RESET | Slippery Slope

(180 Minutes)

Authors

Sara Dok
Ramona Singleton

SUBJECT/GRADE LEVEL

Subject Area(s) Science, Mathematics and Social Studies

Grade Level(s) 4th-12th

Materials

For a class of 30 students.

Oil Spill

PER GROUP: Simulated "Oceans" (Blue Food Coloring + Water in a 10-20 quart container), 20mL of Motor Oil, Newspapers (to cove table tops) Latex-free gloves, Cotton Balls, Feathers, Q-Tips, Cloth Squares, Pipe Cleaners, Liquid Dishwasher Detergent ("Dispersant"), Plastic Grocery Bags, Graduated Cylinder, and Pipets

Water Filtration:

For the Class: 2 bottles, plastic, clear, 2-liter with caps, Funnel, Masking tape, Permanent marker, 5 clear plastic 1-liter bottles with caps, Tea leaves, Potting soil, Cornstarch, Tablespoon measure, Teaspoon measure, 1 cup measure, 16 liters of warm water

For each group: Filter holder, 2-liter bottle cap with hole drilled through it or size 4 rubber stopper with hole in it, 1-liter plastic bottle with cap, Screen, fine nylon, 10"-12" square, 1 cotton ball, jumbo size, Cheesecloth cut into 10"-12" square, 1 coffee filter, paper, round 8-12 cup, Art sand, washed, uncolored, ½ cup, Gravel, aquarium, fine, uncolored, ½ cup, 2 cups, plastic, clear, 16 oz., Student handouts

STANDARDS

Next Generation Science Standards

- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
- MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-1.Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential

impacts on people and the natural environment that may limit possible solutions.
- HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural and environmental impacts.

Mathematics Standards | Common Core State Standards

- MP.2 Reason abstractly and quantitatively. (3-5-ETS1-1)
- MP. 4 Model with mathematics. (3-5-ETS1-1)
- MP.5 Use appropriate tools strategically. (3-5-ETS1-1)
- 3-5.OA Operations and Algebraic Thinking. (3-5-ETS1-1)
- MP.2 Reason abstractly and quantitatively. (MS-ETS1-1)
- 7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1)
- MP.2 Reason abstractly and quantitatively. (HS-ETS1-3)
- MP. 4 Model with mathematics. (HS-ETS1-3)

English Language Arts Standards | Common Core State

- W.5.7 Conduct short research projects that uses several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1)
- W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1)
- W.5.9 Draw evidence from literary or informational texts to support analysis, reflection and research. (3-5-ETS1-1)
- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1)
- WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-3)
- RST.11-12.8 Evaluate the hypotheses, data, analysis and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-3)
- RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-3)

LESSON OBJECTIVE(S)

Students will investigate ways to clean up an oil spill and design a water filtration system to understand the issues of water pollution, the importance of access to clean water, and make informed decisions concerning environmental safety.

CAREER CONNECTION(S)

