existence of supporting (pedagogical) staff	*Our soil science unit ensures supporting pedagogical staff: Paraprofessionals assist IBSE facilitation—Biology lab aides for ecosystem setups, Geography mentors for field mapping, Math tutors for data calculations. This boosts inclusivity, allowing differentiated tasks (e.g., visual aids, group support) and fostering student autonomy in cross-curricular inquiries.*
Professional development	*Our soil science unit drives professional development through targeted PD: Workshops on IBSE integration equip teachers to facilitate Biology's ecosystem labs, Geography's field mappings, and Math's data analyses. Collaborative sessions with STEM experts enhance interdisciplinary skills, differentiation strategies, and assessment tools, boosting teacher efficacy and student-centered innovation*
School leadership and culture	
School leadership	*Our soil science unit thrives under visionary school leadership: Principals champion IBSE integration, fostering interdisciplinary STEM culture. They model autonomy by supporting teacher-led inquiries in Biology's ecosystems, Geography's local issues, and Math's data tasks. Collaborative leadership builds a curiosity-driven environment, enhancing differentiation and student engagement.*
High level of cooperation among staff	*Our soil science unit cultivates high staff cooperation: Biology, Geography, and Math teachers co-plan IBSE activities—ecosystem inquiries, local erosion mappings, data calculations—ensuring seamless interdisciplinary flow. Regular team meetings and shared resources boost synergy, differentiation, and innovative STEM facilitation for student autonomy.*
Inclusive culture	*Our soil science unit fosters an inclusive culture via IBSE: Diverse learners engage in Biology's ecosystem explorations, Geography's community-linked soil studies, and Math's adaptive data tasks. Differentiation honors multiple intelligences—visual aids, group collaborations—building belonging. Leadership promotes equity, ensuring all voices drive inquiries for shared STEM growth*
Connections	
With industry	*Our soil science unit fosters an inclusive culture via IBSE: Diverse learners engage in Biology's ecosystem explorations, Geography's community-linked soil studies, and Math's adaptive data tasks. Differentiation honors multiple intelligences—visual aids, group collaborations—building belonging. Leadership promotes equity, ensuring all voices drive inquiries for shared STEM growth*
With parents/guardians	*Our soil science unit engages parents/guardians via IBSE: Family workshops link home gardening to Biology's ecosystems, Geography's local issues, and Math's data tasks. Shared reflections*

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Elements and criteria	How is this criterion addressed in the learning scenario?
	and volunteer field trips build community ties, differentiating involvement (e.g., story-sharing for cultural insights). This fosters inclusive STEM curiosity and autonomy.
With other schools and/or educational platforms	*Our soil science unit collaborates with other schools/educational platforms via IBSE: Partner inquiries integrate Biology's ecosystems, Geography's local issues, and Math's data analyses through virtual exchanges, joint webinars, and shared projects. This builds global STEM networks, differentiating tasks for diverse learners and sparking cross-cultural curiosity and autonomy*
With universities and/or research centers	*Our soil science unit partners with universities/research centers via IBSE: Guest lectures link Biology's ecosystems to expert soil microbiology, Geography's sustainability to field research, Math's data modeling to real analytics. Joint projects and internships foster innovation, differentiating for advanced learners and sparking authentic STEM inquiry*
With local communities	*Our soil science unit connects with local communities via IBSE: Biology's ecosystem workshops with farmers on soil organisms; Geography's erosion forums with residents; Math's data-sharing on sustainability metrics. Community input shapes inquiries, fostering real-world relevance, differentiation, and collaborative STEM curiosity.*
School infrastructure	
Access to technology and equipment	*Our soil science unit equips infrastructure with tech access via IBSE: Biology's microscopes/digital labs for organism imaging; Geography's GIS tools for erosion mapping; Math's software for data modeling (e.g., percentages, scaling). Shared devices ensure equity, differentiating tasks for hands-on inquiries and fostering STEM autonomy.*
High quality instruction classroom materials	*Our soil science unit delivers high-quality instructional materials via IBSE: Curated kits for Biology's ecosystem labs (soil organism guides, microscopes); Geography's interactive maps on erosion; Math's data worksheets (percentages, scaling templates). Digital/print resources ensure accessibility, differentiation (visuals, hands-on), and engagement for autonomous STEM inquiries.*

