TÜRKİYE ULUSAL AJANSI
TURKISH NATIONAL AGENCY

Co-funded by
the European Union

LIVEGLOBAL

Water Pollution

Teacher's Guidebook

GİRESUN BİLİM VE SANAT MERKEZİ 2006

LICEUL TEHNOLOGIC „SF. ANTIM IVIREANU" · EDUCAȚIA, SPERANȚA VIITORULUI ·

UNIVERSITY OF SILESIA
IN KATOWICE

8th Primary School
of Nea Filadelfeia, Athens

YAŞAM ve ÇEVRE AKADEMİSİ

List of Activities

LIVELOBAL Teacher's Guidebook
Water Pollution
Erasmus+ KA210-SCH Project

Project Number: 2024-2-TR01-KA210-SCH-000280839
Project Duration: 01 May 2025 – 31 October 2026

Published: March 2026

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Turkish National Agency. Neither the European Union nor the granting authority can be held responsible for them.

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ACTIVITY NO	1
ACTIVITY NAME	**The Microplastic Detectives**
GRADE/ LEVEL	5th, 6th, 7th and 8th grade (10-14 years old)
DURATION	7 class hours, 2 hours in the chemistry lab and 4 hours outdoor
LEARNING AREA/TOPIC	Sustainable Living and Interaction / Factors Threatening Biodiversity / Environmental Issues / Water Pollution
LEARNING OUTCOMES	Students will 1.1. gain a basic understanding of the plastic life cycle, the fragmentation process forming microplastics, and the diverse sources of microplastic pollution (Science). 1.2. gain knowledge of the true causes and consequences of the global plastics crisis (Science). 1.3. analyze statistical data and record their thoughts after studying given infographics (Technology, Mathematics and Language). 1.4. become citizen scientists by engaging in authentic scientific research and detecting microplastics (microbeads) in cosmetic products (Science and Technology). 1.5. develop practical experimental skills through hands-on investigation of hidden microplastics, both in the chemistry lab and during an outdoor activity at a nearby lake or river (Science). 1.6. analyze experimentation results using tables and graphs (Mathematics). 1.7. prepare original and digital posters and presentations reflecting environmental awareness (Visual Arts)
CORE SKILLS	Content and scientific literacy • understanding environmental science concepts like plastic pollution and microplastic formation. • applying scientific vocabulary accurately Data literacy and mathematical thinking • Conducting experiments (e.g., filtering water, detecting microbeads in cosmetics, collecting waste at the lake). • Recording findings in shared digital spaces (Google Docs, Padlet, Lumio). • Analyzing infographics on plastic pollution, identifying trends, causes, and consequences. • Interpreting results from lab/field experiments to draw evidence-based conclusions. • Weighing or estimating the amount of microplastics filtered or found in specific samples. • Calculating the mass of microplastics per cosmetic product and extrapolating to yearly use.

- Estimating per-person annual microplastic consumption and scaling results to a community, country, or global level.
- Weighing or estimating the amount of microplastics filtered or found in specific samples.
- Calculating the mass of microplastics per cosmetic product and extrapolating to yearly use.
- Estimating per-person annual microplastic consumption and scaling results to a community, country, or global level.

Digital & technological skills

- Using the Lumio web-based learning platform to learn interactively and collaboratively.
- Conducting online research to discover hidden microplastics in everyday items.
- Using digital tools like Padlet or Lumio whiteboard to collaboratively collect and present information.
- Using the "Beat the Microbead" app for citizen science data collection.
- Creating and managing digital content using web 2.0 tools for project dissemination.

Experimental & analytical skills

- Performing chemistry experiments involving measurement (mass calculation) and estimation (calculating the amount of microplastics per person per year).
- Executing field sampling techniques (e.g., filtering lake water, collecting plastic waste) and quantifying results.

Creative & artistic expression

- Designing infographics and artworks (both hand-drawn and digital) visualizing the microplastics life cycle, aiming to articulate and communicate scientific ideas creatively.

Collaboration & inquiry-based learning

- Working effectively in groups during all stages from research to experimentation to presentation.
- Engaging in inquiry-based learning, with teachers acting as facilitators, providing scaffolding where needed.
- Gaining collaborative outdoor learning experiences to deepen motivation, physical skills, and social interaction.

METHODS AND TECHNIQUES

STE(A)M approach

- Integrates Science, Technology, Chemistry, Art, and Mathematics in a cohesive learning experience.

Inquiry-Based learning

- Students explore concepts through questions, hands-on experiments, data collection, and reflection guided by

	teacher facilitation. Citizen Science integration • Uses real-world apps (e.g., "Beat the Microbead") to involve students in authentic data collection and civic engagement. Blended environment: lab and outdoors • Combines indoor laboratory investigations and outdoor experimentation at a lake or a river, encouraging active learning and application of scientific techniques in real-world contexts. Digital pedagogy • Utilizes contemporary web 2.0 tools and learning platforms (Lumio) to organize, share, and present findings digitally. Blended Learning • Teachers deliver lessons with interactive elements and then allow students to explore the content at their own pace, or vice versa (Lumio learning platform) Game-based learning • Integrates game-like activities (formative assessment in Lumio) to enhance engagement and motivation Creative dissemination • Uses visual arts (infographics), digital/hands-on painting and multimedia content (like videos) to communicate project results to the broader school community and beyond
TOOLS AND MATERIALS	Digital tools and applications • Computer/tablet and Internet connection. • Lumio web-based learning platform. • Life Terra "Terra Mission Waste" and "Terra Mission Water" interactive lessons → to introduce concepts of plastic waste and water pollution. • Interactive video "The Story of Plastic" → to deepen understanding of the plastic life cycle and global crisis. • Beat the Microbead App → for citizen science activity on identifying cosmetics containing microplastics. • Lumio, Padlet, Lino or DigiPad → for collaborative collection and sharing of online research findings. • Lumio or Google Docs → for writing reflections, recording data, and sharing group work. • Digital design tools (e.g., Canva, Piktochart, PosterMyWall, or similar) → for creating infographics and posters.

	Laboratory tools & materials • Cosmetic products (e.g., facial scrubs, shower gels, toothpaste) → to test for the presence of microplastics (microbeads). • Beakers, flasks, and containers → for sample preparation and testing. • Sieve/filter paper and funnels → to separate microplastics from liquid solutions. • Microscope or magnifying glass → to observe microplastics filtered from samples. • Scales → to weigh plastic particles/microplastics. • Stirring rods, spoons, pipettes → for handling samples. • Protective equipment (lab coats, gloves, goggles) → for safe experimentation. • Paper → to record experiment results Outdoor/fieldwork materials • Sampling bottles or jars → for collecting water samples from a lake or local environment. • Nets/filters → for capturing floating microplastics or waste. • Trash collection bags & gloves → for environmental clean-up activities. • Buckets and sieves → for separating larger waste from smaller particles. Artistic & creative materials • Paper, markers, and paints → for drawing or painting the microplastics life cycle. • Multimedia equipment (camera, smartphone, or video editor) → to document experiments and share awareness campaigns.
LUMIO LESSON	https://lum.io/share/9fed9bdf-6df7-40f5-9b61-46f2177a8968
PRE-PREPARATION FOR THE IMPLEMENTER	For the **Lumio Lesson**, the teacher should check the proper functioning of all the slides, especially the Group Workspaces and the Whole-Class Whiteboard activities, using the classroom's or the Computer Lab's mobile devices. **A. Let's meet plastic** Before the activity begins, the implementer should review the Life Terra "Terra Mission Waste" and "Terra Mission Water" interactive lessons in detail, ensuring they are accessible, age-appropriate, and relevant to the learning outcomes. He/She should watch the "The Story of Plastic" interactive video in advance to check for any potentially complex sections that

might need explanation or scaffolding and study the selected infographics to anticipate possible questions from students and to prepare guiding prompts.

As far as the technical preparation is concerned, the implementer should check the internet connection and any platform login requirements for the sessions, especially Lumio Learning platform, and have sharing settings ready so each student or group can work independently but also allow the teacher to monitor progress.

The implementer should plan a brief introductory discussion to activate prior knowledge on plastics before starting the digital activities and decide on the grouping strategy (individual work vs. pairs/small groups) in the ICT lab.

<u>Time Management (2 class hours):</u>

- Short introduction & instructions (10 minutes)
- Interactive lessons (20–25 minutes)
- Video viewing & question answering (20–25 minutes)
- Infographic study & Google doc reflections (20–25 minutes)
- Wrap-up discussion (5 minutes)

B. Let's meet microplastics

For this phase, the implementer should carefully prepare by first reviewing Julie Peller's article and interview, selecting the key vocabulary and concepts about microplastics to introduce to students in an age-appropriate way, and preparing a short glossary to support their understanding. The teacher should also test and prepare access to digital tools such as Padlet, setting up a shared wall in advance with clear sections for each group to post their findings. In addition, the implementer needs to ensure that reliable online sources and links are available for students' web searches, while also preparing guiding questions to help them focus on categories of microplastics (microbeads, microfibres, nurdles, foam, fragments) and their effects on health.

Time management (1,5 class hour):

- 5 minutes for introducing key vocabulary and concepts
- 15 minutes for students' guided reading and discussion of
- the article/interview
- 25 minutes for group web searching
- 20 minutes for posting results on Padlet and a short class wrap-up.

C. The discovery of the hidden microplastics

For this phase, the implementer should prepare by first selecting and reviewing a suitable video on Citizen Science to introduce the concept clearly to students. The teacher must ensure that the "Beat the Microbead" app can be installed and function properly on all

ICT lab mobile devices and provide a short demonstration of its installation and how to use it. A class worksheet template should be created and printed (or shared digitally) for each group to record the results of their scans, and an adapted homework version of the worksheet should also be prepared for use with parents at home. Finally, the implementer should gather and test a few school cleaning products in advance to anticipate what students may discover and prepare guiding instructions to facilitate smooth group work in the lab and ensure consistency in data recording.

Time management (1,5 hour):

- 10 minutes – Introduction to Citizen Science and video viewing
- 20 minutes – Demonstration of the "Beat the Microbead" app, installation and instructions
- 30 minutes – Group activity: scanning school products and recording results
- 5 minutes – Class discussion and reflection on findings
- 5 minutes – Explanation of homework task and distribution of worksheets

D. The young chemists and their experiment

Before the experiment, the implementer should be well prepared to ensure a safe, engaging, and smooth lab experience. The teacher should first review and test the "Discover the microbeads" experiment (Appendix 4) beforehand to confirm that results are visible and calculations feasible within the time available. All necessary lab materials and equipment, cosmetic products with microbeads, beakers, flasks, balances, sieves or filter paper, microscopes or magnifying glasses, protective gear (gloves, goggles, lab coats) should be gathered and organized for group use. Safety instructions must be prepared and explained clearly at the start, alongside a step-by-step guide for the experiment and a ready-made data table for students to record measurements. The teacher should also prepare calculation exercises linked to the experiment, including guided examples for mass calculation, annual microplastic use, and percentage composition, so students can apply their mathematical thinking step by step. Finally, grouping should be pre-decided to ensure collaborative work with assigned roles (recorder, measurer, calculator, observer).

