Field Investigators: Measuring the Living World

Learning Guide 02 — Grades 5-8

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Erdpuls Learning Guide 02 — Grades 5–8

Field Investigators: Measuring the Living World

For Students Ages 11–14 — Middle School

Institution: Erdpuls Müllrose - Center for Sustainability Literacy, Citizen Science and Reciprocal Economics

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Changelog

Version	Date	Changes
1.1	February 2026	Initial generation for OER publication; institution name and license applied
1.0	—	Not released

Overview Table

Element	Detail
Target Group	School classes, Grades 5–8, ages 11–14
Session Length	3–3.5 hours (half-day)
Group Size	12–30 students; 1 facilitator per 15 students; 1 teacher accompanying minimum
Setting	Erdpuls campus garden and surrounding rings; adaptable to school grounds

Element	Detail
Season	All seasons; spring and autumn offer widest biological range
Core Method	The 4A-Pathway (Awareness → Acknowledgment → Attitude → Action); full 13-Question soil protocol; systematic data recording
Toolkit Links	Appendix A (full Questions to the Soil); Appendix B (Token Economy, intermediate); Appendix C (Bioregion Mapping, introductory transect)
Developmental Stage	Second seven-year period transition: awakening capacity for causal reasoning, peer social identity, the emergence of independent judgment; abstract thinking beginning but still grounded in observation
Citizen Science Output	Complete Field Sheet dataset; iNaturalist species observations; openSenseMap data contribution; entry into Erdpuls longitudinal soil record
Token Economy Level	Intermediate — four elements introduced; participants earn real tokens for cooperation, reciprocity, mutualism, and regeneration activities
Languages Available	EN ([emoji]) DE pending PL pending

Five Competency Clusters at This Level

Competency Cluster	Expression for Ages 11–14
Environmental Literacy	Full 13-Question soil protocol; soil horizon reading; seasonal comparison; connecting patch to landscape (Ring 1–3 awareness); reading the ecosystem as a system of relationships
Scientific Inquiry	Systematic data recording; measurement with instruments (pH strip, thermometer, moisture probe); comparison between patches; formulating a "Why?" question from observed data differences
Technology Competence	Operating the senseBox MCU with guidance; reading sensor output; uploading data to openSenseMap; first encounter with the sensor-as-continuous-observer concept
Economic Understanding	Introduction to all four token elements; mapping existing reciprocal exchanges in their own school or neighborhood; recognizing that not all value is monetary

Competency Cluster	Expression for Ages 11–14
Social-Emotional Learning	The 4A-Pathway: from noticing (Awareness) to personal connection (Acknowledgment) to values engagement (Attitude); team data sharing; formulating a question to bring home

Pedagogical Rationale

The Developmental Stage

Students in Grades 5–8 are crossing the threshold into the second major developmental phase: the awakening of **causal thinking**. They are no longer content with *"what"* — they are increasingly driven by *"why."* This is the developmental moment at which environmental education either succeeds in producing genuine inquiry or collapses into passive reception. The distinguishing factor is almost always whether students formulate their own questions from their own observations, or merely receive information formulated by others.

The full 13-Question soil protocol is designed for exactly this moment. Questions 1–9 are observation-rich and empirical; Questions 10–12 require causal and relational reasoning ("Why are the layers different?", "How does this patch relate to what surrounds it?"); Question 13 (*"What would you do?"*) introduces the Attitude stage of the 4A-Pathway. By the end of the protocol, every student has generated an observation, a measurement, a relational interpretation, and an ethical position — all grounded in what they personally found in a patch of ground.

The peer dimension is equally important at this age. Students in Grades 5–8 are acutely aware of each other's evaluations. The team structure of the Erdpuls session makes peer observation a resource rather than a threat: what one team notices, it brings back to the whole group, and the group's assembled data is richer than any individual's. This is not just pedagogy — it is accurate science. The differences between teams' patches are real, and comparing them produces genuine research questions.