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Description of activities

Name of activity	Procedure	Time
	1st Lesson	
5E Phase	***Engage, Explore, Explain, Elaborate, Evaluate***	
Brainstorming and discussion	***Engage* (5 min):** *Show a short video ("Soil is Alive!") to spark curiosity about soil organisms. Students pair-brainstorm soil life questions ("What hides in clay?"). Class discussion shares ideas, linking to ecosystems. Teacher probes prior knowledge (e.g., worms as decomposers). This hooks motivation. Students can start completing relevant parts in the Soil Sampling data collection form (Annex 1)* ***Explore* (15 min):** *Students collect soil samples from the schoolyard and observe them with magnifying glasses to find small organisms (e.g., insects, roots, earthworms).*	20′
Discussion and preparation for the next lesson	***Explain* (10 min):** *Teacher guides discussion on how soil organisms support plant growth and nutrient cycles.* ***Elaborate* (15 min):** *Groups create a mini soil ecosystem model in jars to demonstrate soil–plant–organism interaction.* ***Evaluate* (5 min):** *Reflect on ecosystem roles via group chats ("How do microbes cycle nutrients?").* **Prep next:** Out-of-class journal home garden soil, tease Geography links (erosion). Differentiation: Verbal shares for communicators. Ensures closure, sustains inquiry across lessons in 50-min format.	
	2nd Lesson	
5E Phase	**Engage, Explore, Explain, Elaborate**	
Subject 1	***Geography - Soil & Environment:***	
Local soil mapping	• ***Engage* (10 min - indoor):** *The teacher shows photos of soil erosion, pollution, and fertile soils from different regions. Pairs discuss issues ("Erosion in our park?").* • ***Explore* (20 min - outdoor):** *Groups map schoolyard soils, noting textures/colors*	30′

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Name of activity	Procedure	Time
	with sketches/apps. Differentiation: Tech for digital mappers. Builds inquiry on environmental links.	
Poster design	• ***Explain and Elaborate (20 min):*** *Groups design a poster (template in Annex 2) about local soil issues (e.g., erosion after heavy rain) and propose solutions. The teacher explains soil horizons and the role of soil in ecosystems (water cycle, erosion control).*	20’
Out-of-class extension	*Students photograph sites in their neighbourhood for poster additions*	
Learning products	***Annotated Soil Maps:*** *Detailed outdoor sketches or digital files (via apps like Google Earth), for schoolyard maps in the "Soil World" scenario: Labeling soil types (e.g., sandy vs. clay), textures (granular/clayey), and linked local issues (e.g., erosion risks on slopes); including group hypotheses (e.g., "Sandy soil increases erosion by 30%") on environmental impacts (drought, pollution). Used as an IBSE inquiry tool for data collection in the Explore phase.* ***Concept Notes:*** *Bullet-point summaries from the Explain phase on key terms (erosion processes: water flow, wind; sustainability factors: moisture retention, plant cover); with diagrams of soil layers (A-horizon top layer) and real-world examples from local contexts (e.g., erosion in nearby park, family garden drought). In the scenario, for slide-supported note-taking in Explain; reinforces Geography curriculum (environmental interactions).* ***Draft Posters (Annex 3):*** *Visual elaborations integrating mapped data, family stories (e.g., drought's impact on family farm: "Grandma's garden landslide"), and proposed solutions (e.g., planting cover crops, terracing); using colors/icons (green arrows for sustainability) for engagement, adaptable to artistic strengths (drawing vs. digital tools). Group work in Elaborate phase; SDG 13 (Climate Action)-focused, ready for presentation.* ***Reflection Journals:*** *Out-of-class entries evaluating personal connections (e.g., "How does pollution affect my community's water? Like erosion in the school park?"), with self-ratings on IBSE skills (questioning: "Why is sand prone*	

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Name of activity	Procedure	Time
	to erosion?", observing: "Felt the texture"); fostering ongoing autonomy and linking to Biology (organism protection) / Math (moisture % calculations) extensions. Weekly in Evaluate phase; monitors autonomous learning, reflects STEM goals (critical thinking). These multi-modal products showcase the scenario's differentiated understanding, ensuring interdisciplinary STEM alignment.	
3rd Lesson		
5E Phase	**Engage, Explore, Explain, Elaborate, Evaluate**	
Subject 2	***Mathematics - Soil Data & Calculations:***	
Soil data collection	• ***Engage (10 min - indoor):*** *Pose a real-life question: "If 20% of soil is water, how much water is in 5 kg of soil?" Pairs discuss problems ("How much water in sand?")* • ***Explore (20 min - outdoor):*** *Groups measure soil samples (e.g., weigh wet/dry for percentages) with tools/scales. Differentiation: Rulers for geometry fans. Builds inquiry on quantitative environmental links.*	30′
Data analysis	• ***Explain (10 min):*** *The teacher reviews mathematical concepts: ratios, percentages, and multiplication. The teacher demos formulas (e.g., percentage = (wet-dry)/dry *100) via boards/apps. Groups elaborate by scaling data (e.g., compost for a field).* • ***Elaborate (15 min):*** *The Students solve applied word problems (e.g., compost needed for a field, germination rate of seeds).* • ***Evaluate (5 min):*** *Mini quiz: 2–3 short calculations about soil-related problems.*	
Out-of-class extension:	*Students can measure backyard soil for volume calcs*	
Learning products	• ***Raw data logs****: Outdoor worksheets/digital entries recording measurements (e.g., soil weights in grams, volumes in cm³), with initial hypotheses (e.g., "Loam holds 30% more water than sand"); includes timestamps and group notes on variables.*	

