From Drain to Drinking Water On Earth & In Space

adapted from ***Sparkling Water*** in WET Curriculum & Activity Guide (1995)
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Lesson Overview

Students start by thinking about where the drains are in their homes and what goes down those drains. The instructor adds all of the items mentioned by students (shampoo, conditioner, hand soap, dish soap, dirt, cleaner, mouthwash, toilet paper, food wastes, laundry soap, etc.) to a clear gallon jar half-filled with water. Next, the students work in teams of 3-4 each, to design a method for cleaning the water using their 'environmental engineering toolkit' comprised of a: screen, sand filter, activated charcoal filter, gravel filter, and alum. Students must record the order of filters used and what effect each had on the water quality. One person from each team brings up their 'clean water' for comparison with the other teams' water, and the entire group decides which engineering team they will choose to design their community's wastewater system. As time allows, discuss the wastewater treatment process, the technology already available to make water treatment and wastewater treatment a closed system in some municipality's water systems, and how water is cleaned in space for reuse by astronauts (a process designed by a team of environmental engineers at Michigan Tech, led by Civil & Environmental Engineering Department Chair, Dave Hand) and now in use in NASA spaceships/space stations. Peggy Whitson aboard the International Space Station surpassed the 534-day record for time spent in space by an American on April 25, 2017!

Target Age: middle/high school and college

Objectives

Students will be able to:

1. Define wastewater.
2. Identify the drains in their home and the variety of wastes that go down the drain.
3. List the steps in the process for treating wastewater.
4. Design a process for cleaning wastewater.

Materials

To create "wastewater:"

raisins/cocoa puffs	clear gallon jug	food wastes *(provided by presenter)*	
toilet paper	shampoo & conditioner	dishwashing soap	hand soap
paper litter	laundry detergent	toothpaste	dirt

For each student group/environmental engineering team:

- plastic shoebox tub or other container for easy distribution of supplies to each team
- 1 set of cups* for each student group containing: ¼ c. sand, gravel, charcoal
  (*put filter paper on bottom for cup with sand; punch holes in bottom of plastic cups outward)
- 1 t. alum (in 2-3 oz. cup)
- 2 cups to catch water draining through
- 1 cup each labeled "dirty water" and "clean water"
- pencil
- data sheet

Optional (if testing water quality after cleaning):
wax paper dropper pH paper & 6 vials w/ pH scale

Room Arrangement
Students work in groups of 3-4 at tables or push together four desks.

INTRODUCTION
Welcome! Introduce yourself and your major

Activity Introduction
When we turn on the faucet at home, we expect clean drinkable water. Well, it wasn't always that way. Cities used to pump raw sewage from homes and businesses directly into rivers and lakes. Our drinking water supplies became degraded to the point of causing serious health effects. In 1993, more than 100 people died in Milwaukee from bacteria getting into their drinking water from livestock runoff.

Globally, 1 billion people are without clean drinking water and 2 billion are without sanitation to dispose of their wastes.

Today, we have the challenge of going into space. The astronauts will need clean water to drink…how will that be accomplished? At MTU, there is a team of researchers designing a process to improve NASA's water treatment system that could save millions in the years ahead. NASA spends $15,000 - $20,000 per pound to send anything up into space. By designing a water filtration system so astronauts can reuse their water, they can save NASA millions!! "The challenge is to find the most efficient combination of filters that will be most effective and last the longest," says Dr. David Hand of MTU's CEE Dept.

Let's do some calculating:
How long can we live without drinking water? *3 days*
How much does a gallon of water weigh? *8 pounds*
How much water does the average American use each day? 70-*100 gallons per day*
How much water do the astronauts need to bring into space? *1-3 gallons per day*

Procedure
1. Let's list the drains that we have in our homes: *bathroom, kitchen, laundry room.*
2. While you list the items that go down the drains at home, I'm going to add them to this gallon jug.
3. Now we have WASTEWATER!
4. Your job is to clean this water so it's drinkable again! Think how many times the towns along the Mississippi River reuse the same water before it reaches the Gulf of Mexico. Some cities are now reusing 'cleaned' wastewater in their homes!
5. Here's your assignment – Today, you are environmental engineers working in teams of 3-4 to develop a process for cleaning wastewater. Each team will have a screen, sand filter, gravel filter, charcoal filter, spoon, and alum to work with. Be sure to record your steps…you wouldn't want to

have the cleanest water, but not know how to repeat the process! You have 20 minutes. Assign one person in your group to be the recorder.

6. One representative from each team will bring up their cup of water to the front of the room, and hold it in front of a white sheet of paper. The students each get to vote once (by raising their hand) for the cup which has the cleanest water.? Have the team with cleanest water read their data sheet to find out what steps they followed?

SUMMARY

Wastewater treatment typically has 3 types of treatment:

Primary
Secondary
Tertiary

Final Thought

Think about what happens to your waste the next time it goes down the drain. If you like having clean water, thank an Environmental Engineer the next time you turn on your faucet!

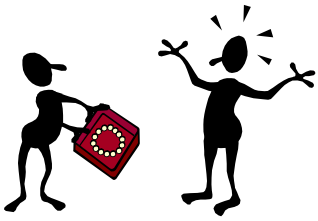
Additional information:

Turning Urine Into Water For Space Station Recycling (Dr. David Hand's research, MTU)
http://www.sciencedaily.com/releases/2008/11/081111210838.htm (Nov.2008)
Water on the Space Station https://science.nasa.gov/science-news/science-at-nasa/2000/ast02nov_1

Clean Water Challenge!

Your mission is to clean up the wastewater we just made in class.

Ways to clean up your wastewater:
Spoon
Gravel Filter… holes in cup
Charcoal filter… holes in cup
Sand filter… holes in cup
Screen
Alum



First, discuss <u>what order</u> your group will use these different cleaning methods
Second, list the method in the table below.
Third, describe how well the method cleaned the water.

Order	Cleaning Method	How well did method work?
1	Spoon: scoop out chunks.	Worked well, but took too much time.
2		
3		
4		
5		
6		

Would you drink your cleaned water? Why or why not?