Time management (2 class hours):

- 10 minutes – Introduction to experiment, safety briefing, and distribution of worksheets
- 45 minutes – Conducting the experiment and recording data
- 20 minutes – Performing calculations with guidance (mass of microplastics, yearly estimation, percentage)
- 5 minutes – Group discussion of results and connection to

real-life environmental impact

E. The lake or river experiment

For the outdoor activity, the implementer should prepare by first arranging all the necessary logistics, including obtaining permission for the trip, ensuring student safety, and checking weather conditions in advance while preparing a backup indoor plan if needed. The teacher must gather and transport all required equipment (sampling bottles, cotton pads, funnels, beakers, sieves, gloves, trash bags, and portable scales) and organize them so that each group has what it needs. Worksheets (Appendix 5) should be printed for students to record their data, and clear instructions must be prepared for dividing roles between groups: one group for water sampling and microplastic filtering, and another for collecting and weighing visible plastic waste. The implementer should also test the method beforehand, ensuring that filtering through cotton pads provides observable results, and prepare guiding questions that connect this fieldwork to Dr. Julie Peller's research and the global issue of water pollution (Appendix 6). Finally, safety guidelines for working near the lake or river and handling waste should be communicated clearly before departure.

Time management (almost 4 hours outdoor):

- 10 minutes – Introduction to the activity, safety instructions, and group role assignment
- 30 minutes – Collection of water samples and filtering through cotton pads
- 30 minutes – Collection and weighing of plastic waste from the banks
- 20 minutes – Recording of data in worksheets and calculation of plastic mass in water and on land
- 10 minutes – Recycling of collected waste into appropriate bins and short group reflection on findings

F. Dissemination through art

For the final phase of the activity, the implementer should prepare by first selecting and testing the web 2.0 tools (such as Canva, Piktochart, or Padlet) that students will use for infographic creation, ensuring that accounts, logins, and access permissions are ready. The teacher should also provide a collection of examples of effective infographics and artworks to inspire students and prepare guiding prompts on how to communicate proposals for a plastic-free life visually. For the painting activity, both digital drawing apps and traditional art materials (paper, paints, markers) should be made available so that students can choose their preferred medium. In advance, the implementer should plan how the students' creations will be exhibited in the school (classrooms, corridors) and organize the use of a content

	curation platform such as Wakelet or Flipboard to collect, display, and share all project outcomes (photos, videos, experiment results, posters, drawings, infographics). Finally, a dissemination strategy should be prepared for sharing outputs through the school's website, e-magazine, social media, and possibly local press. Time management (2 class hours): • 10 minutes – Introduction to Art in STE(A)M and presentation of infographic/art examples • 40 minutes – Creation of infographics and hand-drawn/digital artworks in groups • 15 minutes – Organization of outputs on a digital platform (Wakelet/Padlet) • 10 minutes – Closing reflection and exhibition planning for the school community
STUDENT READINESS	
PROCESS	**Let's meet plastic (Lumio lesson: slides 1-8)** In order to activate prior knowledge, the teacher initiates a brainstorming activity by asking students to share what comes to their mind when they hear the word "plastic" (Lumio lesson slide 4). The responses can be collected on Lumio's digital whiteboard, allowing students to visualize the variety of ideas, associations, and emotions connected to the concept. Then, the students are introduced to the notions of plastic, plastic waste and plastic soup using the interactive lessons of Life Terra (Lumio Lesson slide 5) – "Terra Mission Waste (https://www.gynzy.com/el/biblio8hkh/eidh/terra-mission-enothta-3-apoblhta-hlikies-8-10)" and "Terra Mission Water (https://www.gynzy.com/el/biblio8hkh/eidh/terra-mission-enothta-5-nero-hlikies-8-10)". To deepen their knowledge of further issues relating to the plastic problem, the students watch the interactive video "The story of plastic" (Lumio Lesson slide 6). At their own pace in the ICT lab, they answer questions regarding the plastic's life cycle and the true causes and consequences of the global plastics crisis. After that, to have a complete knowledge of the harmful effects of plastic, the students study and analyse given infographics and write - in a Google doc (Appendix 1) or in Lumio's lesson slides 7 & 8 - their thoughts and concerns about the global impact of plastic pollution. **Let's meet microplastics (Lumio lesson: slides 9-17)** At this phase, the students acquire new knowledge about the microplastics and their categories. Firstly, they watch the video "The Story of microplastic" (Lumio Lesson slide 10) and they

study an image with the origins of microplastics (Lumio Lesson slide 11). To deepen their understanding of the harmful effects of microplastics to the food chain, they watch the video "How microplastics affect your health" and study the vocabulary of "microplastics" from Julie Peller's article and her interview about chemistry in the Futurum website (Lumio lesson slide 14). Thus, the students learn how to talk like a chemist, how a plastic is fragmented to microplastics and how research is conducted.

Secondly, in groups, they search the web to find information about the hidden microplastics in everyday life, the categories of them (microbeads, microfibres, nurdles, foam, and fragments) and their harmful effects in people's health (Lumio Lesson slide 16).

Further, the teams create a digital wall - like Padlet, Lino or DigiPad (Padlet example) or use Lumio's lesson slide 17 - and "hang" on it all the images and their browsing-related information.

The discovery of the hidden microplastics (Lumio lesson: slides 18-23)

The students are familiarized with Citizen Science by watching a relevant video "Citizen Science: The bridge between research and people" (Lumio lesson slide 19). Then they install the citizen science app "Beat the microbead" to the ICT lab's mobile devices. Subsequently, in groups, they scan the ingredients on packaging of school's cleaning products using the app and record the microbead findings to the team's class worksheet (Appendix 2) or to Lumio's lesson slide 20. As a homework, the students use the same app, with the assistance of their parents, scan the ingredients of their personal care products and keep records of their research results to a similar worksheet (Appendix 3). After recording the findings, a reflection discussion follows, either orally in the classroom plenary or through the students' responses on slides 21, 22, and 23 of the Lumio lesson.

Example reflection questions:

- *Which product did you find that contains the largest number of microplastics, and why do you think these ingredients are added to it?*
- *How do you feel knowing that everyday cleaning or personal care products may contain microplastics?*
- *What alternatives or eco-friendly choices could you suggest reducing the use of products with microplastics?*

The young chemists and their experiment

At the chemistry lab of the school, the "Discover the microbeads" experiment (Appendix 4) takes place by the students to excite and empower them with knowledge and confidence in STEM. For this purpose, the young scientists calculate the mass of microplastics (gr) in a certain volume of water mixed with the cosmetic product. In the next step, with data given by the teachers and information obtained from the experiment, the students calculate the mass of microplastics (gr) a person generates in a year while using the specific product. Finally, they calculate the percentage of microplastic in the whole mass of the product.

The lake experiment

During this outdoor activity, the students visit a lake or a river.

The students are inspired by the experiment that Dr Julie Peller's team did. Specifically, the team of Dr Peller tested for the presence of microplastics and microfibres in surface waters flowing into Lake Michigan. In like manner, the little scientists repeat the experiment using the lake or river water. At the beginning, with the chemistry lab's equipment, they collect an amount of water (ml) from the lake or river and filter it through cotton pads. In the aftermath, the mass of microplastics (gr) found into the water is calculated and the measurements are recorded to the experiment's worksheet (Appendix 5).

At the same time, another group of students collect the plastic waste around the lake or near the river banks, and also weigh the mass of it. As a result, the data gathered are used for the calculation of the total mass of plastic around and in the lake or river. Then, the students recycle the plastic waste to the appropriate bins.

After completing the experiments in the laboratory as well as outdoors at the river or lake, the implementer leads a discussion where the students reflect on the results of their experiments and how their own actions are connected to those of Julie Peller and her students (guiding questions Appendix 6 or Lumio slide 25).

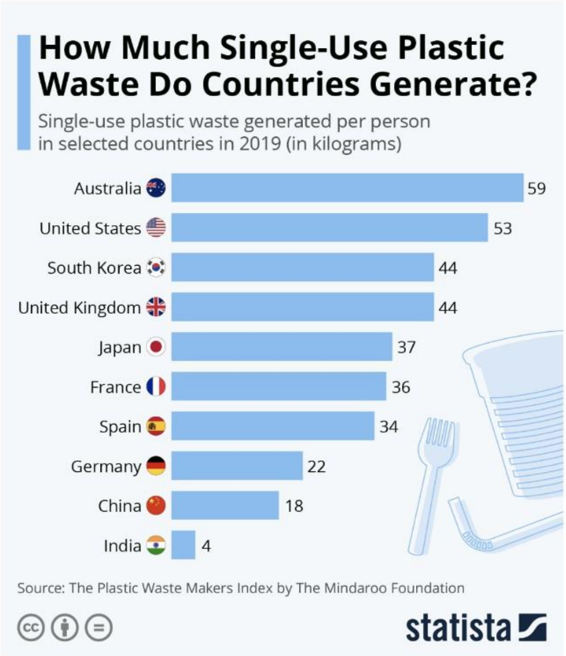
Dissemination through Art

To underline the importance of "A" (Art) in STE(A)M education, the final part of the activity consists of creating infographics and designing. In other words, using web 2.0 tools, the students visualize their proposals for a plastic-free life with engaging imagery and information data. They also paint, by hand or digitally, the life cycle of microplastics in the food chain. The creations of the students are used to decorate the school's classrooms and corridors as a means of raising awareness to the school community.

Furthermore, a content curation platform, like Wakelet, Flipboard or Padlet, can be used to organize the educational material of the project, to post and share content, videos, photos, results of the experiments and learning outcomes. A video with all the sequential activities can be made, optionally, and be communicated through social media, school's website, and e-magazine, local newspapers.