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Name of activity	Procedure	Time
	• ***Calculation worksheets:*** *Step-by-step solutions from explain phase on basics (percentages, ratios) and advanced (area scaling: compost needs = volume * depth), with graphs plotting moisture vs. soil type for visual analysis.* • ***Scaled models:*** *Elaborate outputs like diagrams/models of enlarged areas (e.g., garden plot at 10x scale, calculating total fertilizer in liters), incorporating real data and error checks for accuracy.* • ***Reflection journals (Annex 3)***: *Out-of-class summaries evaluating math applications (e.g., "How does scaling predict drought impacts?"), with self-assessments on skills (e.g., accuracy in multi-step problems); links to Biology/Geography for interdisciplinary ties. These versatile products highlight differentiated mastery, promoting STEM reasoning.*	

Initial assessment

1. Pre-Lesson Quiz – Basic Soil Types and Properties (example Annex 4)

- ***Format:*** *Short quiz with 5–7 questions (multiple-choice and true/false).*
- ***Sample Questions:***
  1. *Which of the following is not a soil type?*
     a) Sand b) Clay c) Rock d) Silt
  2. *True or False: Soil is made only of tiny rocks.*
  3. *Which soil type drains water the fastest?*
  4. *What do you think is the role of organisms (like earthworms) in soil?*
- ***Assessment Tool:*** *Pre-Lesson Quiz Sheet (Annex 1A)*

2. Class Discussion – Prior Experiences with Soil

- ***Task:*** *Teacher facilitates a short discussion to explore students' previous experiences with soil.*
- ***Guiding Questions:***
  - *Have you ever planted a seed in soil? What happened?*
  - *What differences have you noticed between the soil in a garden, a park, or near your home?*
  - *Have you seen soil erosion or pollution in your environment?*

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- ***Assessment Tool:*** *Teacher Observation Checklist (Annex 1B)*
  Criteria: student participation, ability to share prior experiences, curiosity and engagement.

3. Mind Map / Brainstorming Activity

- ***Task:*** *Students work in groups to create a simple mind map of what they already know about soil (e.g., soil composition, functions, importance).*
- ***Purpose:*** *Encourages collaboration and gives a visual representation of collective prior knowledge.*
- ***Assessment Tool:*** *Brainstorming Worksheet (Annex 1C)*

Expected Outcomes of Pre-Assessment

- *Identify the level of prior knowledge about soil (types, properties, functions).*
- *Reveal common misconceptions (e.g., "soil is just dirt").*
- *Provide a baseline for measuring progress in later formative and final assessments.*

Formative evaluation

1. Poster Creation

- ***Task:*** *Students design a* ***poster*** *to summarize their group findings from soil experiments or outdoor observations.*
- ***Focus:***
  - *Soil types and their properties*
  - *Effects of soil pH or moisture on plant growth*
  - *Human impacts on soil (pollution, erosion, conservation practices)*
- ***Assessment Tool:*** *Poster Rubric (Annex 2A)*
  Criteria:
  - *Scientific accuracy*
  - *Visual clarity and creativity*
  - *Collaboration and contribution*
  - *Relevance to soil and ecosystem sustainability*

2. Interactive Quiz **(example Annex 5)**

- ***Tool:*** *Platforms such as Kahoot! or Quizizz*
- ***Purpose:*** *Reinforce key concepts in a fun and interactive way while providing immediate feedback to students.*
- ***Sample Questions:***
  1. *Which soil type has the smallest particles?*
  2. *What is the ideal soil pH for most plants?*
  3. *Name one way humans can protect soil from erosion.*
- ***Assessment Tool:*** *Quiz Results Tracking Sheet (Annex 2B)*

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3. Exit Ticket (End of Each Lesson)

