5E STEM Unit Water Filtration

One Week

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science, Engineering, and Computer Science

Grade Level: Middle School

Materials

- Clean tap water
- Clear plastic cups (6 per group)
- Measuring Spoons/cups
- Plastic spoons
- Granular activated charcoal pellets & powder
- pens/markers
- Timer (1 per group)
- Food color (1 per group)
- Paper Towels
- Gloves & Safety Glasses for every student
- Optional for Elaborate section sand, pebbles, cheese cloth, cotton, coffee filters, etc…

STANDARDS

Next Generation Science Standards

- MS-ESS3-3
- 5ESS3-1

Computer Science Standards | Common Core State Standards

- DA-08 6- 8 Collect data using computational tools and transform the data to make it more useful and reliable.

English Language Arts Standards | Common Core State

- RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

LESSON OBJECTIVE(S)

- Students will be able to understand the importance of clean water.
- Students will identify sources of water pollution
- Students will explore ways to conserve and protect clean water sources.
- Students will use granular activated carbon to determine the effectiveness of removing food color from water samples.
- Students will use collected data to create graphs to aid in data interpretation.
- Students will design and test their own water filter using the engineering design process

CAREER CONNECTION(S)

Mentor Background: Mr. Luke Gurtowski, P.E., is a Research Chemical Engineer in the U.S. Army ERDC's Environmental Engineering Branch. He leads research toward materials science and environmental treatment at bench and field (prototype) scales to support the Military and Civil Works missions. His primary focus involves utilization of nanomaterials and novel technologies/strategies for a variety of applications. Namely, Mr. Gurtowski investigates separations techniques in addition to chemical degradation for water treatment related to traditional and emerging contaminants. Mr. Gurtowski has also led research to support materials development for sustainable infrastructure.

Mr. Gurtowski earned a Bachelor of Science in Chemical Engineering and Master of Science in Civil and Environmental Engineering from Mississippi State University. Mr. Gurtowski is a licensed Professional Engineer in the state of Mississippi. He is also an active member of the American Society of Civil Engineers (ASCE) and was named 2019 Young Engineer of the Year by the organization's Mississippi Section.

STEM Careers:

Bachelor of Science in Chemical Engineering:

1. Process Engineer
2. Chemical Plant Manager
3. Environmental Engineer
4. Materials Engineer
5. Pharmaceutical Engineer
6. Safety Engineer
7. Energy Engineer

Master of Science in Civil and Environmental Engineering:

1. Environmental Consultant: Providing expert advice to businesses and governments on environmental policies, regulations, and sustainable practices.

2. Water Resources Engineer: Designing and managing systems for water supply, drainage, and flood control to ensure sustainable water resources management.

3. Geotechnical Engineer: Analyzing soil and rock properties to design and construct foundations, tunnels, and other structures.

4. Structural Engineer: Designing and analyzing structures like buildings, bridges, and dams to ensure they are safe, stable, and capable of withstanding environmental stresses.

5. Transportation Engineer: Planning and designing transportation systems, including roads, railways, airports, and public transit systems.

6. Environmental Scientist/Engineer: Working on projects related to pollution control, waste management, and the remediation of contaminated sites.

7. Sustainable Design Specialist: Integrating sustainable practices into the design and construction of buildings and infrastructure to minimize environmental impact.

ENGAGEMENT

Brief Description: Open the lesson with an interactive presentation from curipod. All About Water

Procedures:

Step 1 - (5 to 10 minutes) Direct students to open their devices and access the curipod activity.
Step 2 - (20 to 30 minutes) Present the curipod lesson to the students. Allow time for engagement with the interactive activities as you navigate the slides with the students. This will give a brief refresher on water, water sources, water pollution, and why clean water is important.
Step 3 - (10 to 15 minutes) Assign groups for the next class period, pass out 6 cups to label in advance of experiment. Cups should be labeled as ½ teaspoon, 1 teaspoon, and 1 ½ teaspoon (2 of each) and placed in an accessible location for the next class.

EXPLORATION

Brief Description: Students will use granular activated carbon and food color to perform a water filtration experiment.

