Soil Colour as Physics — Detailed Lesson Plan: Classes 1–4

Earth Pigments from the Soils of Müllrose

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Earth Pigments from the Soils of Müllrose

Erdpuls Müllrose — Living Laboratory & Makerspace Garden

Part of the "Brücken bauen durch Boden — 13 Questions to the Soil" project

Overview

Target group	Classes 1–4 (ages 6–10)
Number of units	6 × 45 minutes
Total time	270 minutes (~4.5 hours)
Location	Units 1–2 outdoors / school garden; Units 3–6 in the classroom or Erdpuls Zone B
4A focus	Awareness and Action (Acknowledgment and Attitude introduced lightly)
Cognitive mode	Sensory-phenomenological: encountering before explaining
Core question	*"What colours are hiding in the soil?"*
Binder method	Wet route only — no dry grinding or sieving in this band
Output	Each student's personal colour sheet; class colour palette painting

Teacher Notes for This Grade Band

Children at this age are naturally gifted scientists in the most important sense: they are genuinely curious, they are not afraid to get their hands dirty, and they have not yet decided that science is hard. Your task is to protect that curiosity and direct it, not to explain everything.

The key principle for Classes 1–4: Let the soil ask the questions. Your job is to pose good open questions, give children time to observe, and resist the urge to provide explanations before they have had time to wonder.

What you do NOT need to teach at this level: - The names of iron oxide minerals - Mie scattering - pH values - Any chemistry

What you absolutely DO teach: - Colour differences are real and observable - Wet soil is darker than dry soil - Grinding changes the colour - These colours can make real paint that artists use

Preparation notes: - Pre-collect soil samples from at least three contrasting sites (see Section 2.3 of the concept document) — one sandy/pale, one brown earth, one dark fen or humus-rich sample. - Pre-dry and pre-sieve samples (remove stones and debris) before class. - Use only the **wet route** for all processing. This eliminates dust hazards completely. - Dust masks are not required for wet processing, but have them available.

Unit 1 — The Colour Walk (Outdoors)

Duration: 45 minutes **Location:** School garden, park, or Erdpuls field sites **4A-Pathway stage:** Awareness **Materials needed:** Collecting bags or small containers (one per child), magnifying glasses, crayons or coloured pencils for the journal

Learning Objectives

By the end of this unit, students will be able to: - Name at least three different colours they observed in soil - Describe what they noticed about where the dark soils and pale soils were found - Collect a small soil sample and label it with its location

Unit Plan

Opening (5 min): Gather the class. Pose the question: *"Do you think all soil is the same colour? What colour is soil?"* Take a few answers. Most children will say "brown." Let this prediction sit.

Say: *"Today we are going outside to find out if that is true."*

Direct Experience (15 min): Walk with the class through the outdoor space. Pause at three or four different spots — a dry sandy area, a shaded patch under a tree, a wet area near water or a drain, a garden bed. At each spot: - Ask children to look closely without touching first. - Then invite them to pick up a small pinch of soil and roll it between their fingers. - Ask: *"What colour is this? Does it smell like anything? Is it wet or dry? Rough or smooth?"*

Invite children to collect one small sample from each spot in their containers.

Investigation (15 min): Back at a table or on the ground, lay out the samples side by side. - Ask children to arrange them from lightest to darkest. - Count the colours together. - Ask: *"Which one surprised you the most?"* - Ask: *"Where was the darkest soil? Where was the palest?"*

Synthesis (7 min): Ask the class: *"Was all the soil the same colour?"* Let them answer. Briefly connect: *"The colour of soil tells us something about what has happened there — whether it was wet or dry, whether plants have been growing there for a long time."*

Closing (3 min): Each child draws one colour swatch in their journal and writes or draws where that soil came from. Preview: *"Next time we will bring soil inside and see what we can do with it."*

Unit 2 — Wet and Dry: The Same Soil, Two Colours?

