How to Survive the Zombie Apocalypse: Part 1, Building a Water Filtration Plant

Submitted by: Matthew Hayden, Science
Neil A. Armstrong Middle School, Fairless Hills, Pennsylvania

Target Grade: 6th to 8th grade

Time Required: 50 minutes

Standards:

- MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
    - Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
    - Analyze and interpret data to determine similarities and differences in findings.
- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing human impact on environmental systems.
    - Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
    - Apply scientific principles to design an object, tool, process or system.
- 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.
    - Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
    - Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Lesson Objectives:

Students will:

- Understand that water needs to run through a filtration system in order for it to be safe to drink by humans.
- Be able to create their own water filtration system and test water levels for drinking safety.
- Understand how to take and analyze data on the potability of the filtered water.
- Design a solution to a problem using multiple iterations.

Central Focus:

In this lesson students will create a water filtration system in order to survive a "Zombie Apocolpyse". Students will be testing their filters, collecting data, and analyzing data. At the end of this lesson, students will be able to take their filtration systems home to test and see if they can make water from other places cleaner. Students will be working the principals of engineering, design, and real world problem solving.

Background Information:

Some vocabulary such as PPM (parts per million) and TDS (total dissolved solids) may be prerequisites for this lesson. **Total Dissolved Solids (TDS)** are the total number of charged ions, including minerals, salts or metals dissolved a specific amount of water. TDS is reported as units of mg per unit volume of water (mg/L), or parts per million (ppm). TDS is directly related to the purity of water and the quality of water purification systems and affects everything that consumes, lives in, or uses water, whether organic or inorganic, whether for better or for worse (TDS information).

Materials

- 10 gallon fish tank
- Case of bottled water
- Handful of leaves/grass etc.
- 1 in diameter PVC pipe (20 pieces, 8 inches in length)
- Cotton balls (1 bag)
- 2 lbs, aquarium charcoal, rinsed
- Coffee filters, 100
- 1 inch by 1 inch square sponges (30)
- Rubber bands (50 count bag)
- Paper towels (2 rolls)

- "Zero Water" meter (can be found at Walmart or Amazon for less than $20)
- 1 brand-new gym sock
- Data recording sheet

Instruction

Classroom preparation:

Pre-existing decor may be present as a part of a "Zombie Themed" unit. Set up a table with all supplies and suggested allotment of materials (1 tube, 2 tbs of charcoal). This may be adjusted based upon available supplies and class size.

Prepare the "Zombie Water Supply" near the front of the room. Empty the case of water into the 10 gallon tank and set aside the empty water bottles. To the water, add grass, leaves,etc, and place the new gym sock on top of the water. Cover with a tarp, trash bag, or paper in preparation for the reveal. Caution tape is a nice touch here as well and adds to the "crisis/survival" theme. Cut the empty water bottles in half. The top portion may be inverted to use as a funnel and the bottom portion will become the cup students use to pour the water through their improvised filter.

Introduction: (5-7 minutes)

Greet students solemnly as they enter the room. Once seated, set the tone of the class session as a gathering of survivors, determined to make it in this post-apocalyptic world. Tell them that survival will be difficult as most of the infrastructure of our once beautiful town has been destroyed. Plans for long-term survival must begin immediately. Today's focus is on that most precious of resources: clean drinking water. Unfortunately, due to the drastic situation in which we find ourselves, most of the town's water supply now looks like this: Remove cover to reveal tank filled with "Zombie" water.

Procedure: (30-35 minutes)

- Have students form 2-person teams.
- Introduce them to the available supplies.
- Tell them that their goal is to use the materials to construct an effective water filtration device capable of reducing the "contaminants" to an acceptable level*. (EPA standard is <500 ppm)
- Students may use their cup (bottom half of water bottle) to retrieve a sample of "Zombie Water".
- Circulate to monitor student progress and encourage "trial and error", changing the amounts and order of the ingredients assembled inside the PVC pipe.
- Test water as often as students request using the "Zero Water" PPM meter.