Mentor Background: Dr. Carlos Ruiz. Dr. Ruiz 's love for chemistry and his work experience in high school at his mother's pharmacy pushed him toward Chemical Engineering. He received his B.S. in Chemical Engineering in 1976 from the University of Puerto Rico, Mayaguez Campus. He received his M. S. in Environmental Engineering in 1979 from the University of Iowa. He received his Ph.D. in Civil and Environmental Engineering in 1987 from the University of Iowa. After his PhD, Dr. Ruiz did 4 four years of post-doctoral research at Oklahoma State University in Stillwater, Oklahoma. He began teaching graduate courses in 1991 at the Jackson Graduate Institute, as an Adjunct Professor for the University of Mississippi till 2003. In the fall of 2000, he did a sabbatical at the University of Puerto Rico at Mayaguez where they began the PhD in Engineering Department. Dr. Ruiz taught graduate seminars and webinars at the University of Puerto Rico and here at ERDC. Dr. Ruiz has been a Research Civil Engineer with the U.S. Army Engineering Research and Development Center (ERDC) at the Waterways Experiment Station since 1989. He is responsible for developing mathematical models for water quality and contaminant transport. He has worked in a variety of problems of significant importance to the US Army Corp of Engineers (CE) and others in the areas of contaminant fate and transport to assess the potential impact of nutrients, explosives and priority pollutants. The applications of these models are utilized for planning and engineering applications to minimize environmental impacts as well as maximize potential for environmental sustainability. Specific research areas include Effects of Climate Change, Net Zero (Energy, Water, Waste), Non-Point Source Pollution, Dredged Material Management, and Sediment Remediation. Developed and modified computer models to assess and quantify the impact of non-point source pollution (pesticides and nutrients) from agricultural fields as part of the CE's TMDL program in cooperation with the Environmental Protection Agency. The models were incorporated into the Watershed Modeling System (WMS), tool/computer software to evaluate contaminant transport from field to the aquatic environment. He has been a key component of the ERDC team that has developed and implemented models into the Groundwater Modeling System (GMS), a tool/computer software to evaluate groundwater contamination and remediation and the Army Risk Assessment Modeling System (ARAMS), a tool/ computer software that integrates multi-media fate/transport, exposure, uptake, and effects to assess human and ecological risks. The GMS, WMS, and ARAMS allow the Army community to have tools that are defensible and useful in evaluating management options.

He modified and further developed RECOVERY, a screening model for addressing the impact of contaminated sediment on surface waters. RECOVERY was further modified to address soil/sediment compaction, desiccation, and groundwater flow. The result of this effort will give the CE an easy to use tool to assess the impact of contaminated dredge material, confined disposal facilities, and in water disposal facilities. Dr. Ruiz has been involved in over ten national (Palos Verdes, Los Angeles, San Juan, New Bedford, Duluth) and international (Hong Kong) contaminated sediment capping projects.

Dr. Ruiz established the Sediment Research Laboratory in 2007 to develop algorithms in the laboratory to be incorporate into our cap design mathematical models; estimate parameters and/or coefficients in the laboratory used in our mathematical models; and a testing ground to test proof of concept remediation technologies. The laboratory serves as a near field scale testing of large columns and tanks. He has conducted capping research for EPA superfund program and bioavailability reduction and remediation for EPA's Great Lakes Research Program (GLNPO) that lead to a field demonstration, and several SERDP bioavailability reduction research. Currently Dr. Ruiz is developing a series of laboratory experiments to evaluate effectiveness of thin layer capping technologies for reducing the availability of sediment-associated contaminants. He is studying its technical feasibility, cost, design and construction. Dr. Ruiz is also developing a TLP methodology as a remedy at contaminated sediment

sites under a variety of conditions for ExxonMobil. Dr. Ruiz serves as an adjunct faculty member at The University of Mississippi, Mississippi State University, and the University of Puerto Rico at Mayaguez.

STEM Careers: Biochemists, Environmental Engineers, Industrial Engineers, Miner, and Petroleum Engineers

ENGAGEMENT

Brief Description:

Teacher will: Display before and after oil spill photos.
Students will :
visit Earth Day: The Official Site | EARTHDAY.ORG, Real-time water quality (usgs.gov) and Water Resources - Science (usgs.gov) to gain information on the Earth's water supply. Students will then create their own water filter.

Procedures:

Teacher will: Introduce relevant vocabulary

Relevant Vocabulary: · Pollution: Unnatural or harmful substances. · Filtration: The process of removing matter from a liquid by means of porous media (materials with holes, various-sized).

The teacher will provide background information via Near Pod or Canvas Notes
Information: Although Earth is covered with water (over 70% of Earth's surface), only about 3% of the water on our planet is not salt water. Of this tiny amount of freshwater, much is locked up in ice and glaciers. Of the remainder, less and less is available to humans because of rising populations and increased pollution. Everyone on Earth must share the same water continuously cycling through, and we are all connected by watersheds. Almost everyone in the United States is used to having clean water anytime, at the turn of a faucet. Most of the world's people are not so lucky, and must obtain water from a variety of sources. Many of these water sources contain pollution of some form, whether it is bacteria and microorganisms, chemicals, toxins, waste, litter, or other substances and materials.