Duration: 45 minutes **Location:** Classroom or outdoor table **4A-Pathway stage:** Awareness → Acknowledgment **Materials needed:** Pre-collected soil samples (teacher-prepared), two shallow dishes per pair of students, water in a jug, spoons, white paper, camera or phone

Learning Objectives

By the end of this unit, students will be able to: - Observe that wet soil is darker than dry soil from the same sample - Describe the change using colour language ("darker," "lighter," "more orange," etc.) - Pose a question about why this happens

Unit Plan

Opening (5 min): Bring out two pre-prepared dishes of the same soil — one dry, one freshly moistened. Put them next to each other without explanation. Ask: *"What do you notice? Can you tell which is which? Are they the same soil?"*

Direct Experience (12 min): Give each pair of students a small portion of dry soil on a white dish. Ask them to: 1. Observe it carefully and describe its colour. 2. Then slowly add water — a few drops at a time — with a spoon. 3. Observe the colour after each small addition of water.

Children record (by drawing) what the soil looked like before and after.

Investigation (15 min): Repeat with a second, contrasting soil (e.g., sandy pale soil and dark humus soil). Ask: - *"Which soil changed more when it got wet?"* - *"Which dried out fastest when you blew on it?"* - *"Is the colour always the same before and after?"*

Photograph samples wet and dry for the class record. Allow children to observe the photos on a screen and count the colour differences.

Synthesis (10 min): Bring the class together. Ask: *"Why do you think the wet soil looks darker?"* Accept all answers — write them on the board without correcting. Possible answers children give: "Because it's muddy," "Because the water changes it," "Because water is darker than air." All of these are good thinking.

Say: *"Scientists have found that water fills up the tiny spaces in soil that are normally full of air. That air was bouncing light around and making the soil look lighter. With water there instead, the light doesn't bounce as much."* (Keep it brief — plant the seed, don't explain it all.)

Closing (3 min): Journal: draw both versions of one soil — wet and dry. Write one question you have.

Unit 3 — Grinding: Making the Colour Stronger

Duration: 45 minutes **Location:** Classroom or Erdpuls Zone B **4A-Pathway stage:** Acknowledgment **Materials needed:** Pre-dried and pre-sieved soil samples (teacher-prepared), porcelain mortars and pestles (1 per pair), water in a jug, small dishes, white watercolour paper (300 g/m²), flat paintbrushes, magnifying glasses

Learning Objectives

By the end of this unit, students will be able to: - Observe that ground soil makes a more even and richer colour on paper - Describe the difference between a coarse sample and a ground sample applied to paper - Grind wet soil safely using the wet route

Unit Plan

Opening (5 min): Show children two patches on white paper — one made by rubbing a large lump of soil, one made with finely ground wet soil. Ask: *"Which looks better as a colour? What is different about them?"*

Direct Experience (10 min): Give each pair a small amount of pre-dried soil and a mortar and pestle. First, ask them to try spreading the unground soil on paper with a brush and a little water. Observe and describe the result.

Investigation (20 min): Now ask students to grind the same soil with a little water in the mortar — circular motions, 3–5 minutes. The teacher models this once clearly.

After grinding: - Spread the wet paste on paper with a brush. - Compare side by side with the unground version.

Questions to ask during the work: - *"Is the colour changing as you grind? How?"* - *"What does the paste feel like now compared to before?"* - *"What happens if you grind for longer?"*

If time allows, grind a second sample for longer and compare all three: unground, 3 min, 5+ min.

Synthesis (7 min): Bring the class together with their paper samples. Line them up. Ask: *"What happened to the colour? Why do you think grinding makes the colour stronger?"* (Children's own answers — no need to explain Mie scattering at this stage.)

Say: *"Painters have known for thousands of years that the finer you grind the colour, the richer it becomes. This is how people made paint before they could buy it in tubes."*

Closing (3 min): Journal: draw your mortar and paste. Write one word describing what grinding the soil felt like.