The Sensor Dialogue at This Level

The senseBox MCU is introduced to this age group as a **co-investigator**, not as the authoritative answer. The "Sensor Dialogue" — comparing students' embodied readings with sensor readings — is designed to produce productive disagreement. When a student feels the air is "quite warm" and the sensor reads 9°C, the discrepancy is a learning event: *"What information were you using? What information was the sensor using? Who was more accurate for the question at hand?"*

This is the epistemological core of citizen science: the recognition that human sensing and instrumental measurement are complementary data streams, not competitors. The sensor has temporal resolution (it reads every 5 minutes, continuously). The human body has spatial and multi-channel integration (it senses temperature, texture, humidity, and smell simultaneously, across an area). Both are necessary. Neither is complete without the other.

Preparation and Materials

Facilitator Preparation (48 Hours Before)

- Read the full 13-Question protocol in the Pattern Discovery Toolkit Appendices (Appendix A)
- Read the Sensor Dialogue section and data dashboard notes
- Prepare 4–5 observation patches of contrasting character (under a tree vs. open bed vs. near the wall vs. compost area vs. grassy path edge) — variety produces the richest comparison data
- Print **Field Sheets** (one per student — A4 double-sided; Side 1: 13 Questions with observation spaces; Side 2: Measurement Table with columns for each team's patch and the sensor reading)
- Charge senseBox MCU; test all sensors (temperature, humidity, pH if available, soil moisture probe)
- Prepare the senseBox dashboard display (tablet or projected screen)
- Set up the Comparative Data Board (large paper, ruled into columns by team; headers: Patch Location / Temperature felt / Temperature measured / Moisture felt / Moisture measured / pH / Life Count / Water infiltration time)

Materials List

Per team (4–5 students): - Field Sheets (one per student) - Pencils (not pens — work when cold or slightly damp) - Magnifying glass or hand lens (10×) - Observation frame (30×30 cm, pre-placed) - White tray for Life Count - 3 soil sampling cards (stiff card, to collect small soil samples) - Water dropper bottle (100 ml) + measuring cup for infiltration test - Timer (phone timer acceptable) - pH strips + distilled water + small cup for mixing - Soil thermometer (insert-type)

Shared/facilitator equipment: - senseBox MCU with HDC1080, soil moisture probe - Tablet or device for dashboard display - Comparative Data Board - Marker for facilitator to record shared data

For token economy: - Token cards (Green = Cooperation / Blue = Reciprocity / Orange = Mutualism / Gold = Regeneration) — at least 3 per participant - Token ledger sheet (brief record of who earned what and why)

Session Structure

Opening — Arrival and Framing (15 minutes)

Bridging to prior knowledge:

Students stand in a loose group near the observation area. The facilitator does not begin with a lecture. Instead:

"Before we go to the soil, I want to know what you already know. When was the last time you actually touched soil? Not walked over it — touched it. What did it feel like?"

Brief sharing, 3–4 responses. Then:

"Today you're going to become the world's expert on one specific 30×30 centimeter patch of ground. Not soil in general — that particular patch. By the end of today, you will know more about it than any scientist who has never visited it."

This framing is important for ages 11–14: it establishes that their specific, local knowledge is genuinely valuable — not just a classroom exercise but real science about a real place.

Introduce the 4A-Pathway briefly:

"We use a pathway with four stages. Awareness: noticing what's there. Acknowledgment: understanding that it matters and connects to you. Attitude: deciding how you feel about what you found. Action: doing something because of what you found. We won't force any stage — but see if you can catch yourself moving through them today."

Phase 1 — Full Soil Observation Protocol (50 minutes)

Teams move to their assigned patches. Field Sheets distributed. The facilitator reads each question aloud for the whole group, waits 4–5 minutes for team work, then moves to the next question. Students record both drawings and written notes.

Questions 1–5: First sensory survey

Standard observations: color, smell (use smell comparison jars if available), texture, living things found, evidence of prior life. Students record in Field Sheet drawing/writing spaces.

For the **Life Count (Q4):** Set a 2-minute timer. Students place soil on the white tray and count every organism visible. Any description counts: "tiny orange dot," "white thread," "curved pink segment." The count number itself is data; the descriptions are observation records. The facilitator notes each team's count on the Comparative Data Board.