The teacher will begin this lesson by discussing with the class the importance of water in our daily lives.

The teacher will lead students in a discussion about the overall scarcity of clean water on our planet, and the impact this has on humans around the world:

a) Although Earth is covered with water (over 70% of Earth's surface); only about 3% of the water on our planet is not saltwater. Of this tiny amount of freshwater, much is locked up in ice and glaciers, and of the remainder, less and less is available to humans because of rising populations and increased pollution.
b) What are some sources of water pollution? Oil spills, bacteria and other organisms, toxic chemicals, litter, run-off from city streets, industrial waste, human waste, agricultural waste, etc.
c) In the United States, we are lucky to have sources of freshwater, and sanitation facilities and water treatment plants to clean our water. We are also lucky that most of us have running water in our homes, schools and other buildings, and we can access clean water any time of day.
d) What would you do if you turned on your faucet at home, and no water came out? Where would you find water? Think of nearby bodies of water in your area. Is there a stream or river? A lake? The ocean?
e) What do these places look like? Could you drink the water? Cook with it? Bathe with it? Feed your pet?
f) Many people around the world do not have running water in their homes, or even access to clean water. They must gather water from sources near their homes such as communal wells, sewers, rivers, streams, ponds, lakes or swamps. What do you think they find in this water? Fish, plants and other wildlife, trash, wastes, chemicals etc.…
g) Depending on where they live, there could be all kinds of things in their water.

Students will :
Students will brainstorm how many times today they have used water, and write their answers on the board.

Examples: drinking, flushing the toilet, taking a bath or shower, brushing teeth, watering yard or garden, washing dishes, filling a pet's water dish or fish tank, cleaning, doing laundry, swimming, fishing, etc.

EXPLORATION

Brief Description: Students will have the opportunity to work in groups and investigate the effects of an "oil spill" in a water body. In a simulated "ocean" (a pan of water), students will drop a small amount of motor oil into the water and see the effects and interaction. In an introduction to the lesson, students discuss sources of pollution and oil contamination in water bodies – from point sources (tanker spills) and non-point sources (vehicle run-off). A brief discussion on preventing and cleaning up oil contamination will lead into the activity, in which the students will use a variety of materials to see what method works best for recovering the most oil from the water. The effects of dispersants are addressed in the form of soap droplets added to the water in the second phase of the activity, allowing students to examine the effects of such chemical dispersant that are commonly used in oil spill recoveries.

Procedures:

Teacher will: **25 mins**- The teacher will introduce Environmental Engineering along with the Environmental Protection Agency (EPA), Fossil Fuels and Dispersants. The students will observe a video on Environmental Engineering: https://youtu.be/T2xFDIdjX88. The teacher and students will discuss the topic of Oil spills and pollution to water bodies.

Students will :
Students will observe a brief video on Oil Spills. https://youtu.be/6oYNfvKeznM
45 mins – students experiment with oil spill – investigate clean-up process, dispersant effects
Students will be split into groups of 4 or 5. The will follow the below scenario.
Your engineering firm has been contracted by the Environmental Protection Agency (EPA) to investigate the best way to clean up an oil spill. Your group must use a $100 budget to clean up the most oil from the simulated spill as possible. Every $2 you save will count as one point towards your final score. Using the chart below, determine what Type of Material and how many of each (Quantity) your group wants to order.

When your group has used all the materials you purchased, the remaining percent of oil will be calculated and you will be given a score based on your performance.

For removal of 25% of the Oil: 25 Points
For removal of 50% of the Oil: 50 Points
For removal of 75% of the Oil: 75 Points
For removal of 100% of the Oil: 100 Points

Fill out the following worksheet with your material order requests, and calculate the total cost and the remaining budget. For each 2 dollars saved, one additional point is rewarded. If you SPEND $80, you saved $20 and receive 10 extra points towards your score. If you clean up 90% of the oil, you receive 90 points + 10 extra = 100 total points.