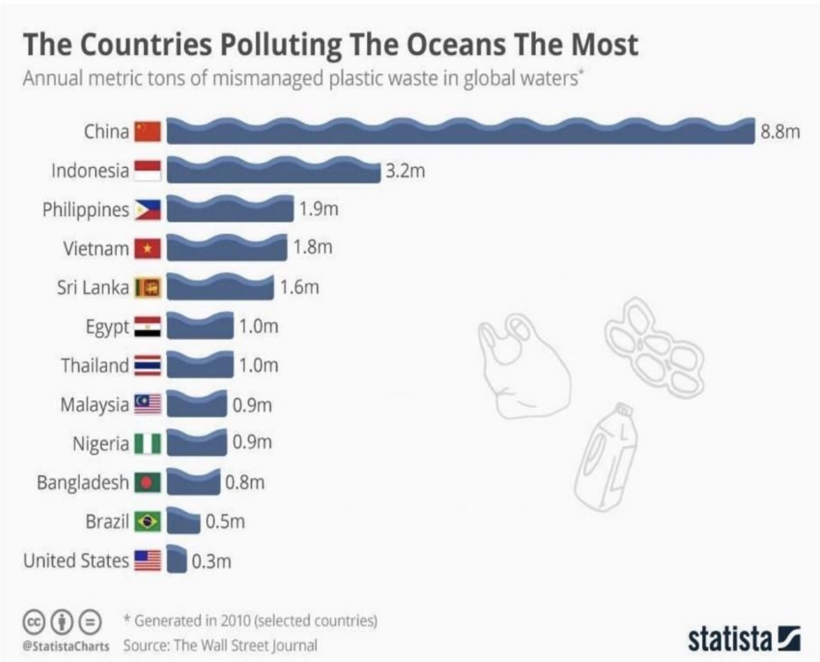
	Assessment Phase At the end of the activity, through Google or Microsoft Forms or Lumio's lesson slides 27 and 28, an assessment phase takes place to evaluate both the learning outcomes of the students and the effectiveness of the implementation from the teacher's perspective. Students complete a post activity knowledge test (Appendix 7 or Lumio slide 27) and a self-assessment/reflection questionnaire (Appendix 8 or Lumio slide 28) where they express what they learned about microplastics, how they developed new skills (scientific inquiry, data handling, digital skills, collaboration, creativity), and how their attitudes towards environmental issues have changed. Teachers, on the other hand, complete an evaluation questionnaire (Appendix 9) focusing on the suitability of the materials, the feasibility of the experiments, student engagement, and the overall impact of the learning scenario. The results of the questionnaires are collected, analysed, and discussed with the class to co-create conclusions about the project's value and to plan possible follow-up actions.

APPENDIX 1. Studying infographics



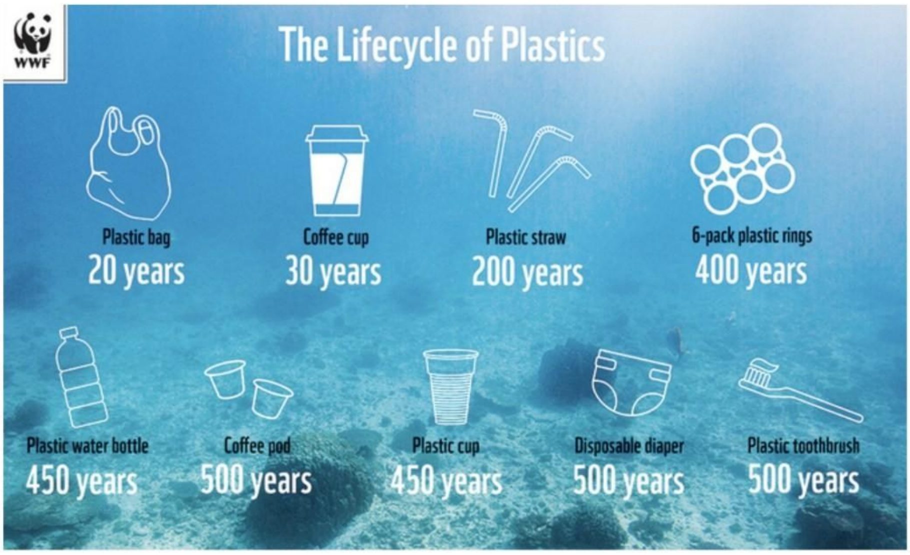
Group 1 - Thoughts and concerns:

Source: https://www.statista.com/chart/24874/single-use-plastic-waste-generated-per-person-in-selected-countries/



Group 2 - Thoughts and concerns:

Source: https://www.plasticethics.com/home/2019/3/17/the-countries-polluting-the-oceans-the-most-with-plastic-waste



Group 3 - Thoughts and concerns:

Source: https://wwfsassi.co.za/all-things-plastic/

Group 4 - Thoughts and concerns:

Source: https://tinyurl.com/2bsc3a5t

APPENDIX 2. School microplastic detective's worksheet

School's microplastic detectives

Group: _____

Cleaning product	microplastic	Soap	microplastic

APPENDIX 3. Microplastic detectives at home worksheet

Microplastic detectives at home

Name: ______________________

Cleaning product	microplastic	Personal care product	microplastic

APPENDIX 4. The “Discover the microbeads” experiment worksheet

“Discover the microbeads” experiment

In this activity, students will try to estimate how much microplastic is in a bottle of a cosmetic product.

Each group of student needs:

- A beaker containing 100ml of water with a generous quantity of exfoliating shower gel mixed in
- Conical flask (205ml)
- Stirring rod
- Filter funnel
- filter paper
- Tap water
- Mass balance (can be shared between groups)

Time 20 minutes

Running the activity

1. Collect your water sample from your teacher. Record the volume in your book.
2. Wet your muslin square and wring it out.
3. Find the mass of your wet square using the mass balance. Record this in your book.
4. Set up your filtering equipment.
5. Carefully pour your sample through the muslin. Make sure none goes over the edge.
6. Rinse the muslin with cold tap water while it’s still in the funnel. This is to remove any foam.
7. Carefully fold the muslin keeping the microplastic beads on the inside.
8. Squeeze the water out.
9. Use the mass balance to find the mass of the muslin with the microplastic folded inside it.
10. Calculate the mass of microplastics.
11. Collect results from two other groups and calculate an average.

How much microplastic did I wash with? **Group** [ ]

Earlier today, your teacher washed their face using an exfoliating shower gel with microplastic beads. Your job is to work out the amount of plastic that was used.

Amount of gel used [ ]

Amount of gel in the bottle [ ]

Table

Group	Volume of water (cm^3)	Mass A: Mass of the wet muslin square (g)	Mass B: Mass of the wet muslin & plastic (g)	Mass of microplastic (g)
			Average	

Mass of microplastic = Mass B – Mass A

Questions

1. If your teacher washed his/her face with this every day, how much microplastic would he/she generate in a year?

2. How much microplastic is in the original bottle?

Source: https://encounteredu.com

APPENDIX 5. The outdoor activity's worksheet

The lake - river experiment

School:

Class:

Date:

Teams	Mass of lake or river water	Mass of plastics & microplastics in the water	Mass of plastics outside the lake or river	Total mass of plastics
Team 1				
Team 2				
Team 3				
Team 4				

APPENDIX 6. Guiding questions for group reflection

Guiding questions that connect the lake/river experiment to Dr. Julie Peller's research and the global issue of water pollution:

- Why do you think Dr. Julie Peller and her team chose to study microplastics and microfibres in Lake Michigan?
- How is our experiment similar to the one carried out by Dr. Peller's team?
- What kinds of microplastics do you expect to find in lake or river water? Where might they come from?
- Why do scientists filter water samples instead of just looking at the surface?
- How can small amounts of microplastics in water affect fish, birds, and other organisms in the ecosystem?
- What are the possible consequences for humans if microplastics enter the food chain through water and aquatic life?
- How does collecting and weighing plastic waste on the riverbank help us understand the bigger problem of plastic pollution?
- What differences do you notice between the visible plastic waste collected on land and the invisible microplastics filtered from the water?
- What actions could we, as students and citizens, take to reduce the amount of plastic entering rivers, lakes, and eventually oceans?

APPENDIX 7. Post activity knowledge test

<u>Multiple Choice questions (Circle the correct answer)</u>

Microplastics are:

a) large pieces of plastic waste
b) plastic particles smaller than 5mm
c) only found in oceans
d) harmless to the environment

Which of these is NOT a type of microplastic?

a) Microbeads
b) Microfibres
c) Nurdles
d) Sand grains

The main sources of microplastics include:

a) Personal care products, clothes, plastic waste breakdown
b) Stones and minerals
c) Only plastic bags

d) Plant-based materials

Why are microplastics dangerous for humans?

a) They are colourful
b) They enter the food chain and can affect health
c) They are too big to be eaten by animals
d) They disappear quickly in nature

True/False questions

Microplastics can be found in drinking water. (**True** / False)

Microplastics never reach rivers or lakes, only oceans. (True / **False**)

Washing synthetic clothes can release microfibres. (**True** / False)

Recycling and reducing plastic use can help limit microplastic pollution. (**True** / False)

Short Answer

Name two products you use every day that may contain hidden microplastics.

Suggest one action you can take in your life to reduce microplastic pollution.

APPENDIX 8. Student reflection questionnaire

Reflection on "The Microplastic Detectives" activity

1. I learned new things about plastics and microplastics. (Yes / Somewhat / No)
2. I can explain how microplastics are formed and why they are harmful. (Yes / Somewhat / No)
3. Which activity helped you learn the most? (Circle one)
    - Interactive lessons & video
    - Citizen science app (Beat the Microbead)
    - Chemistry lab experiment
    - Lake/river fieldwork
    - Infographic/art creation
4. What new skills do you think you developed during this project? (e.g., scientific skills, digital skills, teamwork, creativity)
5. Did the project change your opinion about plastic use in everyday life? (Yes / No – explain)
6. What part of the project did you enjoy the most? Why?
7. What would you suggest making this project even better next time?
8. How do you plan to apply what you learned in your daily life?

APPENDIX 9. Teacher reflection questionnaire

Evaluation of "The Microplastic Detectives" activity

1. Was the learning objectives of the scenario met? (Fully / Partly / Not achieved)
2. Which activities engaged students the most?
    - Interactive lessons
    - Citizen science app
    - Chemistry experiment
    - Lake/river fieldwork
    - Creative dissemination
3. How would you rate the suitability of the provided materials and resources? (Excellent / Good / Fair / Poor)
4. Did students develop key skills (scientific inquiry, data literacy, collaboration, creativity, digital literacy)? Please explain.
5. Were there any challenges in implementing the experiments (lab or outdoor)? If yes, please describe.
6. How effective was the integration of Art (A) into STEM?
7. How did the scenario foster awareness and responsibility towards environmental issues among students?
8. Suggestions for improving the scenario or scaling it to other classes or contexts.