Unit 4 — The Three Farms: One Story in Three Colours

Duration: 45 minutes **Location:** Classroom **4A-Pathway stage:** Awareness → Attitude **Materials needed:** Pre-prepared wet-ground pigment pastes from the three partner farms (teacher-prepared, labelled), three small bowls per table group, white watercolour paper, flat brushes, the project map showing the three farm locations

Learning Objectives

By the end of this unit, students will be able to: - Identify colour differences between soils from three different farms - Connect the idea that different ways of farming can produce different soils - Make a painting using at least two of the farm colours

Unit Plan

Opening (8 min): Show the class a simple map of the three Erdpuls partner farms. Tell students: *"Three farmers grow food near here. One farmer uses lots of machines and fertiliser. One farmer grows food the organic way. One farmer grows food the biodynamic way — that means they pay very close attention to how they treat the soil, almost like it is alive. Let's see if we can tell them apart just by looking at the soil."*

Place three labelled dishes (Hof A, Hof B, Hof C — or actual farm names) on each table without explaining the farming methods yet.

Direct Experience (10 min): Ask children to look at the three colours. Questions: - *"Which one is darkest? Which is lightest?"* - *"Do any of them look the same?"* - *"Which one do you think comes from a farm that has been looked after for the longest time?"*

Let children discuss in pairs. No right answer is given yet.

Investigation / Making (20 min): Children paint a picture using the three farm colours. The subject is their choice — it can be a landscape, a field, a pattern, or simply blocks of colour. The task is to use all three colours intentionally.

As they work, circulate and ask: - *"Which colour is your favourite? Why?"* - *"If you were going to name these colours what would you call them?"*

Synthesis (5 min): Reveal which farm each colour came from. (The darker colour typically comes from the biodynamic farm — more organic matter, more humus.) Ask: *"Does this surprise you? What do you think it means?"*

Brief, honest answer: *"More organic matter — that is the living part of soil — makes soil darker. Farms that take good care of their soil over many years often have darker, richer soil."*

Closing (2 min): Journal: write or draw the farm whose soil colour you liked best, and one reason why.

Unit 5 — Binders: What Holds the Colour On?

Duration: 45 minutes **Location:** Classroom **4A-Pathway stage:** Acknowledgment → Action **Materials needed:** Pre-ground pigment from Unit 3 or 4, small bowls and brushes, three binders in separate labelled cups: water only, linseed oil (a few drops), egg yolk diluted with water; white watercolour paper, ruler for colour test strips

Learning Objectives

By the end of this unit, students will be able to: - Observe different effects of three binders on the same pigment - Describe at least one difference between oil paint, watercolour, and egg tempera - Understand that paint is always "pigment + binder"

Unit Plan

Opening (5 min): Ask: *"What is paint made of? If you couldn't buy paint in a tube, what would you need?"*

Introduce the idea of pigment + binder. Say: *"The pigment is the colour. The binder is the glue that holds it on. Today we will test three different binders with the same colour soil."*

Direct Experience (10 min): Set up three stations, one for each binder. Demonstrate each one — how to mix the pigment paste with the binder and apply it to paper. Allow students to try all three, making a test stripe of each on the same sheet of watercolour paper.

Investigation (20 min): Students work in pairs or small groups, making a strip of each binder on paper. Label each strip clearly. As the strips dry: - Observe: does the colour change as it dries? - Touch when dry: which one is smooth, which is oily, which is dull? - Leave overnight and compare the next day (or observe after 15 minutes if using egg yolk).

Questions during work: - *"Which one makes the most beautiful colour?"* - *"Which one feels different under your finger when dry?"* - *"Does the colour get lighter or darker when it dries?"*

Synthesis (7 min): Discuss: all three should show lightening on drying (connecting back to Unit 2 — the wet-dry effect). The oil paint will dry slowest. The egg tempera will dry fastest and look most matte.

Brief connection: *"Artists in the Middle Ages used egg yolk to paint. Painters like Rembrandt used linseed oil. Watercolour is gum arabic. All of them used earth colours like the ones we made."*

Closing (3 min): Journal: draw your three test strips and write which binder you liked best and why.