- As time allows, encourage student to improve their design for either greater reduction of TDS, or a faster rate of filtration.
- Monitor to ensure students are filling out their Data Collection Sheet while working. (You may choose to post testing results on the board depending upon the motivating factors of competitiveness within your classroom). If time allows, encourage students to make more than one iteration and test more than twice. They can record additional results on the back of the data sheet.
- It should be noted that even though the water should be completely safe to drink (even before the student filtration) it is not recommended as students may replicate this activity at home when the variables may be greater. As opposed to drinking the water, offer the students the chance to test the school's water supply to see if they produced even cleaner water than the school.

Closure: (5-7 minutes)

As the time draws to an end, have students empty the contents of their filter into the sink/trash and return the PVC tube to the supply area. Allow time for the completion of the Data collection sheet and a class discussion. The following questions may aid in the facilitation of a class discussion:

- Why do you think clean water is of such a high importance in a survival situation?
- Which of your supplies was most important in accomplishing your task?
- Given the choice, would your group want more time or additional materials?
- At any point, were you reminded of anything from your life, (pool filter, aquarium)?
- Invite students to share their thoughts about this activity with the class and encourage praise and feedback between students.

Differentiation

For emergent learners:

- More detailed lessons about the water cycle and natural filtration prior to this activity.
- Full labels and descriptions for each item on the supply table.
- Samples of existing filters such as "Brita", "Life-Straw" and "Aqualine".
- Larger teams (three) of students to facilitate faster construction and dialogue.
- Carefully limiting the items at the supply table to make selection easier & faster.

For students readily demonstrating mastery:

- Less guided instruction, more open-ended discovery.
- Restrict teams to only selecting 3 or 4 of the available items from the supply table.
- Challenge them to not only build an effective filter, but an efficient one as well, measure flow rate and GPM (gallons per minute) of clean water being produced. Graph with class comparables.

For ESL learners:

- Multi-language labels for items
- Selected partnering
- Bilingual Data Collection sheet
- Use of Google Translator if needed to facilitate communication

Assessment

Formative

Though the concepts of teamwork, scientific process and effort are stressed above experimental success, the attached rubric is used to determine adherence to the constraints of the activity while also serving to inform the teacher about the class's strengths and weaknesses so as to guide future lessons.

Water Filter Rubric

	1	2	3	4	5
Data Sheet	Missing or blank	Largely incomplete, only partial answers given	All questions attempted. Learner approaches understanding	Sheet is completed with clear understanding of concepts	An exception level of understanding and knowledge demonstrated
Teamwork	Student did not work with a team or actions were counter-productive to team work	Student occasionally interacted with others during activity	Student worked willingly with partner(s) to accomplish the task	Collaboration and cooperation were witnessed during the activity	A high level of teamwork witnessed. Peer assistance was offered & accepted
Use of Materials	Supplies were used in an unsafe/disorderly manner	Some materials were used improperly according to class rules	Most of the materials were used as directed	All supplies and rules for use were respected during the activity	Student showed a high level of respect and safety while using the supplies provided
Effectiveness of filter	Filter reduced TDS to <500 ppm	Filter reduced TDS to <400 ppm	Filter reduced TDS to <300 ppm	Filter reduced TDS to <200 ppm	Filter reduced TDS to <100 ppm
• TDS= total dissolved solids • PPM= parts per million				**Total**	/20

Zombie Water Data Collection Sheet

Names: _____

As you and your partner work together to solve this problem, record your thoughts and findings in the areas below.

After viewing the available supplies, discuss your plan with your partner. Record your idea(s) here:

_____
_____
_____
_____
_____

Results of 1st test:

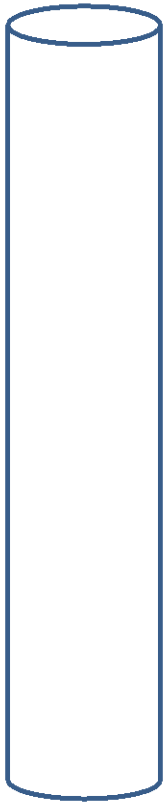
____ppm

What modifications did you make?

_____
_____
_____
_____
_____
_____
_____

Results of 2nd test:

____ppm



Draw and label all of the parts of your water filter

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____