5.5 Eco-Engineers

This 4 stages minimum 3 hours STEAM program for 3rd-grade students explores how to clean dirty water using natural materials like sand, gravel, and charcoal. Students develop critical thinking by making guesses and testing which material layers filter the water most effectively.

Teams practice problem-solving and design thinking skills by building their own models and fixing designs that do not work at first. The activity builds collaboration and a sense of wonder as students work together to find solutions for a global environmental problem. Through planning, experimentation, observation, and reflection, learners experience how design thinking and scientific reasoning can be applied to environmental problems. The activity emphasizes problem-solving, collaboration, sustainability awareness, and creativity, while making abstract global issues tangible and age-appropriate. Children improve their communication skills through drawing and discussion, where they explain their observations and what they learned.

Basic Information Sheet

Age group	Student number	Duration	Number of stages	Subjects connection and relevance
3rd grade students	Whole class (max. 20-25 students)	4 x 45 minutes	4 stages	Science, Technology, Engineering, Arts, Mathematics

STEAM Event Summary

In this STEAM activity, teachers guide third-grade students in exploring the real-world challenge of clean water access and water pollution through hands-on engineering and inquiry-based learning. Students design, build, and test a simple water filtration system using natural and everyday materials such as sand, gravel, and activated charcoal. Through planning, experimentation, observation, and reflection, learners experience how engineering thinking and scientific reasoning can be applied to environmental problems. The activity emphasizes problem-solving, collaboration, sustainability awareness, and creativity, while making abstract global issues tangible and age-appropriate.

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SPIRIT Skill Focus

- Critical thinking
- Problem-solving
- Creativity
- Curiosity, sense of wonder and openness
- Valuing people and nature
- Flexibility
- Resilience

National curriculum Link and Objectives

- Environmental Studies: the role of water in nature and human life, causes and consequences of water pollution, water purification as a real-world solution
- Technology and Engineering: designing and building functional, hands-on models, using simple materials for real-life challenges
- Visual Arts: Artistic representation and creative visual interpretation, process drawing and symbolic communication
- Mathematics: Estimating and measuring quantities, time awareness and simple calculations, comparing amounts.

Real-world STEAM Connection and Problem definition

Access to clean drinking water is a global challenge that affects communities around the world. Children may take clean water for granted, yet many people must rely on polluted or unsafe sources. In this activity, students are challenged to answer the question: How can dirty water be cleaned using simple, natural materials? By designing and testing their own water filters, students discover that science and engineering offer practical solutions to real environmental problems. They learn that improving a solution often requires trial, observation, adjustment, and teamwork, just like real engineers do.

Materials at a Glance

Filtration and Engineering Materials

- Transparent plastic bottles (pre-cut to use as funnels)
- Fine sand
- Small and large gravel / pebbles

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- Activated charcoal
- Coffee filters, cloth, or paper towels

Testing Materials

- "Polluted water" (clean water mixed with soil, sand, leaves, food colouring)
- Clear containers for collecting filtered water

Classroom and Documentation Materials

- Planning sheets with filter diagrams
- Observation worksheets (drawing + text versions)
- Pencils, crayons, markers
- Measuring cups, small containers

Safety and Organization Materials

- Trays or plastic table covers
- Paper towels, cloths
- Child-safe scissors, tape
- Hand-washing supplies

Visual and Support Materials (optional but recommended)

- Illustrated story prompt (Lary/Mary's Adventure)
- Visual instruction cards with icons
- Example filter diagrams
- Reflection sentence starters

Indoor/Outdoor and Classroom layout

- Phase 1 (Introduction) – Indoor / Classroom setting: Students sit in a circle or U-shape formation to ensure visibility and active participation. Interactive discussions, visual stimuli, and hypothesis generation take place. Recommended tools: projector, printed visuals, key terms displayed on the board or flipchart.