Procedures:

- Step 1 - 5 to 10 minutes - Teacher reviews the information from the day before, paying attention to why fresh water is important for people and animals. Have student helpers distribute all materials to the groups.

- Step 2 - 10 minutes - Have students measure out 2 cups of water and place in each plastic cup followed by 3 teaspoons of granular activated carbon pellets (GAC). Do this for one set of cups. Reserved the other set for part 2.

- Step 3 - 10 minutes - Have students measure out ½ teaspoon of food color and place it in a cup marked ½ tsp. Stir with a plastic spoon to mix well. Immediate start stopwatch to time how long it takes for the GAC to absorb all color. Record the results on a spreadsheet or other table.

- Step 4 - (Time Varies) - Have students measure out 1 teaspoon of food color and place it in a cup marked1 tsp. Stir with a plastic spoon to mix well. Immediate start stopwatch to time how long it takes for the GAC to absorb all color. Record the results on a spreadsheet or other table.

- Step 5 - (Time Varies) - Have students measure out 1 ½ teaspoon of food color and place it in a cup marked 1 ½ tsp. Stir with a plastic spoon to mix well. Immediate start stopwatch to time how long it takes for the GAC to absorb all color. Record the results on a spreadsheet or other table.
- Step 6 - 10 to 15 minutes - Allow students to complete their spreadsheet and create a table showing the time elapsed to remove the color from the water. Have students make inferences on what will happen in PART 2 when they use crushed GAC instead of the pelleted form.

PART 2

- Repeat Steps 1 - 5 using the crushed GAC. Record the results on a spread sheet and create a graph using the data.
- Step 6 - Compare the results of the data and have students make inferences as to why they achieved different times when using the crushed vs pellet forms of GAC.

EXPLANATION

Brief Description: Students will analyze the results from the experiment and explain the results.

Procedures:

Step 1 - Allow the students about 15 minutes to compare their results with other teams. Allow time for the group to share their inferences about the "why" using a different form of GAC gave different time results.

Step 2 - Have student research and prepare a short slide presentation explaining their results and why the results were different based on the types of carbon used. Students should include slides explaining why clean water is important, graphs showing their results, and why there were differences in the time frames between the 2 different types of GAC.

Step 3 - Allow time for student groups to present their slides to the class.

ELABORATE

Brief Description: Students will try a real world application to create a simple water filter to help create clean water.

Procedures:
Step 1 - 10 to 15 minutes - Allow students to research ideas on building a water filter with common materials.

Step 2 - 10 to 15 minutes - Allow students to sketch out their simple filter designs on paper, including a hypothesis on how well the filter will remove the color from the water. Make sure students know in advance the materials they may choose to work with.

Step 3 - 5 to 10 minutes - Allow students to gather their materials from the supply area.

Step 4 - 20 to 30 minutes - Students will assemble their filter prototype. They may use up to 3 different types of media plus coffee filters to build a filter. Once the filter is complete, they may test the filter

Step 5 - 10 to 15 minutes - Students will prepare a 2 cup mixture of water and 1 ½ tsp food color. Once mixed well, slowly pour 1 cup of the mixture into their filter. Reserve the remaining mixture to make comparisons after the filter process. Record the time it takes the water to flow through the filter and assign a rating to the sample where "0" is totally clear and "10" is the same color as the original sample.

Step 6 - Repeat the filter process with the sample 2 more times, each time recording the amount of time the water takes to go through the filter and how much color remains.

Step 7 - Students will evaluate the effectiveness of the filter created and improve on their design if time allows.

EVALUATION

Brief Description: Students' understanding will be assessed through their presentations and filter creations.

Procedures:
Presentations (10 - 15 minutes per group): Students present their research findings to the class.
Discussion and Q&A (5 to 10 minutes after each presentation/filter demonstrations): Class discussion and questions on the presentations to reinforce learning.

REFERENCES

- Water Filtration Material
- Protect Your Body, Filter Your Water! - Activity - TeachEngineering
- https://kids.nationalgeographic.com/books/article/water-wonders
- https://www.science-sparks.com/cleaning-up-water-looking-at-filtering/