ACTIVITY NO	2
ACTIVITY NAME	**Water Cycle in Nature - Pollution and Natural Water Purification Mechanisms**
GRADE/ LEVEL	5th, 6th, 7th and 8th Grade (11-14 years old)
DURATION	2-4 class hours
LEARNING AREA/TOPIC	Sustainable Living and Interaction / Factors Threatening Biodiversity / Environmental Issues / Water Pollution
LEARNING OUTCOMES	Students will: 1.1 understand the natural water cycle and describe its main stages (evaporation, condensation, precipitation, infiltration) (Science) 1.2. analyze and interpret data and infographics related to global water pollution and water scarcity (Technology, Mathematics, Language) 1.3. develop hands-on experimental skills by exploring natural water purification methods such as sedimentation, soil filtration, and evaporation (Science) 1.4. present the results of their water experiments using tables, diagrams, or graphs (Mathematics) 1.5. create posters or digital presentations demonstrating the importance of clean water and natural purification processes (Visual Arts)
CORE SKILLS	Scientific process skills • observing the stages of the water cycle and identifying where natural purification occurs (evaporation, infiltration, sedimentation) • conducting simple hands-on experiments on sedimentation and filtration and drawing evidence-based conclusions Problem-solving and decision-making skills • analyzing real or simulated cases of water pollution and proposing practical ways to minimize environmental risks Research and inquiry skills • investigating local water sources, collecting samples, and examining signs of natural purification in soil, sand, or vegetation Data literacy and mathematical thinking • measuring and presenting water-quality test results using tables, simple statistics, diagrams, and graphs Creativity and design-oriented thinking • designing and building physical or digital models of the water cycle and natural purification mechanisms (e.g., filtration tower or sedimentation system) Environmental awareness and sustainability consciousness • recognizing the importance of clean water for humans,

	animals, and plants, and understanding personal responsibility for water protection Collaboration and teamwork • working together on experiments, sharing roles and responsibilities Communication skills • presenting research findings and water protection ideas through posters, presentations, or discussions Self-regulation and responsibility • ensuring safety during experiments, using water responsibly, and reducing pollution in everyday life
METHODS AND TECHNIQUES	STE(A)M approach • Integrates Science, Technology, Environmental Chemistry, Art, and Mathematics to provide a cohesive understanding of the natural water cycle, sources of pollution, and natural/mechanical purification processes (sedimentation, filtration) Inquiry-Based Learning • Students explore water cycle stages and purification mechanisms by asking questions, designing simple experiments, collecting and analyzing data, taking water samples, and reflecting on their findings with teacher guidance Citizen Science Integration • Students participate in real-world environmental monitoring by recording water quality data (e.g., turbidity, pH) and—if available—using apps or online databases to compare their data with regional or global water observations Blended Environment: Lab and Outdoors • Learning combines indoor laboratory experiments (building sedimentation and filtration models) with outdoor fieldwork (examining local water sources such as rivers, ponds, or school runoff areas) Digital Pedagogy • Use interactive digital platforms (e.g., Lumio, online simulations, concept maps) to organize, share, and present findings about water pollution and natural purification Blended Learning • Alternates between teacher-guided instruction on water cycle mechanisms and student-driven investigation using digital simulations, videos, virtual labs, and online collaborative platforms Game-Based Learning • Introduce interactive, game-like activities (e.g., quizzes, challenges in Lumio) to reinforce knowledge of pollution types, water cycle processes, and purification mechanisms

	Creative Dissemination • Communicate project outcomes through visual arts (infographics, digital posters, or drawings of the water cycle), short videos, or multimedia presentations for the school community and beyond
TOOLS AND MATERIALS	Digital Tools and Applications • Computer/tablet with Internet connection • Lumio web-based learning platform for interactive lessons and assessments • LIVELOBAL Project resources (e.g., Terra Mission Water interactive lessons) – to introduce concepts of water pollution, scarcity, and sustainability • Interactive video lessons or documentaries on the water cycle, pollution, and natural purification – to deepen conceptual understanding • Citizen science apps (e.g., local water monitoring apps or online databases) – for authentic data collection and civic engagement • Lumio, Padlet – for collaborative sharing of water pollution research and fieldwork results • Google Docs or Lumio – for recording reflections, analyzing data, and presenting group findings • Digital design tools (Canva, Piktochart, PosterMyWall, etc.) – for creating infographics, digital posters, and water cycle diagrams Laboratory Tools & Materials • Beakers, bottles, and transparent containers – for preparing, observing, and testing different water samples • Filter paper, sieves, sand, gravel, and cotton/cloth layers – to simulate natural purification mechanisms such as sedimentation and filtration • Paper or digital logs/data sheets – for systematic recording of experimental observations and results Outdoor/Fieldwork Materials • Sampling bottles or jars – for collecting water from natural or school-area water sources • Nets or hand-held filters – for capturing floating debris or visible pollutants during field investigation • Field notebooks or tablets – for documenting measurements, reflections, sketches, and location details Artistic & Creative Materials • Paper, markers, paints, and modeling materials – for illustrating the water cycle, pollution sources, and natural purification models • Camera, smartphone, or video editing tools – to document the experiment process and create awareness campaigns or presentations for the school community

LUMIO LESSON	https://lum.io/share/2d6facc7-92a2-4035-973b-a06b1ffd7d25
PRE-PREPARATION FOR THE IMPLEMENTER	Preparations before the lesson: • Review the key information about the water cycle in nature and natural self-purification processes (evaporation, sedimentation, filtration, biodegradation) • Prepare materials for the experiment: - Materials for building a model of circulating water plastic boxes, stand, water pump, flexible pipe, a piece of rigid tube with small holes, etc… - Materials for building simple filters (e.g., sand, gravel, fabric, plastic bottles) - Samples of water with varying levels of contamination (e.g., dirty water with sand/soil, etc.) • Divide materials and tools among student groups - Provide materials posters/brochures to summarize observations (paper, colored markers, scissors, etc.) • Ensure the availability of the classroom, school garden, or laboratory for carrying out the experiment (reserve the space in advance) • Plan the class hours for each stage: - Practical experiment - Watching an educational film about the water cycle - Working with Lumio games - Summary and group presentations • Offer guidance during the experiment and observation: - Clarify instructions for conducting the experiment - Encourage collaborative problem solving among groups • Prepare and test interactive Lumio games so they can be used smoothly during the lesson
STUDENT READINESS PROCESS	The goal of the class is to understand how water circulates in nature and what physical processes lead to its self-purification during the cycle. In the second part of the class, students build a working model of the water cycle, drawing on the knowledge they have acquired, along with the basic mechanisms of its self-purification. At the beginning of the class, the teacher introduces general information: about the physical states of water found on Earth: ice, liquid, and water vapor (gas), about water resources on our planet, about the division of water into saltwater and freshwater, and basic information about the water cycle in nature. The role of solar energy in driving the mechanisms and processes occurring throughout the full water cycle is discussed, along with the stages of this cycle: evaporation of water from oceans, lakes, rivers, and land surfaces, and transpiration of water in plants,

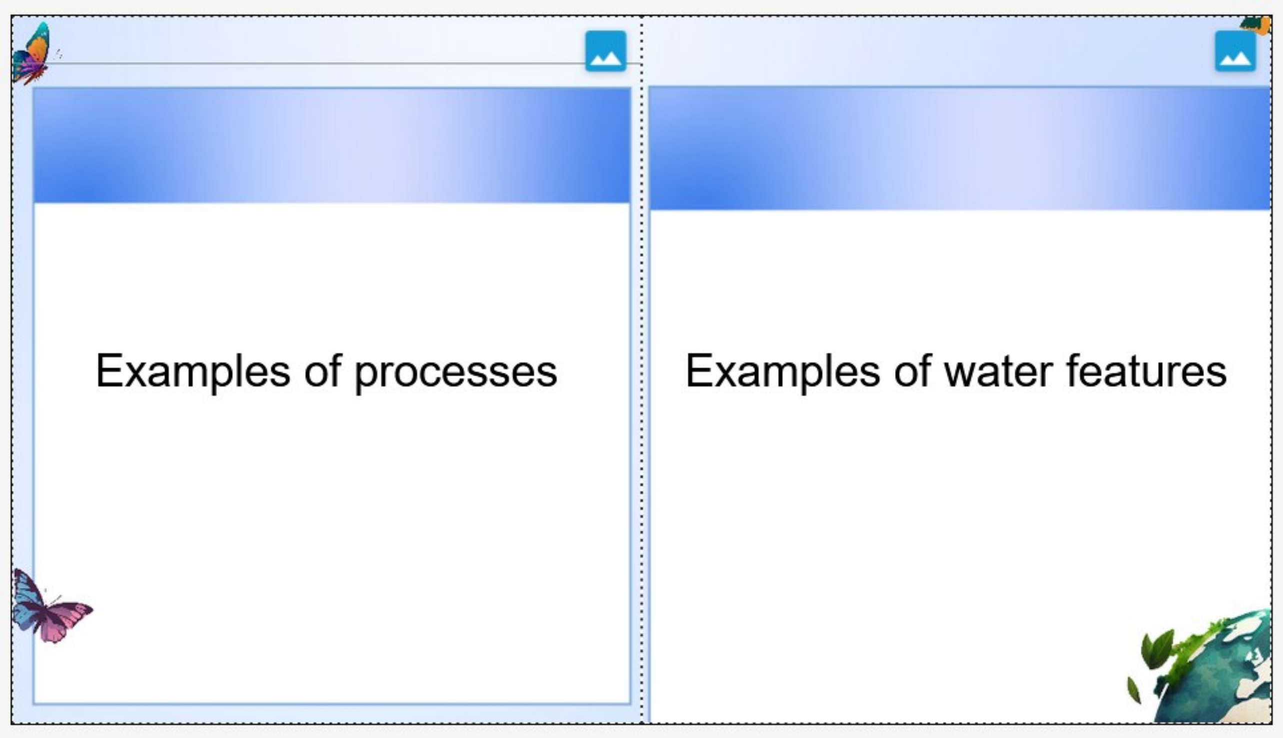
condensation of water vapor, cloud formation and their movement,
precipitation in the form of rain, snow, or hail,
water runoff from rivers into lakes, seas, and oceans, and sedimentation of mechanical pollutants,
soil percolation, percolation into deeper layers, and filtering of mechanical macroscopic and microscopic pollutants,
groundwater recharge, spring recharge, and underground runoff into lakes and oceans.
Particular attention is paid to the mechanisms of natural water purification:
sedimentation, filtration, and evaporation.
The second part of the course involves applying the acquired knowledge, designing, and building a working model of the water cycle, along with the basic mechanisms of its self-purification.
Students determine which objects should be included in the model: above-ground water bodies with sedimentary deposits, underground reservoirs, rivers carrying pollutants, springs, clouds, precipitation in the form of rain, and soil layers that filter the water.
The design includes the construction, arrangement, attachment, and connection of all objects and elements of the model, methods for forcing water circulation, supplying water to a rain shower, powering a water pump, constructing filters, and modeling pollutants.
After completing the model, students observe how water circulates and model pollutants using various small elements made of different materials. They observe how pollutants are carried downstream, how some suspended particles settle to the bottom (sedimentation), and how others are carried further by the flowing river water. Finally, they observe how water percolates into the ground, how water percolates through various soil layers and materials, and how pollutants are retained during the various stages of filtration. Students observe the ongoing processes, take photographs and record videos showing the various stages of purification, analyze changes in the water, and draw conclusions about the effectiveness of natural purification mechanisms.
At the end of the experiment, the class summarizes their observations and reflections together, discussing the importance of water conservation and human impact on water quality.
The lesson develops students' skills in critical thinking, model design and construction, observation, teamwork, data analysis, and environmental awareness.