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- Phase 2 (Planning and building) – Indoor / Group table arrangement: Students work in small groups at separate tables where materials and tools are pre-arranged. A large tray or table cover helps manage mess. A shared "material station" is available for replenishing supplies.
- Phase 3 (Testing) – Outdoor or designated indoor "experiment zone": If possible, testing should take place outside or near washrooms, where spills are manageable. Indoors, a protected space (lined with plastic or trays) is prepared. The teacher ensures safe water handling procedures.
- Phase 4 (Artistic reflection) – Indoor / Individual or pair work setting: After experimentation, students reflect and create artwork or posters at their desks. Their work can be displayed in a "gallery zone" (e.g., classroom wall, windowsill, board space) to share results.

Note: It is recommended to organize the design, construction, testing, and reflection phases as a carousel brainstorm method (For more details on the carousel brainstorm method and examples of hands-on STEAM activities), allowing groups to progress step-by-step or work in time blocks, supporting flow and organization.

Notes on Research-based approach and integration

This STEAM activity is based on inquiry-based learning: students do not receive ready-made scientific facts about water purification but instead discover them through hands-on experimentation. The teacher acts as a facilitator and guide, encouraging brainstorming, revisiting problems, and retrying solutions. Students begin by forming hypotheses about possible purification methods, then design and build their own filter systems, and finally test them using realistic, playful experimentation. Through this process, they internalize the steps of scientific thinking: Question → Idea → Plan → Experiment → Observation → Conclusion → Revision. The activity applies an interdisciplinary approach:

- Science: observing and understanding natural filter materials
- Technology: using simple tools for real-world problem-solving
- Engineering: planning and building a working physical model
- Arts: expressing and communicating findings creatively
- Mathematics: comparing quantities, measuring time, counting materials (e.g., pebbles)

Small group work promotes social learning, encourages collaboration, and fosters emotional safety. Learners are active participants in the learning process, making discoveries and learning from their own successes and mistakes. This program offers excellent opportunities for differentiated instruction: Less confident students may take roles such as observers or illustrators, more active learners formulate hypotheses and rebuild solutions, advanced learners analyse functional differences independently. This STEAM activity also serves as a model for education for sustainability: access to clean drinking water is a global issue, and students explore it through their own solutions, fostering ownership and awareness.

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Lesson Flow Overview (linked to details below)

Stage	Title	Brief Description	SPIRIT Skills	Duration	Link to Details
1st	**Introduction and Motivation**	The teacher introduces the topic through a fictional but realistic story: "Once upon a time, there was a little boy/girl named Lary/Mary. On a hot summer day, they went hiking with their family. After walking for a long time, they ran out of drinking water. Nearby, they found a puddle - but the water looked dirty. 'How could we drink from this water if it's dirty?' - the child asked. And so began their engineering adventure..." Following the story, the teacher initiates a discussion by asking questions such as: Why can't we drink just any water we find? How do you think we could clean it? What would you do if all you had was dirty water? Do you think we can solve a problem like this ourselves? The goal is to spark interest, establish a personal connection, and introduce the idea of inquiry-based learning. Students are invited to share their own experiences, brainstorm ideas together, and begin thinking about possible solutions.	• Curiosity, sense of wonder and openness • Critical thinking • Flexibility • Resilience • Problem-solving • Connectedness	45 minutes	**STAGE 1 – Introduction and Motivation**
2nd	**Planning and Building**	In small teams, students plan and build their own water filter system using natural materials. First, they discuss and sketch a plan for the filter: What order will they layer the materials in? Why? They are encouraged to make assumptions about which materials will trap dirt most effectively. Once the plan is agreed upon, they begin constructing the water filter using a cut plastic bottle as the base. The materials they can use include gravel, sand, paper filter or cloth, and activated charcoal. These are placed in different layers inside the bottle. During the process, students are encouraged to make changes if something doesn't fit or if a new idea arises. The goal is not perfection but experimentation, collaboration, and testing their ideas in practice.	• Problem-solving • Curiosity, sense of wonder and openness • Creativity • Flexibility • Resilience	45 minutes	**STAGE 2 – Planning and Building**