Questions 6–8: Measurement round

Q6 (Structure): Students categorize their soil as: sandy (falls apart immediately), loamy (holds shape briefly), or clay-like (stays in a lump, can be rolled). Record on Field Sheet.

Q7 (Water Infiltration Test): Pour exactly 100 ml of water onto the undisturbed soil surface adjacent to the frame. Count seconds until water disappears. Record time. This is the first quantifiable cross-team comparison.

Q8b (Auditory enrichment): Ear to within 5 cm of ground, 30 seconds of silence. Students note sounds in Field Sheet. Stand up. Compare what changed. *"What did you hear at ground level that disappeared when you stood? What does the soil community sound like from where the worms are?"*

Questions 9–12: Structural and relational observations

Q9–10 (Roots and Layers): Students describe root architecture visible in their frame (depth, direction, thickness). If a small excavation is approved (10 cm depth maximum, refill afterward), they observe soil layers (horizons): color changes, texture changes, root density changes at different depths.

Q11 (History): First interpretive question. *"From what you've observed — not from what you know already — what has happened to this soil? Has it been dug up? Compacted? Enriched? Neglected? What are your clues?"* Students write a brief evidence-based narrative on the Field Sheet.

Q12 (Relationships): Students stand and look outward from their patch. *"What feeds this patch? What drains it? What casts shadow on it? What grows differently on the patch five meters away — and why might that be?"* Students draw a simple relationship web on the Field Sheet.

Question 13: Attitude and Action

"If you were responsible for this specific patch of ground — not soil in general, this patch — what would you do? What would you stop doing? What would you leave completely alone?"

Students write individually for 3 minutes before sharing with their team. This is a personal response; there is no team consensus required. It marks the Attitude stage of the 4A-Pathway.

Phase 2 — The Sensor Dialogue (20 minutes)

Gather the whole group around the Comparative Data Board. Display the senseBox dashboard.

The facilitator reads aloud each team's body-sensing results (from field sheets) and plots them against the sensor readings. A typical comparison table:

Team	Patch	Temp felt	Temp measured	Moisture felt	Moisture measured	Life Count	H_2O infiltration
1	Under apple tree	Cool	8°C	High	68%	17	6 sec
2	Open bed	Warm	13°C	Medium	41%	8	18 sec
3	Near brick wall	Hot	17°C	Dry	22%	3	51 sec
4	Compost area	Warm	15°C	Very wet	84%	24	3 sec

Discussion questions (facilitator chooses 2–3):

- *"Where did your body's reading agree with the sensor? Where did it disagree? What explains the disagreement?"*
- *"Look at the life count column. What pattern do you see? Is it related to any other column?"*
- *"Team 3 found almost no living organisms and the water took nearly a minute to absorb. Team 4 found 24 organisms and the water absorbed in 3 seconds. Why might these patches be so different, even though they're in the same garden?"*
- *"The sensor has been running here for months. It knows the temperature every 5 minutes, continuously. You know it right now, in three dimensions, with all five senses. What can you find out that the sensor can't? What can the sensor find out that you can't?"*

Citizen Science Moment: The facilitator uploads this session's data to openSenseMap and pulls up the map view showing other sensors across Germany and Europe. *"Your readings are now in this network. Someone researching soil temperature patterns in Brandenburg might use your data next year."*

Students note their openSenseMap station ID on their Field Sheet — their permanent contribution record.

Phase 3 — Token Economy: Seeing What We Already Have (20 minutes)

Before introducing the Erdpuls token system, the facilitator asks students to map what they already do:

"Think about the last week in your school, your home, your neighborhood. Can you name one thing you did that helped someone else — not for money, not for a grade, just because it was the right thing to do? One thing someone did for you that they didn't have to? One thing you contributed to something bigger than yourself?"

2-minute individual reflection. Brief sharing.

Then introduce the four token elements:

- **Cooperation (Green):** Working together so the result is better than either of you could produce alone
- **Reciprocity (Blue):** You contribute something; you receive something different back — a two-directional flow
- **Mutualism (Orange):** Your action benefits people who weren't even present — it contributes to a commons
- **Regeneration (Gold):** Your action leaves something better than you found it — ecological or social improvement

"Look at your data collection today. You were in a team. Was that Cooperation? You shared your team's findings with everyone. Was that Mutualism? If you upload your observations to iNaturalist and someone in Poland uses your data to understand migration patterns — is that Mutualism or Reciprocity?"