Building the model.
The prepared boxes will serve as an underground lake and a second above-ground lake. Place them so that one is approximately 40 cm above the other.
The bottom box is closed with a lid, and two holes are made in the side walls through which plastic tubing will be fed.
Place a water pump in the box and run a tubing from it to the outside. Connect the end of the tubing to a short, closed tube, in which we previously made a series of small holes in the side wall.

	Place the pipe that will act as the rain barrel horizontally above the upper box. Place the lid of the box under the rain barrel, allowing the water to flow into the lake. Decorate the lid with leaves imitating trees and shrubs. Cover the rain shower with a faux cloud. Make a hole in the side of the upper box and glue a gutter cut from a plastic cup underneath. This will act as a river flowing out of the lake. Water pouring from the lake soaks into the soil – we build filters from cut-off plastic bottles filled with pebbles, gravel, or sand, and stack them one below the other, simulating deeper layers of soil. From the last filter, water free of mechanical impurities is poured into an underground tank and pumped back to the rain barrel, simulating the process of evaporation and condensation in clouds.

APPENDIX 1. Say it!

What comes to your mind when you hear "the water cycle in nature"?

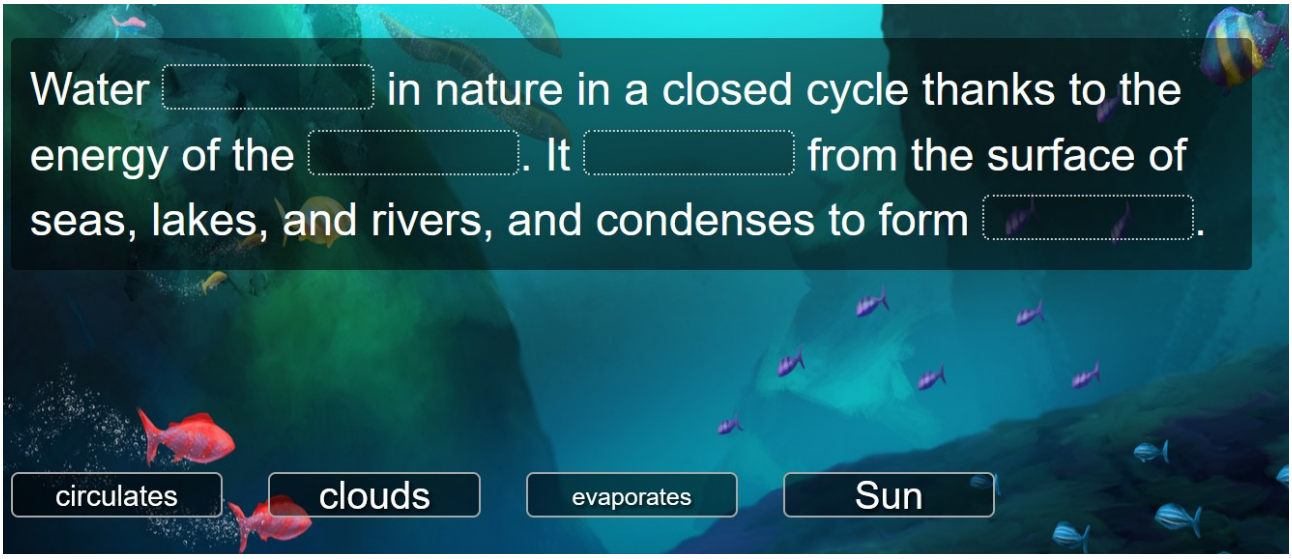


APPENDIX 2. YouTube video about the Water Cycle in Nature

Source: https://youtu.be/L7vhTCKyfIY

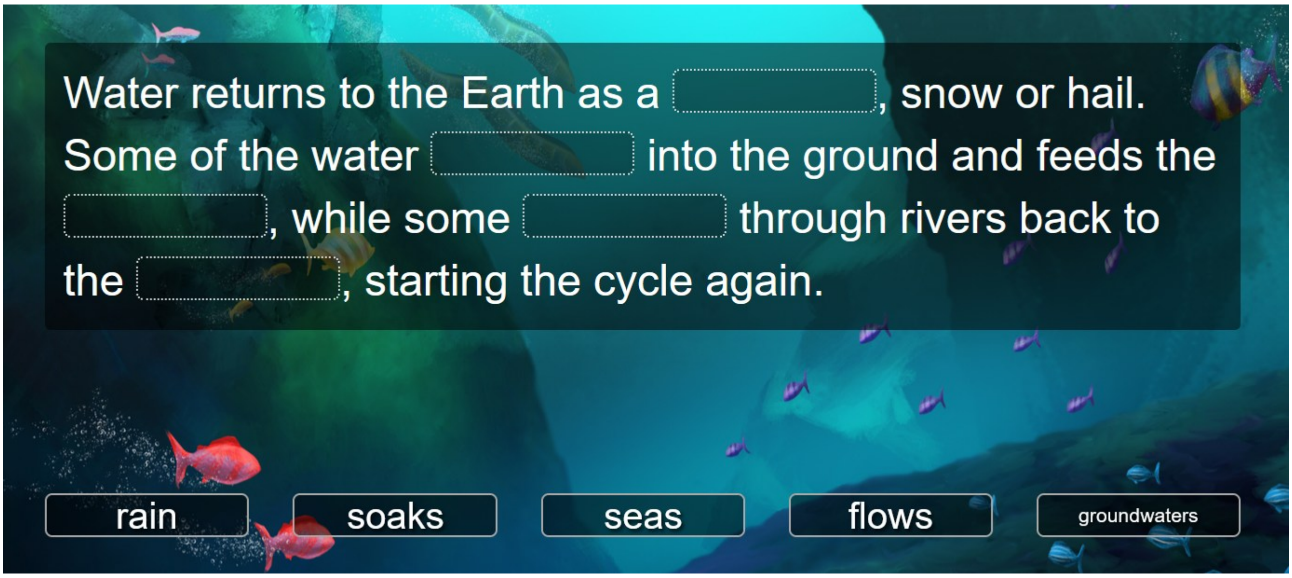
APPENDIX 3. Fill in the Blanks

Water {{circulates}} in nature in a closed cycle thanks to the energy of the {{Sun}}. It {{evaporates}} from the surface of seas, lakes, and rivers, and condenses to form {{clouds}}.



APPENDIX 4. Fill in the Blanks

Water returns to the Earth as a {{rain}}, snow or hail. Some of the water {{soaks}} into the ground and feeds the {{groundwaters}}, while some {{flows}} through rivers back to the {{seas}}, starting the cycle again.



APPENDIX 5. Match the process to the result

Proces	Result
evaporation	water vapor
condensation	liquid water
freezing	ice
precipitation	hail, snow, rain

APPENDIX 6. Word search

APPENDIX 7. Post activity knowledge test

<u>Multiple Choice questions (Circle the correct answer)</u>

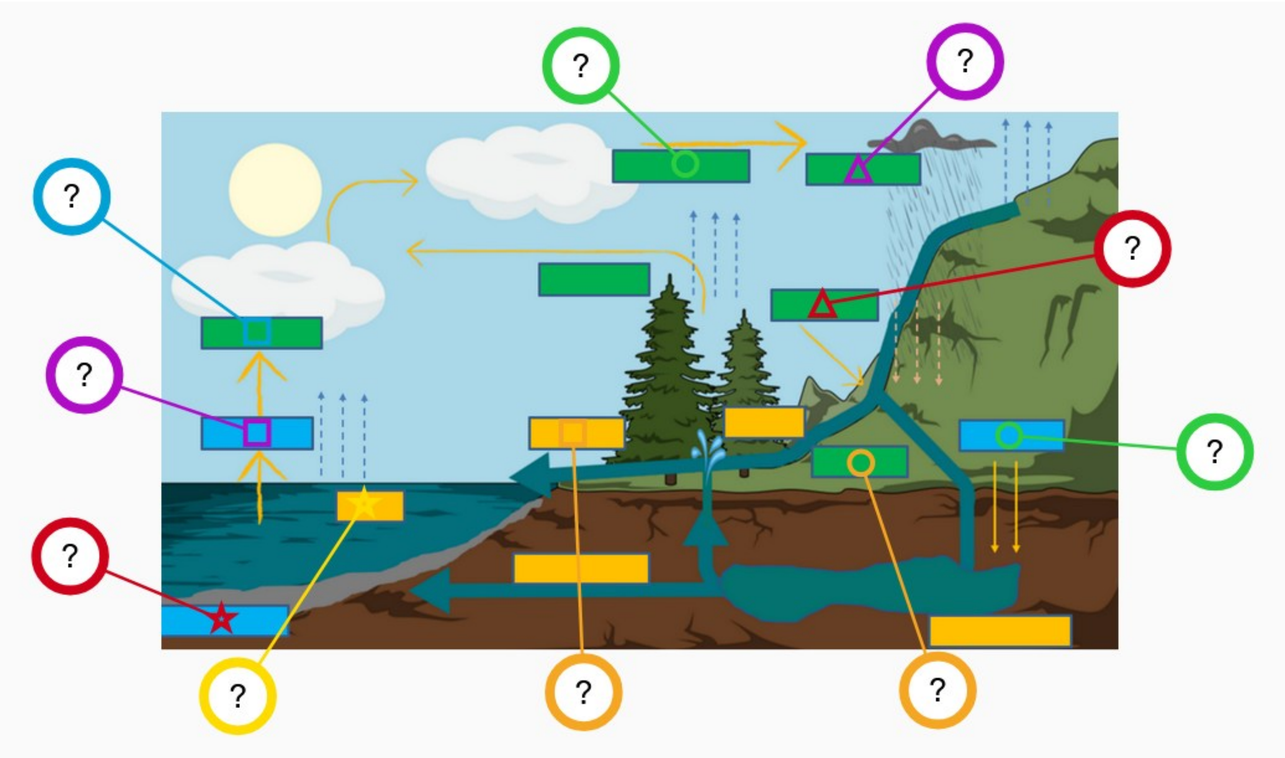
1. What is sedimentation in water cycle in nature?
   a) The absorption of pollutants by aquatic plants
   b) The dissolution of mineral substances in water
   c) <u>The settling of heavier particles to the bottom of a water reservoir</u>
   d) The evaporation of water from the surface of lakes and rivers
2. Which phenomenon contributes to the purification of water in the natural cycle?
   a) Evaporation
   b) Condensation
   c) Sedimentation
   d) <u>All of the above</u>
3. What happens to pollutants during the evaporation of water?
   a) They evaporate together with the water
   b) <u>They remain in the place where evaporation occurs</u>
   c) They turn into water vapor
   d) They dissolve in the air
4. What happens when water flows through layers of soil and sand?
   a) <u>It undergoes mechanical filtration</u>
   b) It becomes polluted by the sand
   c) It takes on the color of the sand
   d) It disappears from the water cycle