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3rd	**Testing and Observation**	Each group tests their self-built water filter by pouring "polluted water" (a mix of clean water with natural impurities such as soil, small leaves, sand, or food colouring) into the top of their bottle filter. The water flows through the layers of materials and drips into a clear container placed below. Students observe what happens, collect the filtered water, and compare the before and after. They record their observations by drawing the two water samples and describing them using adjectives (e.g., cloudy, clearer, brown, almost clean). Groups compare their results with one another and discuss why some filters worked better than others. The goal is not just to get clean water, but to understand the filtering process and how different materials influence the result.	• Critical thinking • Curiosity, sense of wonder and openness • Problem-solving • Resilience • Creativity	45 minutes	**STAGE 3 – Testing and Observation**
4th	**Reflection and Artistic Processing**	After completing the filter construction and testing, students reflect on their experiences through creative visual expression. Individually or in pairs, they create a poster, drawing, or comic strip that illustrates: How their water filter worked, what materials they used and in what order, What the water looked like before and after, what they learned from the experiment. Some may choose to draw a “before and after” comparison, while others may illustrate the full story of their engineering adventure, including challenges or surprises. Students are encouraged to label their drawings with simple words or phrases, and then they present their work to the class or display it in a “gallery” area. This fosters pride in learning and gives space for multiple forms of expression	• Critical thinking • Empathy • Resilience • Creativity	45 minutes	**STAGE 4 – Reflection and Artistic Processing**

Tips and Tricks for dealing with challenges (for the whole STEAM program)

- Different group paces: Prepare differentiated tasks (e.g., extra experiment, colourable filter model, redesign template).
- Handling failure: Emphasize that in science it’s okay not to succeed on the first try – it's part of the learning process!
- Material/tool shortages: Have backup options ready (e.g., CD case pieces as prisms, soil instead of charcoal, small stones).
- Noise and focus management: Use timed tasks such as: “You have 5 minutes to plan!” – helps maintain concentration.

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- Hygiene and order: Always include handwashing before and after working with water; paper towels should be easily accessible.
- Shared success experience: At the end, each group receives a certificate or an “Eco Engineer Stamp” to boost motivation.

Difficulty level tailoring notes

The activity is easily adaptable to students’ abilities:

- Basic participation: The student observes, uses a template for drawing, chooses answers from picture options. Speaks minimally but can participate through pair work or quiet presentation.
- Intermediate participation: Actively takes part in building and testing, explains the process in their own words. Adds simple explanations to observations and draws independently.
- Advanced participation: Experiments with variations, suggests alternative materials, analyses results from multiple angles. Asks deeper questions, explores multiple working methods.
- Teachers may use these levels for formative or self-assessment, e.g., with coloured sticker systems or visual self-evaluation sheets.

STEAM Program Debriefing and Reflection Questions

- What was the most exciting part of the day for you?
- What was the biggest challenge?
- What did you learn about water filtration?
- Did this help you understand why clean water is important?
- What idea did you come up with for the future?
- If you could do this again, what would you change?
- Could you build a filter at home? What would you use?

Reflection tools:

- Emoji scale (🙂 😐 😕)
- “I liked – I was surprised by – I’d like to try” reflection board
- Word cloud on the board (e.g., clean, dirty, filter, gravel, success)

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5.5.2. Stage details and Activities Flow

STAGE 1 – Introduction and Motivation

How does this develop particular SPIRIT skills

The activity develops several SPIRIT skills in an authentic, hands-on way

- Curiosity: The story context and guiding questions spark children's sense of wonder about water and the environment.
- Critical thinking: Students challenge everyday assumptions (e.g., "tap water is always clean") and evaluate which filter designs work best.
- Problem-solving: They experiment with different materials and methods until they find effective solutions.
- Resilience: Trial-and-error builds persistence; failed attempts are reframed as opportunities to improve.
- Empathy and Valuing people and nature: By reflecting on communities without access to clean water, learners connect their work to real human and environmental needs.
- Connectedness: Group work fosters collaboration and helps children see their role in contributing to shared, global challenges

What do we want to achieve regarding SPIRIT skill development (student understanding and/or behaviour)?

- Students recognize that solving a problem begins with asking the right questions.
- They are able to formulate and test hypotheses (e.g., "I think the gravel will catch the dirt").
- They develop critical thinking by questioning everyday assumptions about water quality and problem-solving by testing and revising different filter designs.
- Their oral expression based on personal experience improves (e.g., sharing what they know or think about water with peers).
- They realize that effective solutions don't require being a scientist - they begin with curiosity, creativity, and collaboration.
- The activity also strengthens social skills: learners practice listening, turn-taking, and constructive group discussion, which are complementary to cognitive skill growth.