Students earn token cards for the session's activities: - **Cooperation:** Completing the team field sheet together - **Mutualism:** Uploading observations to openSenseMap / iNaturalist - **Reciprocity:** Sharing a surprising finding with the whole group that changed another team's understanding - **Regeneration:** (awarded at end of session) If a student identifies a specific action they commit to taking — at home, at school, in their neighborhood — based on what they observed

Each student should leave with 2–4 token cards. These are real tokens that enter the Erdpuls system and can accumulate toward community threshold rewards.

Closing — Bringing it Back (15 minutes)

"My One Question":

Each student writes on the back of their Field Sheet: *"The question I couldn't answer today that I most want to know the answer to."*

These are shared briefly around the circle. The facilitator notes them on a visible list. These questions are: 1. The Action stage of the 4A-Pathway — the seeds of follow-up inquiry 2. The most valuable citizen science output of the session — genuine questions from direct observation that no existing dataset has already answered

"Scientists spend their careers looking for the questions that nobody has answered yet. You just produced a page full of them. That's not a sign that today wasn't enough — that's the sign that it worked."

Post-Visit Classroom Activities

Data Analysis (1 lesson): Use the class's Comparative Data Board to graph the correlations: Life Count vs. Moisture; Infiltration Time vs. Temperature; pH vs. Life Count. Which correlations are strongest? What does the correlation suggest about what living things need?

Soil Story — Systems Version (1 lesson): Write a "day in the life" narrative from the perspective of the whole soil patch — what does it receive, what does it give, what threatens it, what sustains it? This is a systems-thinking exercise disguised as creative writing.

The "One Question" Follow-Up (ongoing): Students research one of the questions they brought back from the session. Present findings in 3 minutes at a subsequent lesson. This closes the 4A-Pathway loop from Attitude to Action.

Brandenburg Curriculum Connections:

Subject	Curriculum Element	Erdpuls Connection
Biology (Gr. 5–6)	Soil organisms and ecology	Life Count, organism identification, soil food web discussion
Biology (Gr. 7–8)	Ecosystems and interdependence	Patch relationships (Q12), sensor-to-biodiversity correlation
Geography (Gr. 5–6)	Local landscape and land use	Q11 (history), Q12 (relationships), transect extension
Chemistry (Gr. 7–8)	pH and chemical properties	pH measurement, soil acidity and plant growth connection
Mathematics (Gr. 5–8)	Data collection and graphing	Comparative Data Board, correlation analysis
Ethics/Social Studies	Value beyond money	Token economy, reciprocal exchange mapping

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Facilitator Notes

The most common facilitation error at this age: Moving to explanation before observation is complete. Students of this age have a high tolerance for ambiguity and genuine curiosity about "why" — but the "why" must emerge from their own data, not be supplied before they have gathered it. Resist the impulse to explain the Life Count difference between patches before students have discussed it themselves. Give them the data; give them the question; wait.

If students rush the observation phase: The measurement round (Phase 1, Questions 6–8) tends to accelerate student engagement — instruments are inherently motivating for this age. If observation is losing energy, introduce the thermometer or pH strips slightly earlier as a bridging tool, then return to observational questions.

If the sensor is unavailable: The Sensor Dialogue becomes a class discussion about what instruments could measure what the body cannot — an equally valid exercise. Students design a "perfect instrument" for one observation they made.

Seasonal Variations

Season	Key Adaptation
Spring	Soil warming measurable day-over-day; Life Count highest for invertebrates; seed germination in soil visible under layers. Best for Q9–10 (roots and layers).
Summer	Infiltration test most dramatic (dry surface); temperature contrast between patches at maximum. Best for cross-patch comparison.
Autumn	Decomposition focus; fungal threads visible in Q7; Life Count rich with decomposers; Q11 (History) richest with visible leaf layer accumulation.
Winter	Frost effects on structure; under-snow temperature measurement (contrast with exposed soil). "Where did the summer life count organisms go?" as driving inquiry question.

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