STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**Would You Drink THAT?**
Economic Cluster	Advanced Manufacturing & Materials Human Performance and Medicine
Targeted Grades	7
STEM Disciplines	Science Technology Engineering Math
Non-STEM Disciplines	English Language Arts Social Studies

Section I: STEM Unit Overview

Unit Overview

Students are challenged to engineer an effective water filtration system that will assist victims of natural disasters. They will investigate the hydrologic cycle, the effects natural disasters and contaminated water have on living organisms, and compare the body systems of various organisms while testing the effectiveness of their team's filtration system. After filtering contaminated water, they observe the hydrologic cycle's natural ability to purify water by distilling their filtered water. Testing for particulate matter, bacteria, and turbidity are performed in order to observe comparisons between the contaminated water sample, the filtered water sample, and the distilled water sample.

Essential Question

How do contaminants cycling through the Earth's Systems affect our drinking water and how can the contaminants be filtered out of the water?

Enduring Understanding

Water is a precious resource that cannot be created. Therefore, the hydrologic cycle is a natural water filtration system that should be protected.

Releasing pollution into the atmosphere, hydrosphere, and lithosphere will have negative effects on our already limited fresh water supply.

Engineering Design Challenge

Due to many recent occurrences of hurricanes and floods, disaster relief kits are in the process of being assembled. These kits will be stored and ready for use in the event of a natural disaster. Student teams of scientists and engineers are presented with the challenge to design, test, provide a kit material list, and instructions for a basic portable, compact water filtration system that will aid in the provision of clean drinking water. A flood-like contaminated water sample is provided for each team's use in analyzing, testing, and designing your water filtration system. Teams analyze and record quantitative and qualitative data regarding the water sample's turbidity, odor, pH level, containment of particulate matter and microorganisms, etc.

Time and Activity Overview

Day	Time Allotment	Actvities
1	50 minutes	Pre-test Form teams and complete Code of Conduct Discussions regarding water View hook videos Engineering design challenge and materials Filtration design brainstorming
2	50 minutes	Test materials for filtration effectiveness Set Decision Analysis Matrix goals Individuals brainstorm and sketch

3	50 minutes	Present individual design sketches to team Decision Analysis Matrix and team design choice Test contaminated water and record data
4	50 minutes	Construct design Filter contaminated water 1-3 times
5	50 minutes	Observe hydrologic cycle through distillation
6	50 minutes	Instructional guide
7	50 minutes	Instructional guide Post-test

Pre-requisite Knowledge & Skill

Students should be familiar with the basic processes of the hydrologic cycle and the Law of Conservation of Matter and Energy.

Academic Content Standards

Add Standard	Mathematics
Grade/Conceptual Category	7
Domain	Statistics and Probability
Cluster	Use random sampling to draw inferences about a population
Standards	1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences. 2. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election.

Add Standard	Mathematics
Grade/Conceptual Category	7
Domain	Statistics and Probability
Cluster	Draw informal comparative inferences about two populations
Standards	3. Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable. 4. Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.

Add Standard	Mathematics
Grade	
Standard	
Benchmark	
Indicator	

Add Standard	English Language Arts
Grade	7
Strand	Reading: Informational Text
Topic	Craft and Structure
Standard	4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of a specific word choice on meaning and tone.

Add Standard	English Language Arts
Grade	7
Strand	Writing
Topic	Text Types and Purposes
Standard	2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples. c. Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style. f. Provide a concluding statement or section that follows from and supports the information or explanation presented.

Add Standard	English Language Arts	
Grade	7	
Strand	Writing	
Topic	Prosecution and Distribution of Writing	
Standard	4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience. (Grade-specific expectations for writing types are defined in standards 1-3.) 5. With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed. 6. Use technology, including the Internet, to produce and publish writing and link to and cite sources as well as to interact and collaborate with others, including linking to and citing sources.	

Add Standard	English Language Arts	
Grade	7	
Strand	Speaking and Listening	
Topic	Comprehension and Collaboration	
Standard	1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. b. Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed. c. Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed. d. Acknowledge new information expressed by others and, when warranted, modify their own views. 2. Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study. 3. Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.	

Add Standard	English Language Arts	
Grade	7	
Strand	Speaking and Listening	
Topic	Presentation of Knowledge and Ideas	
Standard	4. Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation. 5. Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. 6. Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.	

Add Standard	English Language Arts	
Grade	7	
Strand	Language	
Topic	Knowledge of Language	
Standard	3. Use knowledge of language and its conventions when writing, speaking, reading, or listening. a. Choose language that expresses ideas precisely and concisely, recognizing and eliminating wordiness and redundancy.	