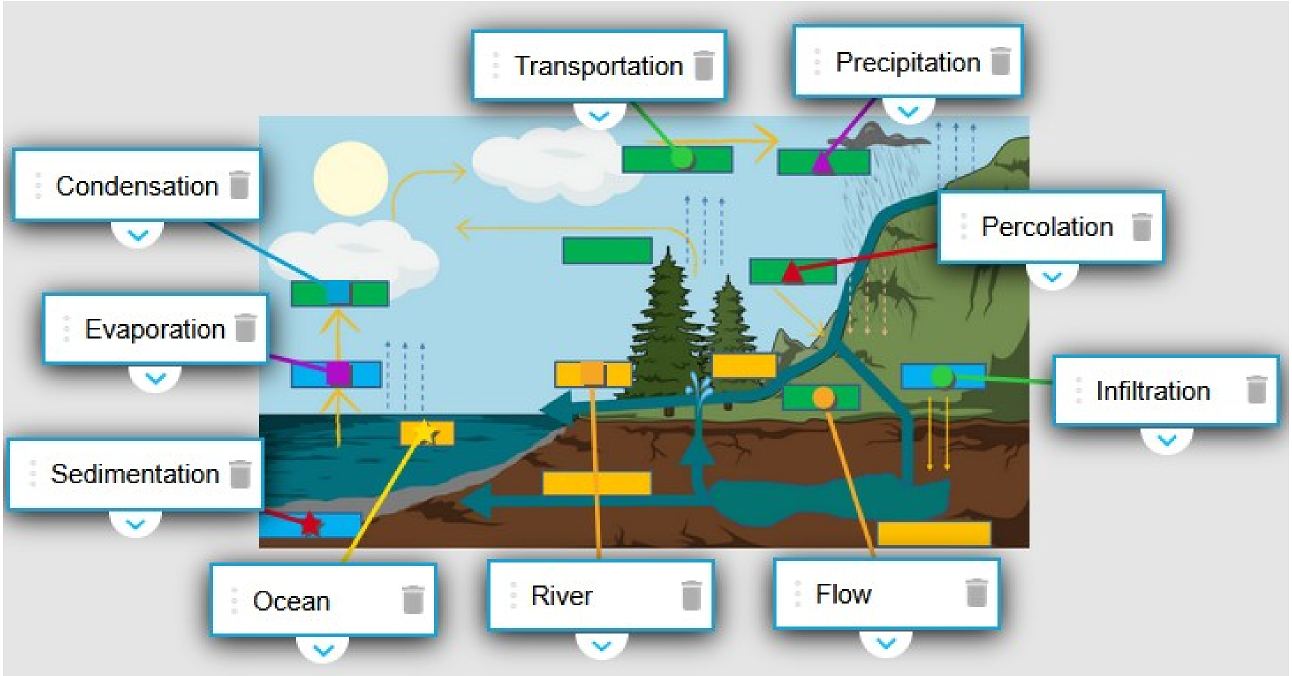
5. What does "self-purification of water" mean?
   a) The process of artificial water filtration
   b) The natural breakdown, capture and removal of pollutants by natural mechanisms
   c) Human activity using water treatment plants
   d) The evaporation of water from rivers and lakes
6. Clouds are formed by the condensation of water vapor.
   a) True
   b) False
7. When liquid water turns to water vapor it is called:
   a) Precipitation
   b) Condensation
   c) Evaporation
   d) Sedimentation
8. The water cycle in nature is possible thanks to the energy of the Sun.
   a) True
   b) False

APPENDIX 8. YouTube video of water purification mechanisms

Source: https://youtu.be/sDcyc6Eh1NE

APPENDIX 9. Discover the label





Research:

Question:

Review of the Water Pollution Control Regulation:

- Which criteria should be examined in water?
  - pH
  - Temperature
  - Turbidity
  - Biological substances

Sample Collection and Test:

- From which region did you take your water samples?

- Record the data by making the following measurements:

Station No	pH Value	Temperature (°C)	Turbidity (NTU)	Color	Observation

Notes:

🛠 Solution Development and Planning:

Questions:

- How can we reduce the pollution identified in this water?
- What are the available natural materials? (e.g., sand, charcoal, gravel, cloth, cotton)
- Which material can hold which pollutant?
- How can a portable and economical filter system be?

✍ Your Ideas:

___

___

✏ ***Simple Design Plan (schematic drawing):***

Draw or explain the natural solution system you will prepare below:

(example: filter samples using materials in different proportions, observation chart, etc.)

📌 ***Tip:*** *Do not forget details such as labeled filters and water samples, a weekly application plan, and a comparative observation area.*

Prototype Development:

Questions:

- What are the filter materials you will use?
- In what order will you place these materials?
- Which pollutants do you expect the filter to be effective against?
- List the bottle, apparatus, containers, etc. you will use.
- Create your filter with the materials.

🛠 **Material List:**

- ______________________________
- ______________________________
- ______________________________

💻 **Used Code Logic (briefly explain):** Explain how your design will work before testing it.

____

____

____

Testing and Evaluation

Questions:

- What properties changed when the dirty water passed through your filter?
- Write the initial and final values in the table below:

Measurement Parameter	Initial Value	Final Value	Explanation
pH			
Temperature			
Turbidity			

- Which pollutants did your filter reduce?
- Do you think the filter performed an adequate filtration process?
- Are there aspects of your design that need to be improved?

🔍 Aspects that are missing or need improvement:

Improvement and Presentation

Questions:

- Do you find the filter you designed useful in real life?
- Does your prototype overlap with the real-life filtration process?
- Which material are you considering changing?
- What would happen if you had to add a new layer to your filter?
- What would you do to make your filter portable?

💡 Improvement Ideas:

🗣 Notes for the presentation:

☑ Group Self-Assessment:

Mark the following areas:

Evaluation Area	Yes	No
Everyone worked actively	☐	☐
We developed our ideas together	☐	☐
We were creative in problem-solving	☐	☐
We used technology and sensors correctly	☐	☐

APPENDIX 2. EVALUATION FORM (RUBRIC)

Evaluation Criterion	**Insufficient (1)**	**Needs Improvement (2)**	**Sufficient (3)**
Understanding and interpreting the problem statement			
Conducting research and using information			
Developing a creative and functional design			
Effective communication and presentation			
Contributing to group work			

ACTIVITY NO	3
ACTIVITY NAME	**The Eco-Recycling of Peanut Shells**
GRADE/ LEVEL	5th, 6th, 7th and 8th Grade
DURATION	4–6 class hours
LEARNING AREA/TOPIC	Living Beings and Life – Environmental Protection / Waste Management / Water Treatment
LEARNING OUTCOMES	1.1. Observes the environmental impact of domestic waste oils and develops eco-friendly solutions. (Science). 1.2. Designs and develops a sustainable water treatment system by reusing organic wastes (peanut shells). (Science – Technology and Design – Engineering) 1.3. Analyzes observation results using tables and graphs; quantitatively expresses the treatment efficiency. (Mathematics). 1.4. Prepares original posters, brochures, and presentations that reflect environmental awareness; effectively utilizes artistic expression, aesthetic values, and principles of visual communication in this process. (Visual Arts – Turkish). 1.5. Actively participates in group work and develops scientific process skills. (Values Education - Interdisciplinary). 1.6. Creates original designs for the packaging or presentation of the developed water treatment product by integrating aesthetics and functionality. (Visual Arts – Engineering). 1.7. Applies color theory and principles of composition to visualize the data and results used in the study. (Visual Arts – Mathematics).
CORE SKILLS	Scientific process skills, problem-solving and decision-making, research and inquiry, data literacy and mathematical thinking, creativity and design-oriented thinking, environmental awareness and sustainability consciousness, collaboration and teamwork, communication skills, self-regulation, and responsibility, developing artistic thinking and creating aesthetic perception.
METHODS AND TECHNIQUES	Project-based learning, experiment and observation, research-inquiry method, problem-solving method, collaborative learning, creative thinking techniques, brainstorming, drama/role-playing, visualization, and presentation techniques, artistic drawing and design workshop, color theory applications, techniques for developing aesthetic products with recycled materials.
TOOLS AND MATERIALS	Domestic waste oil (e.g., frying oil), water, peanut shells (dry, preferably ground or crushed), transparent plastic bottles (empty, cut) or a funnel, cotton, muslin or filter paper, charcoal (optional, activated charcoal), gravel, sand (for filtration layers), measuring cups, graduated cylinder, observation form, student worksheets, ruler, graph paper, poster paper, paints in various colors

	(watercolor, pastel, acrylic), paintbrushes, art paper, colored pencils, various recycled waste materials for designs (fabric scraps, string, newspaper, cardboard, etc.), phone camera, computer/tablet, gloves, lab coat (for safety).
PRE-PREPARATION FOR THE INSTRUCTOR	Before the activity begins, the instructor should review fundamental information regarding the environmental effects of domestic waste oils and the principles of water treatment. Topics such as the oil absorption potential of peanut shells should be researched for the introductory information to be presented to students. (Specific information that forms the scientific basis of this activity, such as the oil absorption mechanism of peanut shells, is not directly available in these resources. It is recommended that such scientific details be researched from external sources prior to the activity and then presented to the students.) The materials to be used must be procured and allocated according to the groups. A sufficient quantity of materials and observation forms should be prepared for each group. Charts for recording observations should be duplicated in advance, and the necessary stationery materials for poster/brochure preparation must be procured. The class periods for implementing the activity should be planned, and spaces such as laboratories should be reserved in advance if required. Furthermore, for student safety, hygiene materials should be available, and guidance must be provided throughout the observation process. Curiosity and motivation should be fostered by presenting the problem statement to the students in an effective manner. Additionally, artistic materials should be prepared to develop students' aesthetic and design skills; a brief introduction to artistic expression and design principles (e.g., use of color, composition, balance) can be provided.
STUDENT READINESS	Students are expected to have basic knowledge about waste management and recycling and to be sensitive to environmental issues in daily life.
PROCESS	The teacher begins the lesson by stating, "Today, we will tune in to a hidden danger in our homes and a sustainable solution we can develop against it," and presents the scenario titled “**The Eco-Recycling of Peanut Shells”** to the students (Appendix 1). Through this scenario, students initiate a discussion on the environmental consequences of pouring waste oils down the sink, a common household problem. The teacher stimulates student interest by asking, “Can we solve this problem using natural materials through an approach that is both scientific and artistic?” Students investigate the oil-absorbent properties of peanut shells and begin designing filtration systems to separate domestic waste oils from water. Subsequently, working in groups, they construct a layered purification setup within transparent plastic bottles, utilizing natural materials such as peanut shells, cotton, gravel, and sand arranged in layers. Each student in the group assumes a specific role, contributing to the construction phase and

	conducting the observation process. Observations regarding the clarity, color change, and oil retention of the waste oily water passed through the filter systems are recorded using weekly logs. The obtained data is analyzed through tables and graphs; students evaluate the efficiency of the filter system and, if necessary, refine their prototypes. At the end of the activity, each group prepares a banner, poster, or digital presentation detailing the working principle of the purification system they created, the data obtained, and the visual design of the system. During the presentation, students share both their scientific findings and their environmental awareness with their peers. Throughout this process, students' key competencies - such as scientific process skills, creative thinking, problem-solving, teamwork, and environmental sensitivity - are developed, while their aesthetic perspectives and artistic expression skills are also supported, ultimately helping them gain a sense of responsibility toward both nature and society.