Academic/Curriculum Objective connection

- Environmental Studies: water use, pollution, importance of clean drinking water
- Language and Literacy: storytelling, understanding and discussing a heard text
- Natural Sciences: identifying problems, hypothesis formulation

Materials and tools needed for implementation

- The story (told aloud, illustrated, or with props/puppets)
- Pictures of various types of water sources: tap water, bottled water, swamp, puddle
- Chalkboard or flipchart for collecting key terms
- Drawing paper, notes sheet, chalk or markers
- Concept map of key terms (e.g., water – clean – polluted – filter – materials)

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Preparation notes

- Practice telling the story beforehand; optionally add drama elements (e.g., role play)
- Prepare printed or digital images of different water types
- Plan open-ended guiding questions
- Arrange classroom seating in a circle or small groups to encourage participation
- Collect and display key terms on the board to support learning in the next phases

Guided Questions

- Where do you usually get your drinking water?
- Have you ever seen dirty water? What was in it?
- Which water would you choose to drink from? Why?
- How do you think we could clean up a puddle?
- Why is it important to always drink clean water?
- What can happen if we drink polluted water?

Stage Debriefing Questions (Optional)

- What was the most interesting part of the story for you?
- Did you say something today that you hadn't thought about before?
- What challenge do you think we'll face today?
- Do you believe your group can solve a problem like this?

Tips and Tricks for dealing with stage challenges

- For shy students: Offer them the option to draw or just listen first, they can join in later when they feel ready.
- For highly energetic students: Use structured question–answer formats to channel their energy productively.
- For quiet classrooms: Use direct, labelled questions to gently invite responses (e.g., "Lary, what would you do in this situation?")
- To support diverse responses: Use visual prompts and pictograms to aid thinking and expression.
- As a warm-up: Play a quick activity like "Show me what a thirsty person looks like!" or "Draw the dirtiest water you've ever seen!

STAGE 2 – Planning and Building

How does this develop particular SPIRIT skills

- Problem-solving: Students take an abstract challenge (dirty water) and work to create a practical solution.
- Creativity: They use everyday materials in novel ways to design an effective filter.
- Resilience: When their first idea doesn't work, they revise and try again.
- Flexibility: They adapt their approach when outcomes differ from expectations.

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- Curiosity, sense of wonder and openness: Students explore how different materials affect water quality and ask questions about the process.
- They practice giving and receiving feedback within their team.

What do we want to achieve regarding SPIRIT skill development (student understanding and/or behaviour)?

- Students are able to describe why they chose a specific sequence of layers in their filter.
- They become more confident in planning and building simple functional models.
- They improve their fine motor skills and develop material sense through hands-on work.
- They learn that testing and redesigning is part of every engineering process.

Academic/Curriculum Objective connection

- Environmental Studies: understanding how filtration works using natural materials
- Science and Engineering: planning, building and testing a simple model
- Mathematics: estimating material quantities, comparing volumes, basic sequencing
- Communication and Collaboration: team discussion, collective problem-solving

Materials and tools needed for implementation

- 1 empty transparent plastic bottle per group (cut open to use as a funnel)
- Filtering materials: fine sand, small and large gravel/pebbles, activated charcoal
- Filtering base: coffee filter, cloth, or paper towel
- Tape, scissors (child-safe), measuring cup, small containers
- Tray or plastic tablecloth to catch spills
- Planning sheet (with blank filter diagram)
- Pencil, crayons for labelling or sketching
- Access to "Material Station" with spare supplies

Preparation notes

- Prepare material kits in advance, one per group, with a backup "material station" for refills.
- Print or draw a filter diagram as a visual planning aid.
- Consider group dynamics: assign flexible roles (e.g., designer, builder, materials manager) to balance participation.
- Allow enough time for construction, and expect some teams to revise mid-process.
- Pre-cut the bottles for safety and time-saving.
- Have paper towels or cloths ready for cleanup

Guided Questions

- Which material do you think will block the most dirt? Why?
- What happens if we put the sand first? Or last?
- How could we stop the small pieces from falling through?
- What order do you think will work best to clean the water?
- If this doesn’t work, what could you change next time?
- How can we make sure the water passes slowly through the filter?