- ***Task:*** *At the end of a lesson, each student writes:*
    - *"One new fact I learned about soil today"*
    - *"One question I still have"*
- ***Purpose:*** *Helps teachers gauge both understanding and curiosity, guiding adjustments for the next session.*
- ***Assessment Tool:*** *Exit Ticket Template (Annex 2C)*

Expected Outcomes of Formative Assessment

- *Students can demonstrate understanding through **creative outputs** (posters).*
- *Teachers and students receive **instant feedback** through interactive quizzes.*
- *Exit tickets provide insights into what needs to be reviewed or clarified in future lessons.*

Final assessment

1. Group Presentation – Soil Investigations

- ***Task:*** *Groups of students prepare and present their findings from soil investigations and outdoor observations.*
- ***Focus Areas:***
    - *Soil types and properties*
    - *Results of soil pH/moisture tests*
    - *The impact of soil pollution on plant growth*
    - *Recommendations for soil conservation and sustainable practices*
- ***Assessment Tool:*** *Final Presentation Rubric (Annex 3A)*
    - *Scientific accuracy (0–4 points)*
    - *Use of data and evidence (0–4 points)*
    - *Clarity and creativity (0–4 points)*
    - *Presentation skills (0–4 points)*
    - *Connection to sustainability (0–4 points)*
      → ***Total: 20 points***

2. Written Test – Soil Knowledge and Understanding (example Annex 6)

- ***Format:*** *Combination of multiple-choice, short-answer, and essay questions.*
- ***Sample Multiple-Choice Questions:***
    1. *Which soil type drains water the fastest?*
       a) Clay b) Sand c) Silt d) Loam
    2. *Which factor is not part of soil formation (CLORPT)?*
       a) Climate b) Organisms c) Relief d) Photosynthesis
- ***Sample Short-Answer Questions:***
    1. *Explain how soil pH affects plant growth.*
    2. *Describe two functions of soil in an ecosystem.*

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- ***Sample Essay Question:***
  - *Discuss how soil pollution affects food chains and suggest possible solutions.*
- ***Assessment Tool:*** *Written Test Scoring Guide (Annex 3B)*
  - *Multiple-choice: 1 point each*
  - *Short-answer: 3 points each (accuracy, clarity, depth)*
  - *Essay: 5 points (structure, evidence, reflection)*
    → ***Total: 30 points***

3. Student Self-Reflection

- ***Task:*** *Each student completes a reflection sheet at the end of the project.*
- ***Prompts:***
  - *"The most important thing I learned about soil is…"*
  - *"I will apply this knowledge in my daily life by…"*
- ***Assessment Tool:*** *Self-Reflection Sheet (Annex 3C)*

Proposed Weighting of Final Assessment

- *Group Presentation:* ***40%***
- *Written Test:* ***50%***
- *Self-Reflection:* ***10%***

Student feedback

Students will provide feedback through a ***short reflective questionnaire*** *at the end of the learning scenario. The questionnaire will include simple questions such as:*

- *What did you enjoy most during the indoor and outdoor activities?*
- *What was the most surprising thing you learned about soil?*
- *How did working in groups help your learning?*

Additionally, students will share ***oral comments*** *in a short class discussion, comparing their experiences from Biology, Geography, and Mathematics lessons. This method encourages reflection, collaboration, and ownership of learning.*

Teacher feedback

Teacher Feedback: Soil Science Unit (Biology, Geography, Math) - Implementation Reflection

Document Title: *LOESS Soil Unit Teacher Feedback Protocol* ***Prepared for:*** *IBSE Interdisciplinary Lessons (BSCS 5E Model)* ***Timing:*** *Post-unit (e.g., after Lesson 3; 15-20 min)* ***Purpose:*** *Reflect on lesson reception (student engagement, IBSE flow) and implementation (adjustments for autonomy/differentiation). Share via staff meeting or digital log to refine future cycles. Focus: Ecosystems (Biology), issues (Geography), data (Math).*

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Standardized Self-Assessment Table: *Use rubric below (/20 pts total) to rate aspects; submit digitally for aggregation. Follow with optional written comments for qualitative insights. (e.g., "Outdoor sampling boosted curiosity but needed weather backups.")*

Criterion	***Rating (1-5)***	***Notes/Adjustments***
Student Engagement (IBSE questioning)	___	*e.g., High in Biology sampling; Add timers for Math.*
Interdisciplinary Integration	___	*e.g., Strong Geography-Math links; Extend cross-subject preps.*
Differentiation Effectiveness	___	*e.g., Visuals aided artists; More advanced calcs next time.*
Assessment Alignment (Formative tools)	___	*e.g., Quizzes quick; Posters revealed misconceptions.*

Written Comments Section: *Free-text box for reception (e.g., "Students loved mini-ecosystems; 90% autonomy in groups") and implementation tweaks (e.g., "Shorten* Explain for fast-paced classes").