Unit 6 — The Colour Library: Our Contribution to the Exhibition

Duration: 45 minutes **Location:** Classroom or Erdpuls Zone B **4A-Pathway stage:** Action **Materials needed:** All pigments produced in previous units, small glass jars with lids (one per student or one per table group), labels, white cardstock for the final class palette painting, brushes

Learning Objectives

By the end of this unit, students will be able to: - Name the soils they collected and explain where each colour came from - Label a jar of pigment with location, date, and farm name - Contribute their pigment jar to the Müllrose Earth Colour Library

Unit Plan

Opening (8 min): Remind students of the project context: *"The Erdpuls project is making 104 paintings using only colours made from local soils. Your soil colours are going to be part of that collection — a painter will use them to make a real painting. Today we are going to pack your colours and give them names."*

Direct Experience / Making (25 min): Each student or pair: 1. Selects their best ground pigment paste from previous sessions. 2. Fills a small glass jar with the pigment paste. 3. Labels the jar: **Site name / Farm name / Date / Class / Name of student**. 4. Photographs the jar on white paper for the class record. 5. Makes a final colour swatch on the class palette sheet — a large piece of white cardstock where every student contributes one colour swatch.

As students work, discuss: - *"What would you name this colour? Not just 'brown' — think of a real name, like 'Autumn Field' or 'Lake Shore Orange.'"* - Write the student's chosen colour name on the label if there is space.

Synthesis (8 min): Lay out all the jars. Stand back and look at the full collection together.

Ask: *"What does this collection tell you? Is there anything surprising about the colours we found?"*

Brief reflection: *"All of these colours came from the ground within a few kilometres of here. Artists have been using colours like these for 40,000 years — we found the oldest known cave paintings made with iron oxide pigments similar to these. You have joined a very long story."*

Closing (4 min): Closing circle. Each student says one word about what they remember most from the whole unit. Write all the words on a shared card and pin it next to the colour palette.

Assessment for Classes 1–4

Assessment is informal, observation-based, and process-focused. No written test is expected or appropriate for this grade band.

Observe and note: - Does the child engage directly with the material (hands on, curious)? - Can the child describe what they observed in their own words? - Does the child connect colour to its source (farm, site, wetness)? - Does the child show care in the making phase (labelling, grinding with attention)?

The journal (colour swatch book) is the primary artefact. At the end of Unit 6, each child should have: - At least four colour swatches from different soils - At least one wet/dry comparison drawing - At least two written or drawn observations with a "because" statement

Closing question (optional, verbal): *"Tell me about one colour you made and where it came from."* The quality of a child's answer to this question — the specificity of place, the connection to the material — is the most meaningful indicator of learning at this age.

Materials Summary for Classes 1–4

Unit	Key materials
1	Collection bags, magnifying glasses, crayons/coloured pencils, journals
2	Pre-collected soil samples (3 contrasting), shallow dishes, water, spoons, white paper
3	Pre-dried soil, porcelain mortars and pestles, water, watercolour paper, brushes
4	Pre-ground pigment pastes from 3 farms, bowls, brushes, project map, watercolour paper
5	Ground pigment, 3 binders (water / linseed oil / egg yolk), brushes, watercolour paper
6	All produced pigments, small glass jars with lids, labels, large white cardstock

No FFP2 masks are required for this grade band (wet route only). Safety goggles available but typically not needed for wet processing.

Further Reading (for teachers)

- Toland, A., Noller, J.S. & Wessolek, G. (Eds.) (2019): *Field to Palette — Dialogues on Soil and Art in the Anthropocene.* CRC Press. [Foundational reference for soil as sensory and artistic knowledge; relevant inspiration for the exhibition connection in Unit 6]
- Feller, C., Landa, E.R., Toland, A. & Wessolek, G. (2015): Case studies of soil in art. *SOIL* 1: 543–559. DOI: 10.5194/soil-1-543-2015 [Open access; accessible background on earth pigments and children's relationship with soil colour. Free download]
- Doerner, M. / Hoppe, T. (2011): *Malmaterial und seine Verwendung im Bilde.* 24th ed. Maier, Ravensburg. [Classic German reference on binders and pigments; background for Units 5 and 6. In German]
- Delamare, F. & Guineau, B. (2000): *Colour: Making and Using Dyes and Pigments.* Thames & Hudson. [Accessible introduction to pigment science and history]