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Stage Debriefing Questions (Optional)

- What was your team's plan, and how did it change during building?
- What did you find difficult about making your filter?
- Did everyone in your group get to help? How?
- What would you do differently if you started again?
- What would you tell another group trying this for the first time?

Tips and Tricks for dealing with stage challenges

- For fast finishers: offer an extra challenge: redesign the filter with one material removed.
- For students who struggle with planning: provide a visual prompt or a “filter sequence” example sheet.
- For dominating team members: assign rotating roles to ensure equal participation.
- For sensitive students: emphasize that no filter is perfect, this is about testing and learning, not competition.
- To keep the classroom clean: use trays or newspapers under each work area and have a cleanup routine planned.

STAGE 3 – Testing and Observation

How does this develop particular SPIRIT skills

- Curiosity, sense of wonder and openness: Students are motivated to explore how each layer affects the water and to ask questions about what they observe.
- Critical thinking: Learners reflect on the effectiveness of their filter designs and consider ways to improve them.
- Problem-solving: They experiment with different combinations of materials and adjust their approach to achieve better results.
- Resilience: Students persist when initial attempts do not produce clean water, revising their filters and testing again.
- Creativity: They try innovative ways to arrange or combine materials to optimize filtration outcomes.

What do we want to achieve regarding SPIRIT skill development (student understanding and/or behaviour)?

- Curiosity: Students explore how different materials affect water clarity and ask questions about the process.
- Critical thinking and Problem-solving: They compare outcomes, reflect on cause-and-effect relationships, and adjust their approach to improve results.
- Resilience: Learners gain confidence in making predictions and learn to persist when initial attempts do not produce the desired results.
- Creativity: They develop imaginative ways to combine materials for better filtration results.
- Connectedness: Through collaborative reflection, students consider how their solutions relate to real-world water challenges and the needs of others.

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Academic/Curriculum Objective connection

- Science: filtering, observation, comparison, and drawing conclusions
- Technology and Engineering: evaluating the performance of a functional design
- Mathematics: comparing quantities (volume of filtered water), simple measurements
- Language development: describing observations and presenting results
- Environmental awareness: understanding how filtering simulates real-life water purification

Materials and tools needed for implementation

- Each group's homemade filter
- Pre-mixed "polluted water" in transparent containers
- Clear cups or jars for collecting filtered water
- Drawing sheets or observation charts
- Markers, pencils for labelling and sketching
- Towels, trays or plastic sheets to manage spills
- Optional: magnifying glass for closer observation

Preparation notes

- Prepare polluted water in advance using safe, natural materials (e.g., soil, coffee grounds, tea leaves, food colouring)
- Label each group's container to track results
- Create a simple observation chart or two-frame drawing sheet: "Before / After"
- Emphasize safety and cleanliness: handwashing before/after, no touching dirty water
- Encourage students to speak respectfully about different results (no "better/worse" filters - only different strategies)

Guided Questions

- What does your filtered water look like compared to the original?
- Which material do you think helped the most? Why?
- Did the water smell different after filtering?
- Was your filter better at catching big pieces or tiny particles?
- What surprised you about what came out?
- Would your filter be safe enough to drink from? Why or why not?

Stage Debriefing Questions (Optional)

- How close was the result to your expectations?
- Did your plan work the way you thought it would?
- What would you change next time?
- Was your filter more about blocking dirt, or slowing the water down?
- Do you think real water filters work the same way?

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Tips and Tricks for dealing with stage challenges

- If a group's filter doesn't work at all: normalize it! Say, "Great! You learned something important, now you get to try again."
- For impatient students: use timers or challenge cards ("Can you test twice in 5 minutes?")
- For messy situations: assign a "clean-up chief" per group to manage water and materials
- To encourage careful observation: have students compare their water to a clean sample under light
- If time is short: skip re-testing and focus on describing the first result thoroughly

STAGE 4 – Reflection and Artistic Processing

How does this develop particular SPIRIT skills

- Creativity: Students explore new ways to represent their scientific and personal observations visually.
- Critical thinking: They reflect on what worked or didn't work in their designs and consider improvements.
- Resilience: Learners gain confidence in trying new ideas and learning from feedback.
- Empathy: Viewing each other's work fosters respect for diverse solutions and collaborative learning.