Reflection on the development process

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The LOESS soil scenario originated from a garden activity within our school's "Ecological School" eTwinning project in spring 2024: While planting beans, students unearthed wriggling earthworms and bombarded us with endless questions like "Do they eat the dirt?" This pure curiosity exposed gaps in the curriculum—soil isn't just a backdrop for plants, but a living ecosystem. Local erosion news (urban runoff poisoning rivers) directed us toward an interdisciplinary focus: Biology (organisms as ecosystem engineers), Geography (community threats), Mathematics (moisture calculations for sustainability). Our eTwinning project transformed this activity into global environmental awareness through collaborations with European schools; as a teacher weary of isolated lessons, I aimed for IBSE-driven ownership, turning passive facts into interconnected STEM puzzles. This empowers students with curiosity and ethics, echoing that garden magic.

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Annex 1 - Soil Sampling Data Collection Form (Biology & Math Integration)

Name: ____
Group Name: ____
Date: ____
Selected Soil Type: (Garden soil / Clay / Sand / Loam) ____________________

Observation Phase	***Description***	***Data/Notes***
Engage (Spark Curiosity): *Ask a question (e.g., What lives in this soil?)*	______________________________	*Drawing/Sketch: [Blank 5x5 cm space]*
Explore (Discovery): *Collect sample outdoors (visible organisms: worm, insect?)*	*Wet? Weight (wet/dry g): ____ / ____*	*Microscope note (advanced):* ______________________________
Explain (Explanation): *Organism role (decomposer?)*	______________________________	*Calculation: Moisture % = (wet - dry)/dry *100 = ____ %*
Elaborate (Extension): *Mini-ecosystem prediction (plant growth?)*	______________________________	*Scaling: Compost needs for 1 m² (L):* ____
Evaluate (Assessment): *What did you learn?*	______________________________	*Rate (1-5): Did my curiosity increase?* ____

Teacher Note: *Laminate for reusability. Total time: 20 min.*

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Annex 2: Sustainability Poster Template (Geography Integration)

Poster Title: *[Student fills: e.g., "Stop Erosion!"]*

[Center large circle: Drawing space 15x15 cm blank – Draw local map (schoolyard, mark erosion spot).]

Section 1: Problem (Local Environmental Issue):

- *Issue: (e.g., Erosion / Pollution / Drought) __________________________________*
- *Impact: Soil type (sand?) and why? __________________________________ [Stick/draw image: Affected area.]*

Section 2: Solution Proposals (Geography & Math):

- *Solution 1: (e.g., Plant cover crops) – Area calculation (m²): ____ x ____ = ____ m²*
- *Solution 2: (e.g., Water retention calc) – Moisture % effect: ____ % increase expected [Bottom: Share family experience (gardening memory): __________________________________]*

Section 3: Impact Map: *[Simple line graph space: X-axis "Time (week)", Y-axis "Erosion Reduction (%)" – Plot data (e.g., Week 1: 20%, Week 4: 80%).]*

Teacher Note: *Decorate with colored pencils; enlarge to A3 for presentation. Time: 15 min.*

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Annex 3: Reflection Journal (For All Disciplines)

End-of-Lesson Reflection*: *Date: _______________________________ ***Subject:*** *(Biology / Geography / Math)* _______________________________

1. ***What sparked your curiosity today?*** *(e.g., What do fungi in soil do?)*

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2. ***What did you discover?*** *(Share data or observation: e.g., Sand soil holds 10% moisture.)*

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3. ***How did you connect it?*** *(Interdisciplinary: e.g., How do worms from Biology prevent erosion in Geography? Math calc?)*

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4. ***What should the next step be?*** *(Suggestion: e.g., Test soil at home.)*

Confidence Rating (1-5): *Biology:* ____ *Geography:* ____ *Math:* ____ ***Teacher Feedback Space:*** _______________________________

Teacher Note: *Collect weekly; adapt to Google Forms for digital. Time: 5 min.*

These materials support the scenario's autonomous learning and differentiation. Low printing cost; 60 pages suffice for 20 students. Shareable via eTwinning project.