Your goal is to reach 80 total Points.

Fill out this order form by choosing x materials to help you clean up the oil spill. Your team has a $100 budget to buy the materials

Type of Material	Cost	Quantity	Cost x Quantity
Straw + Tape (2”)	$2 =	x	
Q-tip	$6 =	x	
Cotton Ball	$8 =	x	
Feather	$12 =	x	
Fiber Cloth Square	$20 =	x	
Pipet	$40 =	x	
CANNOT BE OVER $100	**Total Expenses* =_____**		
	Remaining Budget = ($100 – Total Expenses)		

20 mins – Wrap-up – discuss results and analyze performance of various materials and dispersant effects.

EXPLANATION

Brief Description: Students will be broken into groups to discuss what they have learned from the engagement and exploration phase.

Procedures:

Teacher will: Circulate to each group to observe discussions and provide feedback as necessary.

Students will:
Student groups will be given 15-20 minutes to discuss and create a summary explaining what they have learned from the engagement and exploration phase. They will include correct vocabulary.

ELABORATION

Brief Description: Students will use their knowledge of water filtration to filter water from the oil spill activity.

Procedures:

Teacher will: Display before and after oil spill photos. The teacher and students will discuss what is observed.
Monitor groups as students complete the water filtration activity.

Students will:
Visit Earth Day: The Official Site | EARTHDAY.ORG, Real-time water quality (usgs.gov) and Water Resources - Science (usgs.gov) to gain information on the Earth's water supply. Students will then create their own water filter.
Students will discuss and document their discoveries for later use.
Students will observe https://youtu.be/60Big9Ut6Mc.
Students will then create their own water filter.

1. Students are placed into small groups and pass out Worksheet #1 – Water Filter Procedure (one for each student, or one for each lab group) and Worksheet #2 – Water Filter Lab Worksheet (one for each student). Distribute lab supplies to each station (2-liter soda bottle pre-cut in half, filtration materials, "pollution" materials (Left over water from oil spill lab).
2. Students will think about the types of pollution they discussed in the first activity. How could they represent these with the materials provided?
3. Each group follow the procedure outlined in Worksheet #1 – Water Filter Procedure and answer the questions in Worksheet #2 – Water Filter Lab Worksheet.
4. Clean up.

EVALUATION

Brief Description: Students will submit worksheets from each lab and create a flip grid explaining their procedures and findings.

Procedures:

Teacher will: provide an example of a flip grid summary and the flip grid code for submissions. The teacher will demonstrate how to make a recording on flip grid.
Students will:
Each group of students will have 10-15 minutes to prepare a script and record the summaries. Every student in each group is expected to say something in the summary. Each group will observe and comment on two other group's videos.

REFERENCES

- https://stem.northeastern.edu/programs/ayp/fieldtrips/activities/oilspill/
- https://prezi.com/t0jqtefd_jie/who-polluted-water-filters-oil-spill/
- https://ocean.si.edu/conservation/gulf-oil-spill/gulf-mexico-oil-spill-interactive
- https://youtu.be/T2xFDIdjX88. What is Environmental Engineering?
- https://youtu.be/6oYNfvKeznM Oil pollution in our oceans
- https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/spill-containment-methods.html
- https://www.calacademy.org/sites/default/files/assets/docs/pdf/062_oilspill_refresh.pdf
- Earth Day: The Official Site | EARTHDAY.ORG
- Real-time water quality (usgs.gov)
- Water Resources - Science (usgs.gov)
- https://my.flipgrid.com/

- https://jamboard.google.com/
- https://nearpod.com/
- https://www.nationalgeographic.org/activity/simulate-oil-spill-cleanup/
- https://youtu.be/60Big9Ut6Mc DIY water filter