What do we want to achieve regarding SPIRIT skill development (student understanding and/or behaviour)?

- Creativity: Students creatively express their observations and learning through drawing, labelling, and other visual means.
- Critical thinking: They reflect on what worked or didn't in their experiments and consider ways to improve.
- Resilience: Learners understand that learning comes from both successes and repeated attempts.
- Emotional awareness: They connect their emotional experience with scientific exploration and appreciate the perspectives of peers.
- Empathy: Students observe and value others' approaches and solutions, fostering respect for diverse ideas

Academic/Curriculum Objective connection

- Visual Arts / Creativity: Expressing scientific observations and processes through drawing, design, or other creative media.
- Science / Critical thinking and Problem-solving: Reviewing experimental steps and analysing outcomes.
- Collaboration / Connectedness and Empathy: Working together, sharing materials, and discussing results respectfully.
- Language / Curiosity, sense of wonder and openness and Critical thinking: Using descriptive vocabulary to explain observations and ask questions.

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Materials and tools needed for implementation

- A4 or A3 drawing paper
- Coloured pencils, markers, crayons
- Rulers, stencils (optional)
- Stickers or stamps for feedback
- Simple checklist or reflection prompts for each student
- Wall or board space for displaying final products

Preparation notes

- Prepare example posters or formats (comic strip, step-by-step process drawing, “My filter story” frame)
- Provide both visual and written reflection prompts
- Support different skill levels: allow drawing, writing, or both
- Plan time at the end for a brief “gallery walk” or peer presentations
- Reinforce that all work is valuable - this is about expressing learning, not making perfect art

Guided Questions

- What did your filter look like inside?
- What surprised you the most?
- What would you try differently next time?
- What was the hardest part? What part made you feel proud?
- If you had to explain this to someone else, how would you do it?
- What do you think an engineer does, and did you feel like one today?

Stage Debriefing Questions (Optional)

- What did you learn today that you didn’t know before?
- Did your drawing help you remember the steps?
- Would you like to try this experiment again in a new way?
- What did you enjoy more building the filter or reflecting on it?
- What feedback would you give to your team or yourself?

Tips and Tricks for dealing with stage challenges

- For students with less confidence in drawing: offer templates or allow mixed media (cutouts, stickers, collage)
- For groups that rush: use a timer to slow down stages ("5 more minutes on the drawing", "Now write two labels")
- For more advanced students: challenge them to design a new filter or explain how to improve global water access
- To encourage presentation: give each student a chance to choose how to share (gallery walk, pair share, or mini stage)
- To support deeper reflection: provide sentence starters ("I discovered that...", "Next time I would...", "Our filter was...")

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Annexes

Pilot implementation (detailed example with lesson/activity plan), attachments

1. Storytelling prompt – "Lary/Mary's Adventure"
   - Short illustrated story on A3 cards or digital format
   - Can be performed with puppets
   - Introduces the core problem: water scarcity – polluted water – search for solutions
2. Planning template
   - Blank PET bottle drawing where students can mark filter layers
   - Text box: "Why did we choose this order?"
3. Visual instruction cards
   - Icon-based station instructions (e.g., sand, water, pour) with simple language
   - Designed to be accessible for early readers and emerging readers
4. Experiment observation sheet
   - Drawing sections: "This is what the water looked like before/after," "I observed..."
   - Text-based version for more advanced learners
5. Student reflection and evaluation sheet
   - I observed how the water changed.
   - I participated in the planning.
   - I did a drawing.
   - I helped someone else.
6. Exhibition template – "Explorer Wall"
   - One large A2 or multiple A3 sheets joined together
   - In the centre: "This is how we cleaned the water – We were Eco Engineers!"
7. Teacher's guide:
   - Activity steps (with timing), role cards, differentiation ideas
   - Sample answers, guiding questions, assessment guidelines

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