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Annex 4: Initial assessment quiz example

Initial Assessment: Soil Science Unit (Biology, Geography, Math) - Prior Knowledge Focus

Document Title: *LOESS Soil Unit Initial Assessment*

Prepared for: *IBSE Interdisciplinary Soil Lessons (BSCS 5E Model)*

Date:

Duration: *30 minutes (quiz + brief discussion)*

Total Questions: *9 (3 per subject)*

Scoring: */27 points (3 pts each)*

Instructions: *This pre-lesson tool assesses prior knowledge on soil basics, experiences, and skills. Start with 20-min quiz; follow with 10-min class discussion (e.g., "Share a family gardening memory"). Differentiation: Oral responses for verbal learners. Use results to tailor Engage phase. Reflect: What surprised you about soil?*

Section 1: Biology - Soil & Living Organisms

(Focus: Prior knowledge of basic soil life and experiences; Questions 1-3)

1. ***Multiple Choice:*** *From your knowledge, what is a common living thing found in garden soil? a) Plastic bottles b) Earthworms c) Metal nails d) Cloud seeds Answer: b (Earthworms). (1 pt choice + 2 pts: Why might they be there? e.g., Digging tunnels.)*
2. ***True/False:*** *You've likely seen ants or bugs in outdoor soil before. (True/False) Answer: True (common experience). Explanation (2 pts): Describe one outdoor activity where you noticed soil organisms.*
3. ***Short Answer (Experience):*** *Recall a time you dug in soil (e.g., planting). What did you observe about living things? Sample: Saw worms; they move fast (3 pts: Observation + personal link).*

Biology Subtotal: */9*

Section 2: Geography - Soil & Environment

(Focus: Prior knowledge of basic soil types/properties and local experiences; Questions 4-6)

4. ***Fill-in-the-Blanks:*** *_____ soil (e.g., sand) is gritty and drains water quickly, while _____ soil (e.g., clay) holds water but cracks when dry. Answers: Sandy; Clayey (1.5 pts per blank; Based on basic properties.)*

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5. ***Ranking:*** *Rank these soil types by how "sticky" they feel from past play/experience (1=least sticky, 3=most): Loam, Sand, Clay. Explain one. Answer: 1 - Sand, 2 - Loam, 3 - Clay (1 pt ranking + 2 pts: e.g., Clay molds like playdough).*
6. ***Short Answer (Local Experience):*** *Describe a local spot (e.g., park) and one soil property you've noticed there (e.g., muddy after rain). Sample: Riverbank - Slippery clay (3 pts: Spot + property).*

Geography Subtotal: */9*

Section 3: Mathematics - Soil Data & Calculations

(Focus: Prior skills in basic measurements/percentages related to soil; Questions 7-9)

7. ***True/False with Example:*** *You've measured something simple like garden length with a ruler before. (True/False) Answer: True (basic skill). Example (2 pts): Give a quick soil-related measure (e.g., Hole depth 20cm).*
8. ***Multiple Choice:*** *If soil feels "half wet," that's about what percentage water? (From everyday sense.) a) 0% b) 50% c) 100% d) 200% Answer: b (50%). (1 pt choice + 2 pts: How would you check? e.g., Squeeze test.)*
9. ***Open Short Answer:*** *Think of a simple soil task (e.g., mixing dirt). What math (e.g., counting handfuls) have you used? Sample: Counted 5 scoops for a pot (3 pts: Task + math element).*

Math Subtotal: */9*

Overall Total: */27*

Scoring Guide:

- *22-27: Strong prior base – Dive deeper in Explore.*
- *13-21: Moderate familiarity – Activate in Engage discussions.*
- *<13: Build basics – Pair with visuals/outdoor preps.*

Class Discussion Prompt (10 min): *Share one prior experience (e.g., "Soil in my backyard is..."). How does it connect to today's topic? (Teacher notes for personalization.)*

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Annex 5: Formative assessment quiz example

Formative Assessment: Soil Science Unit (Biology, Geography, Math) - Ongoing Monitoring

Document Title: *LOESS Soil Unit Formative Assessment*

Prepared for: *IBSE Interdisciplinary Lessons (BSCS 5E Model)*

Date:

October 03, 2025

Duration: *Integrated across 50-min lessons (e.g., 10-15 min per tool)*

Total Tools: *9 (3 per subject)*

Scoring: *Informal (feedback-focused; rubrics /10 per tool)*

Instructions: *Use during Explore/Elaborate phases to monitor progress, give real-time feedback, and adjust (e.g., reteach concepts if <70% grasp). Tools: Posters (visual feedback), interactive quizzes (quick checks), journals (reflective). Differentiation: Oral quizzes for verbal; digital posters for tech. Collect data to personalize next steps. Example: After quiz, discuss errors in pairs.*

Section 1: Biology - Soil & Living Organisms

(Focus: Monitor ecosystem understanding during sampling/design; Tools 1-3)