APPENDIX 1. " The Eco-Recycling of Peanut Shells"

Nehir noticed her mother pouring used frying oil down the sink while cooking in the kitchen; her mother explained that she did not know where else to dispose of it and that throwing it in the trash was troublesome. Having learned from her research that pouring oil down the sink **pollutes water sources**, damages sewage systems, and poses a major threat to wildlife, Ayşe decided to take action. She specifically wanted to find **a beneficial solution to this problem - without harming the environment -** by utilizing the **peanut shell waste** found in their home. But was it possible to address this environmental concern and produce a unique solution to the waste oil problem using both a scientific approach and an artistic touch? If you were an environmental and engineering expert in this field, how would you advise Nehir to solve the waste oil problem using peanut shells in a way that is **effective, visually appealing, and embodies an environmentally conscious aesthetic**?

🔍 Problem Identification:

Questions

1. What is the fundamental problem Nehir is facing?

2. For whom is this problem important? (Is it only Nehir, or others as well?)

3. Why does this problem need to be solved?

What are the constraints and requirements that need to be considered in the solution of the problem? (Example: it must be environmentally friendly, applicable at home, economical, the visual presentation of the solution must be aesthetic and visually appealing, and peanut shells must be used.)

✍**Answer:**

..

..

Research:

Questions:

◦ How do waste oils negatively impact the environment?

◦ What is water purification? What are its fundamental principles?

◦ Why can organic waste, such as peanut shells, be utilized in the purification process? (At this stage, the teacher may provide a brief explanation regarding the adsorbent properties of peanut shells, noting that this specific information might not be included in the students' initial resources.)

◦ How do simple water filtration systems function? What layers are typically used?

◦ Are there examples of how individuals implementing natural solutions visually present their products or observations? (e.g., attractive labels, informative brochures, artistic observation sketches, etc.)

Notes:

....
....

🛠 Solution Development and Planning:

Questions:

◦ How can we purify household waste oils using peanut shells through natural methods?

◦ What materials (peanut shells, sand, gravel, cotton, etc.) and layers will the purification system you design consist of? What should be the ratios of the materials?

◦ How will the implementation be carried out? (The order of the filter layers, water flow rate, etc.)

◦ What are the observation period and the evaluation method? (e.g., the color, clarity, and oil content of the treated water)

◦ What kind of design will the packaging or label of your product (the purification system or the presentation of the treated water) feature? What message will its colors, fonts, and overall aesthetic convey?

◦ How will the composition and color harmony of the visuals (banner, poster, presentation template) you use to present your solution be structured?

✍ Your Ideas:

....

Simple Design Plan (schematic drawing):

Students create schematic drawings of filtration systems, plan material lists and application steps. In addition to the functionality of the design, they also demonstrate how to combine aesthetic elements (colors, shapes, textures).

Prototype Development:

Questions:

◦ What natural materials did you use and why?
◦ What are your mixture ratios and filter layers?
◦ How did you build the purification system?
◦ What is the application frequency?
◦ What will you monitor during the observation period?
◦ What are the advantages of this solution?
◦ Which colors did you use when designing your product's packaging or label, and why did you choose these colors? (For example, blue can represent cleanliness, green can represent nature.)
◦ Which artistic touches did you add to make your product's appearance more appealing (handwriting, illustrations, texture, etc.)?

Material List:

- ______
- ______
- ______

Testing and Evaluation

Questions:

◦ Was your natural treatment system effective?

◦ Did you observe positive changes (clarity, reduction in oil layer) in water containing waste oil?

◦ Which filter layer was more effective? Did peanut shells perform as expected?

◦ How did you analyze your observation results? (Measurements, visual comparisons)

◦ Were there any unexpected situations?

◦ What types of graphs did you use to visualize your observation data and results? How did you evaluate the color and composition in these graphs?

Observations Notes:

....

Data Observations / Graph (optional):

....

Improvement and Presentation

Question:

- What can you improve in your treatment system or application process?

  - What can be added to increase its applicability in real life? (For example, a larger-scale system, adaptation for different types of waste oil.)

  - Can you use your solution for different types of waste or in different environments?

  - How can you introduce this process to others?

  - When preparing your presentation materials (banners, posters, digital presentations), which artistic principles (psychological effects of colors, visual composition rules, typography, original drawings, etc.) did you use to express environmental awareness in an aesthetic language, in addition to scientific data?

  - What are your thoughts on the overall aesthetics of the product you created and your presentation? How did your artistic perspective develop during this process?

Improvement Ideas:

Your notes for the presentation:

APPENDIX 2. EVALUATION FORM (RUBRIC)

Evaluation Criterion	Insufficient (1)	Needs Improvement (2)	Sufficient (3)
Understanding and interpreting the problem statement			
Conducting research and using information			
Developing a creative and functional design			
Effective communication and presentation			
Contributing to group work			
Artistic Expression and Aesthetic Perception			

ACTIVITY NO	4
ACTIVITY NAME	**Green Team: Protect Nature, Save the Water!**
GRADE/ LEVEL	5th, 6th, 7th and 8th Grade
DURATION	4–6 class hours
LEARNING AREA/TOPIC	Sustainable Living and Interaction / Factors Threatening Biodiversity / Environmental Issues
LEARNING OUTCOMES	1.1. Observes environmental and human-caused problems that can lead to water pollution and produce solutions (Science). 1.2. Develops products to purify water using self-devised methods (Science - Technology and Design) 1.3. Analyzes observation results using tables and graphs (Mathematics). 1.4. Prepares original posters, brochures, and presentations reflecting environmental awareness (Visual Arts - Turkish). 1.5. Actively participates in group work, developing scientific process skills (Values Education - Interdisciplinary). 1.6. Grasps the importance of water pollution and develop solutions.
CORE SKILLS	Scientific process skills, problem-solving and decision-making, research and inquiry, data literacy and mathematical thinking, creativity and design-oriented thinking, environmental awareness and sustainability consciousness, collaboration and teamwork, communication skills, self-regulation, and responsibility.
METHODS AND TECHNIQUES	Project-based learning, experiment and observation, research-inquiry method, problem-solving method, collaborative learning, creative thinking techniques, brainstorming, drama/role-playing, visualization, and presentation techniques.
TOOLS AND MATERIALS	Transparent bottle, cotton or fiberfill, fine and coarse sand, small and large gravel, tulle or thin fabric, activated charcoal, stopwatch, pH paper or pH meter, thermometer, ruler, turbidity meter, microscope (optional), labels, observation form, student worksheets, gloves, and paper towels.
PRE-PREPARATION FOR THE INSTRUCTOR	Before the activity begins, the instructor should review fundamental information about the water cycle and the factors causing water pollution. The materials to be used (e.g., sensors for detecting water pollution, filter design materials) should be procured and divided among the groups. A sufficient number of filter materials, measurement sensors, and **observation forms** should be prepared for each group. The charts for recording observations should be duplicated in advance, and the necessary stationery for poster/brochure preparation should be procured. The class hours for the activity should be planned, and if necessary, areas such as the school garden or laboratory should be reserved in advance. Additionally, **hygiene materials** (gloves, paper

	towels, etc.) should be available for student safety, and guidance should be provided throughout the observation process.
STUDENT READINESS	
PROCESS	The problem situation should be presented to the students effectively to generate curiosity and motivation. The teacher enters the class with an enthusiastic tone and writes on the board: "Today, we will listen to a story where nature asks for our help." Then, the teacher shows the students a news clipping or a visual and presents the scenario titled **"Green Team: Protect Nature, Save the Water!" (Appendix 1).** "Swimming in the sea was banned in Giresun after the flood. The seawater was severely polluted due to the waste brought by the flood and the mixture of sewage. Human health is under threat!" The teacher shows a transparent plastic bottle with cloudy, dirty-looking water and asks: "So, can we clean this water and use it again? How might nature be asking for our help?" With this question, the teacher directs the students to think and produce solutions. Students explore ways to prevent water pollution through natural means. They then work in groups to conduct experiments on different water samples with the filters they designed. The effects of the mixtures are observed for a week, and the data obtained are converted into tables and graphs. At the end of this process, each group prepares a poster, a brochure, or a digital presentation that includes the effectiveness of the solution, observation results, and their conclusions. During the presentation, students raise awareness by sharing both their solution proposals and the importance of protecting the environment with the class. In the final stage of the activity, students have the opportunity to evaluate **(Appendix 2)** and reflect on both their learning processes and the products they have created as a group. Throughout this process, students develop fundamental skills such as critical thinking, scientific process skills, collaboration, data analysis, creativity, and environmental responsibility. **Additional Developments / Suggestions:** 1. "Science Hotline" Theme: Students can feel like "environmental detectives." Each group receives a "tip-off," takes a water sample from the scene, and identifies the problem. 2. Comparison with Real Data: Students examine examples of real regulations related to water quality in their country (Water Pollution Control Regulation). 3. Presentation Alternatives: They can present their findings through a short video, a poster, or a mock-up. 4. Suggested Materials for the Filter System: * Sand, gravel, activated carbon, cotton, cloth, recycled plastic bottle. * Bonus task: They can create a biofiltration layer using plant roots.

APPENDIX 1. "Green Team: Protect Nature, Save the Water!"

 Swimming ban in Giresun!	You are on your summer vacation. While you are dreaming of swimming in the cool waters of the Black Sea with your family, everything changes with a piece of news from the Giresun Governor's Office. "Swimming in the sea is prohibited for 3 days to protect public health." In the images on local news channels, rivers had overflowed after heavy rains, sewage systems were mixed in, and the seashore had become turbid. Many people had gotten sick after swimming, so the beaches were empty. You were also affected by this situation. Not just the holiday, but also the environmental health is in danger! So, is it possible to solve this problem.

Problem Identification:

Questions

1. What is the problem situation in this case?

2. In your opinion, how did this pollution occur?

3. What pollutants that affect human health could be present?

4. What are the environmental, social, and economic effects of this case?

5. Who is concerned with this problem? (e.g., environmental engineer, public health specialist, etc.)

Research:

Question:

Review of the Water Pollution Control Regulation:

- Which criteria should be examined in water?
    - **pH**
    - **Conductivity**
    - **Temperature**
    - **Turbidity**
    - **Dissolved Oxygen**
    - **Color**
    - **Biological Materials**

Sample Collection and Test:

- From which region did you take your water samples?
- Record the data by making the following measurements:

İstasyon No	pH	Conductivity	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen	Color

Notes:

🛠 Solution Development and Planning:

Questions:

- How can we reduce the pollution identified in this water?
- What are the available natural materials? (e.g., sand, charcoal, gravel, cloth, cotton)
- Which material can hold which pollutant?
- How can a portable and economical filter system be?