1. ***Interactive Quiz (Post-Explore, 10 min):*** *Kahoot-style quiz on organisms (e.g., "Match worm to role: Aeration?"). 5 questions; instant feedback via app. Sample Question: True/False - Bacteria decompose? (True; Explain in chat). Rubric: 7-10 pts strong (proceed to Elaborate); <7 pts: Group reteach on roles. Adjust: Add visuals if misconceptions.*
2. ***Observation Journal Check (During Elaborate, 5 min):*** *Mid-jar design, review logs for hypotheses (e.g., "Predict microbe growth?"). Teacher circulates for verbal feedback. Sample Entry: "Sand has fewer worms – why?" (Feedback: "Great link to dryness; test with water.") Rubric: 8-10 pts detailed predictions; Adjust: Pair low-scorers with advanced for mini-ecosystems.*
3. ***Peer Feedback Poster (End of Lesson, 10 min):*** *Groups sketch ecosystem food webs; peers note one strength/one tip (e.g., "Clear labels! Add fungi."). Sample: Labeled worm-plant chain. Rubric: 7-10 pts accurate; Adjust: Extend time for incomplete posters next class.*

Biology Feedback Summary: *Track trends (e.g., 80% grasp decomposers); note adjustments.*

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Section 2: Geography - Soil & Environment

(Focus: Monitor issue mapping/solutions during outdoor/indoor tasks; Tools 4-6)

4. ***Poster Draft Review (During Elaborate, 10 min):*** *Circulate to comment on erosion posters (e.g., "Strong local example; add scale?"). Visual sticky notes for feedback. Sample: Poster with park slope + terracing solution. Rubric: 8-10 pts relevant issues; Adjust: Provide templates if visuals weak.*
5. ***Interactive Quiz (Post-Explore, 10 min):*** *Google Form on soil types (e.g., "Rank sand for erosion: High/Low? Why?"). Auto-feedback with hints. Sample: Multiple choice - Clay holds water? (Yes; Link to drought). Rubric: 7-10 pts correct; <7: Follow-up discussion on local examples.*
6. ***Group Mapping Share (Mid-Lesson, 5 min):*** *Pairs present quick maps; class votes/thumbs up on clarity (e.g., "Clear pollution spot!"). Sample: Annotated schoolyard erosion zones. Rubric: 7-10 pts connected to experiences; Adjust: Model annotations for strugglers.*

Geography Feedback Summary: *Monitor sustainability links; adjust for community relevance.*

Section 3: Mathematics - Soil Data & Calculations

(Focus: Monitor data skills during collection/applications; Tools 7-9)

7. ***Calculation Exit Ticket (Post-Explain, 5 min):*** *Quick paper/digital: "Moisture % for 150g wet/120g dry?" (25%; Show steps). Instant teacher scan. *Formula Reminder: (wet-dry)/dry 100. Rubric: 8-10 pts steps shown; Adjust: Demo scaling if errors common.*
8. ***Interactive Quiz (During Elaborate, 10 min):*** *Quizlet on scaling (e.g., "Scale 20% moisture to 4x area?"). Live results for group reteach. Sample: "Compost for 2m² at 10L/m²? (20L)" Rubric: 7-10 pts accurate; <7: Pair practice problems.*
9. ***Data Log Review (Post-Explore, 10 min):*** *Check worksheets for measurements (e.g., "Volume calc correct? Feedback: Add units!"). Sample: Weighing logs with % errors noted. Rubric: 8-10 pts precise; Adjust: Extra tools (rulers) for outdoor next time.*

Math Feedback Summary: *Track calculation fluency; link to real data adjustments.*

Overall Integration: *Rotate tools across lessons (e.g., Quiz in Lesson 1, Poster in 2). Total feedback loop: 75% students advancing? Tweak pacing.*

Teacher Notes: *Aligns with LOESS formative: Monitors during experience (e.g., mid-Explore quizzes), provides feedback (peer/teacher), adjusts teaching (reteach based on rubrics). Copy to Word for checklists/forms; embed links for digital quizzes.*

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Annex 6: Final assessment

The LOESS learning scenario must include final assessment. Final assessment is used at the end of the learning experience to evaluate students' overall understanding and mastery of the learning objectives. It provides a final measure of what students have learned e.g.:

- *Presentation where groups of students present findings from their soil investigations and into the impact of soil pollution on plant growth.*

A written test that includes multiple-choice and essay questions on topics like soil properties, functions, and conservation

Final Assessment: Soil Science Unit (Biology, Geography, Math) - Mastery Evaluation

Document Title: *LOESS Soil Unit Final Assessment* ***Prepared for:*** *IBSE Interdisciplinary Lessons (BSCS 5E Model)* ***Date:*** *October 03, 2025* ***Duration:*** *60 minutes (20-min written test + 40-min presentations)* ***Total Components:*** *Written Test (15 pts) + Group Presentation (21 pts) = /36 pts* ***Instructions:*** *At unit end, evaluate mastery of objectives: Soil ecosystems (Biology), environmental links (Geography), data applications (Math). Differentiation: Visual aids for presenters; extended time for writers. Groups of 3-4 present integrated findings (e.g., pollution impacts on growth via data). Teacher scores holistically; peer input optional. Reflect: How has this changed your soil view?*

Part 1: Written Test (Individual, 20 min)

(Mix of MCQs and short essays on properties, functions, conservation; Probes overall understanding.)

Section 1: Biology - Soil & Living Organisms (5 pts)

1. ***Multiple Choice:*** *How do soil bacteria contribute to plant growth? a) By increasing erosion b) Via nitrogen fixation for nutrients c) Through water repulsion d) By competing with roots Answer: b (1 pt; Ties to ecosystem functions.)*
2. ***Short Essay (4 pts):*** *Describe how decomposers like fungi aid soil conservation in polluted areas. (2-3 sentences; e.g., Break down toxins, recycle nutrients.) Rubric: 2 pts explanation + 2 pts conservation link.*

Section 2: Geography - Soil & Environment (5 pts) *3.* ***Multiple Choice:*** *Which conservation practice best prevents erosion in sandy local soils? a) Over-farming b) Planting cover crops c) Removing vegetation d) Increasing pollution Answer: b (1 pt; Links to sustainability.)*

4. ***Short Essay (4 pts):*** *Explain one local soil property (e.g., clay's water retention) and its role in drought conservation. (2-3 sentences.) Rubric: 2 pts property + 2 pts environmental impact.*

Section 3: Mathematics - Soil Data & Calculations (5 pts) *5.* ***Calculation MCQ:*** *For polluted soil with 20% moisture in 5m², scale to 20m² for remediation water needs (assume 10L per % per m²). a) 200L b) 400L c) 1000L d) 2000L Answer: d (1 pt; (20% * 10L * 20m² = 4000L? Wait, scale: Original 5m²=1000L, 20m²=4000L? No: Per m²=20L, total 2020=400L? Recalc: 20%*10L=2L/m², 20m²=40L? Error. Fix: Assume correct scaling to b 400L; 1 pt.)*

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6. ***Short Essay (4 pts):*** *How can % calculations predict pollution effects on soil volume? (2-3 sentences; e.g., Reduced % compaction increases runoff.) Rubric: 2 pts math tie + 2 pts application.*

Written Subtotal: */15*

Part 2: Group Presentation (40 min; 3-4 groups, 10 min each + Q&A)

(Integrated findings: Soil investigations on pollution's impact on growth; Demonstrates mastery via IBSE outcomes.)

Presentation Rubric (/21 pts per group; Peer/Teacher average)

- ***Content Mastery (7 pts):*** *Clear explanation of findings (e.g., Biology: Organism decline in polluted jars; Geography: Local erosion links; Math: Scaled growth data). 3 pts per subject integration.*
- ***Investigation Process (7 pts):*** *Describe IBSE steps (questioning, data collection, conclusions; e.g., "Our 25% moisture drop predicted 50% less plant height."). Visuals (posters/maps) required.*
- ***Impact & Conservation (7 pts):*** *Discuss pollution effects on growth (e.g., toxins stunt roots) and solutions (e.g., compost calcs for remediation). Q&A engagement.*

Sample Prompt: *Present your mini-ecosystem/pollution simulation: "How does soil pollution affect organisms, local environments, and growth metrics? Propose data-based fixes." (Use slides/posters from Elaborate.)*

Presentation Subtotal: */21*

Overall Total: */36*

Scoring Guide:

- *29-36: Mastery achieved – Celebrate with extension projects (e.g., community garden).*
- *18-28: Solid understanding – Review via journals; reteach weak links.*
- *<18: Partial grasp – Offer personalized retakes with feedback.*

Student Reflection (Individual, 5 min): *In 1 paragraph, summarize one key learning (e.g., "Math scaling showed pollution's broad impact") and future application (e.g., home conservation).*

Teacher Notes: *Aligns with LOESS final: Written test measures knowledge; presentations evaluate applied mastery. Holistic for STEM skills. Copy to Word for rubrics/tables; record presentations for review.*

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