✍ Your Ideas:

....

✏ ***Simple Design Plan (schematic drawing):***

Draw or explain the natural solution system you will prepare below:

(example: filter samples using materials in different proportions, observation chart, etc.)

📌 ***Tip:*** *Do not forget details such as labeled filters and water samples, a weekly application plan, and a comparative observation area.*

Prototype Development:

Questions:

- What are the filter materials you will use?
- In what order will you place these materials?
- Which pollutants do you expect the filter to be effective against?
- List the bottle, apparatus, containers, etc. you will use.
- Create your filter with the materials.

🛠 **Material List:**

- ______
- ______
- ______

💻 **Used Code Logic (briefly explain):** Explain how your design will work before testing it.

______

______

______

Testing and Evaluation

Questions:

- What properties changed when the dirty water passed through your filter?
- Write the initial and final values in the table below:

Measurement Parameter	Initial Value	Final Value	Explanation
pH			
Temperature			
Turbidity			

- Which pollutants did your filter reduce?
- Do you think the filter performed an adequate filtration process?
- Are there aspects of your design that need to be improved?

🔍 Aspects that are missing or need improvement:

Improvement and Presentation

Question:

- Do you find the filter you designed useful in real life?
- Does your prototype overlap with the real-life filtration process?
- Which material are you considering changing?
- What would happen if you had to add a new layer to your filter?
- What would you do to make your filter portable?

💡 Improvement Ideas:

🗣 Your notes for the presentation:

☑ Group Self-Assessment:

Mark the following areas:

Evaluation Area	Yes	No
Everyone worked actively	☐	☐
We developed our ideas together	☐	☐
We were creative in problem-solving	☐	☐
We used technology and sensors correctly	☐	☐

APPENDIX 2. EVALUATION FORM (RUBRIC)

Evaluation Criterion	Insufficient (1)	Needs Improvement (2)	Sufficient (3)
Understanding and interpreting the problem statement			
Conducting research and using information			
Developing a creative and functional design			
Effective communication and presentation			
Contributing to group work			

ACTIVITY NO	5
ACTIVITY NAME	**Dâmbovița Under the Lens: Exploring Water Pollution in Bucharest**
GRADE/ LEVEL	5th, 6th, 7th and 8th Grade
DURATION	4–6 class hours per major stage (Project duration: 4–6 weeks)
LEARNING AREA/TOPIC	Sustainable Living and Interaction / Factors Threatening Biodiversity / Environmental Issues
LEARNING OUTCOMES	1.1. Observes environmental and human-caused problems that can lead to water pollution and produce solutions. 1.2. Develops simple products to purify water using self-devised methods. 1.3. Analyzes observation results using tables and graphs. 1.4. Prepares original posters, brochures, and digital presentations. 1.5. Actively participates in group work, developing scientific process skills. 1.6. Grasps the importance of water pollution and develops solutions.
CORE SKILLS	Scientific process skills, problem-solving and decision-making, research and inquiry, data literacy and mathematical thinking, creativity and design-oriented thinking, environmental awareness and sustainability consciousness, collaboration and teamwork, communication skills, self-regulation, and responsibility.
METHODS AND TECHNIQUES	Project-based learning, experiment and observation, research-inquiry method, problem-solving method, collaborative learning, creative thinking techniques, brainstorming, drama/role-playing, visualization, and presentation techniques.
TOOLS AND MATERIALS	Potted plants (optional), water samples (tap, bottled, rain, Dâmbovița River), pH strips or red cabbage indicator, thermometer, liquid soap, sand, gravel, activated carbon, cotton, recycled plastic bottle, labels, observation forms, student worksheets, graph paper, poster paper, colored pencils, phone camera, computer/tablet, gloves.
PRE-PREPARATION FOR THE IMPLEMENTER	Before the activity begins, the implementer reviews fundamental information about water pollution and quality indicators (pH, temperature, turbidity). Materials for filter design and experiments are prepared and divided among groups. Observation charts are duplicated. Digital tools are tested. Hygiene materials are prepared and safety guidance is ensured.
STUDENT READINESS	Students have prior knowledge about the water cycle, states of matter, ecosystems, and basic environmental problems. They are familiar with simple scientific experiments and basic data recording in tables.

PROCESS	The problem situation is introduced through a real-life case of river pollution. Students analyze causes, possible pollutants, and environmental impacts. Students collect water samples (tap water, bottled water, rainwater, Dâmbovița River) and conduct experiments: pH testing, turbidity observation, temperature measurement, hardness test, and filtration comparison. Groups design a natural filter prototype using sand, gravel, charcoal, cotton, and recycled plastic bottles. They record initial and final values in tables and convert data into graphs. Students create digital maps (Google My Maps/ArcGIS), posters, brochures, or digital presentations. The project concludes with group presentations and self-assessment.

APPENDIX 1.

EXPERIMENT SHEET

Water Analysis – Dâmbovița River

Location of sampling: ____
Date: ____________________
Team Members: ____

Measurement Table:

Measurement Parameter	Initial Value	Final Value	Explanation
pH			
Temperature (°C)			
Turbidity			
Hardness			

APPENDIX 2. EVALUATION FORM (RUBRIC) **EVALUATION FORM (RUBRIC)**

Evaluation Criterion	Insufficient (1)	Needs Improvement (2)	Sufficient (3)
Understanding and interpreting the problem statement			
Conducting research and using information			
Developing a creative and functional design			
Effective communication and presentation			
Contributing to group work			

ADDITIONAL LEARNING ACTIVITIES AND EXERCISES

Project: ***Dâmbovița Under the Lens: Exploring Water Pollution in Bucharest***

1. Warm-Up Activity (Engagement Phase – 20 minutes)

Activity Title: "What's in the Water?"

Objective:
Activate prior knowledge and introduce the concept of water pollution through guided observation and reasoning.

Procedure:

1. Show 3 images:
    - Clean mountain river
    - Urban section of the Dâmbovița River
    - Polluted river with visible waste
2. Students work in pairs and answer:

Discussion Questions:

- What differences do you observe?
- What might cause these differences?
- Which water source would you consider safe? Why?
- Can water look clean but still be polluted? Explain.

Expected Skills Developed:

- Observation
- Hypothesis formation
- Environmental awareness

2. Guided Inquiry Activity (Concept Development – 45 minutes)

Activity Title: "Sources and Types of Water Pollution"

Task: Classification Exercise

Students receive cards with different pollution sources:

- Industrial discharge
- Agricultural runoff
- Household detergents
- Plastic waste
- Oil spills
- Sewage
- Heavy metals

- Fertilizers

Exercise 1: Categorization

Students classify them into:

Category	Examples
Chemical Pollution	
Physical Pollution	
Biological Pollution	

Exercise 2: Cause–Effect Matching

Match each pollutant with its possible environmental effect:

- Eutrophication
- Fish mortality
- Decreased oxygen levels
- Waterborne diseases
- Increased turbidity

3. Experimental Design Exercise (Before Laboratory Work)

Activity Title: "Design a Fair Test"

Task:
Students must answer the following before conducting experiments:

1. What variable are we changing?
2. What variables must remain constant?
3. How will we measure improvement in water quality?
4. Why is repeated measurement important?

Extension Question (Critical Thinking):
Is filtration the same as purification? Justify scientifically.

4. Data Literacy Exercises (After Experimentation)

Exercise 1: Data Table Interpretation

Students receive sample data:

Sample	pH	Turbidity	Temperature
Tap Water	7.2	Low	18°C
River Water	6.1	High	21°C
Filtered River Water	6.5	Medium	20°C

Questions:

1. Which sample shows the greatest acidity?
2. Did filtration change pH significantly?
3. What does turbidity indicate about water quality?
4. Is temperature directly related to pollution level? Explain.

Exercise 2: Graph Construction

Students must:

- Create a bar graph comparing turbidity levels.
- Create a line graph showing pH changes before and after filtration.
- Interpret trends in 3–4 sentences.

5. Problem-Solving Activity (Application Phase)

Scenario:

"The local municipality wants to reduce pollution in the Dâmbovița River but has limited funding."

Task:

In groups, students must:

1. Propose 3 realistic intervention strategies.
2. Estimate which would have the greatest impact.
3. Identify possible obstacles.
4. Present a short evidence-based justification.

6. Creative Learning Activity

Activity Title: "Environmental Awareness Campaign"

Students design:

- A poster
- A short video script
- A social media awareness message
- A brochure for local citizens

Mandatory Scientific Content:

- At least 2 causes of pollution
- At least 2 consequences
- At least 3 prevention strategies
- One data-based argument from their experiment

VERIFICATION AND ASSESSMENT EXERCISES

A. Short Knowledge Check (Individual – 15 minutes)

Multiple Choice

1. Which parameter indicates acidity?
   a) Turbidity
   b) pH
   c) Temperature
   d) Hardness
2. High turbidity usually means:
   a) High oxygen levels
   b) Clear water
   c) Suspended particles present
   d) Neutral pH
3. Which activity contributes to eutrophication?
   a) Recycling
   b) Fertilizer runoff
   c) Solar energy use
   d) Water filtration

B. True or False

1. Water that looks clear is always safe to drink.
2. Filtration removes all dissolved chemicals.
3. Acidic water has a pH below 7.
4. Industrial waste can alter river ecosystems.

C. Open-Ended Questions

1. Explain why biodiversity decreases in polluted rivers.
2. Describe one limitation of your filter prototype.
3. Suggest one scientific improvement to your design.

7. Higher-Order Thinking Questions (For Advanced Students)

- How might climate change influence river pollution levels?
- Can urban rivers be fully restored? Support your answer with arguments.
- Compare mechanical filtration with biological remediation.

Formative Assessment Checklist (Teacher Use)

During the project, evaluate:

- Ability to formulate hypotheses
- Proper data recording
- Logical interpretation of results
- Use of scientific vocabulary
- Quality of collaboration
- Environmental responsibility

Optional Extension (Interdisciplinary)

Geography Integration:
Students analyze the urban course of the Dâmbovița River and identify possible pollution hotspots.

Mathematics Integration:
Calculate percentage change in turbidity after filtration.

ICT Integration:
Use Google My Maps or ArcGIS to map sampling points and annotate pollution risks.

Outcome

These additions:

- Strengthen scientific inquiry
- Improve data interpretation skills
- Encourage environmental responsibility
- Develop argumentation and critical thinking
- Provide structured formative and summative evaluation tools

If you would like, I can now:

- Integrate everything directly into your original document structure,
- Create printable student worksheets,
- Or design differentiated tasks for Grades 5–6 and 7–8 separately.