Add Standard	English Language Arts	
Grade		
Standard		
Benchmark		
Indicator		

Add Standard	Social Studies	Ohio
Grade		
Theme		
Strand (pk-8 only)		
Topic		
Content Standard		

Add Standard	Social Studies	Ohio
Grade		
Standard		
Benchmark		
Indicator		

Add Standard	Science	Ohio
Grade	7	
Theme	Order and Organization	
Topic	Cycles and Patterns of Earth and the Moon	
Content Standard	The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere. Thermal energy is transferred as water changes state throughout the cycle. The cycling of water in the atmosphere is an important part of weather patterns on Earth. The rate at which water flows through soil and rock is dependent upon the porosity and permeability of the soil or rock. Note: Contamination can occur within any step of the hydrologic cycle. Ground water is easily contaminated as pollution present in the soil or spilled on the ground surface moves into the ground water and impacts numerous water sources. Thermal-energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns. The sun is the major source of energy for wind, air and ocean currents and the hydrologic cycle. As thermal energy transfers occur in the atmosphere and ocean, currents form. Large bodies of water can influence weather and climate. The jet stream is an example of an atmospheric current and the Gulf Stream is an example of an oceanic current. Ocean currents are influenced by factors other than thermal energy, such as water density, mineral content (such as salinity), ocean floor topography and Earth's rotation. All of these factors delineate global climate patterns on Earth. The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere. The atmosphere is held to the Earth by the force of gravity. There are defined layers of the atmosphere that have specific properties, such as temperature, chemical composition and physical characteristics. Gases in the atmosphere include nitrogen, oxygen, water vapor, carbon dioxide and other trace gases. Biogeochemical cycles illustrate the movement of specific elements or molecules (such as carbon or nitrogen) through the lithosphere, biosphere, hydrosphere and atmosphere.	

Add Standard	Science
Grade	7
Theme	Order and Organization
Topic	Cycles of Matter and Flow of Energy
Content Standard	In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors. Biomes are regional ecosystems characterized by distinct types of organisms that have developed under specific soil and climatic conditions. The variety of physical (abiotic) conditions that exists on Earth gives rise to diverse environments (biomes) and allows for the existence of a wide variety of organisms (biodiversity). Ecosystems are dynamic in nature; the number and types of species fluctuate over time. Disruptions, deliberate or inadvertent, to the physical (abiotic) or biological (biotic) components of an ecosystem impact the composition of an ecosystem.

Add Standard	Science
Strand	
Course Content	
Content Elaboration	

Add Standard	Science
Grade	
Standard	
Benchmark	
Indicator	

Add Standard	Fine Arts
Grade	
Subject	
Standard	
Benchmark	
Indicator	

Add Standard	Technology
Grade	7
Standard	6: Design
Benchmark	A: Evaluate the aesthetic and functional components of a design and identify creative influences.
Indicator	Universal Design 1. Identify environments or products that are examples of the application of the principles of Universal Design (e.g., equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use). Ergonomic Design 2. Apply ergonomic considerations to a design to maximize a design's ease of use and to minimize product liability (e.g., ergonomic keyboards decrease wrist injury). Requirements 3. Categorize the requirements for a design as either criteria or constraints. Optimization and Trade-offs 4. Document compromises involved in design (e.g., cost, material availability). Design Application 5. Apply a design process to solve a problem in the community (e.g., identify need, research problem, develop solutions, select best

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Water filtration system instructional pamphlet Engineering design challenge Decision Analysis Matrix Instructional Guide
Quizzes, Tests, Academic Prompts	Pre/Post Test Recorded data
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Observations of team engineering design challenge completion Water filtration system artifact Team Code of Cooperation Peer/Self Evaluation Instructional Guide
Student Self- Assessment	Student scores his or her individual design proposal Students test and redesign water filtration systems Team Code of Cooperation Peer/Self Evaluation Reflection

Technology
Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	Multi-media instructional guide Internet Interactive white board Elmo
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Graphing Calculator with pH sensor and temperature probe MS Word MS Excel
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	http://www.epa.gov go to "Water", and "Surf Your Watershed" feature.
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	http://www.noaa.gov go to "Weather", and then access the appropriate national weather stations.
C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	Document creation software / freeware such as Publisher and googledocs.com
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Connections

Career Description

Water and Wastewater Treatment Plant Operators-
Operates and maintain the pumps and motors that move water and wastewater through filtration systems. They monitor the indicators at their plants and make adjustments as necessary. They read meters and gauges to make sure that plant equipment is working properly. They take samples and run tests to determine the quality of the water being produced. At times, they may adjust the amount of chemicals, such as chlorine and fluorine, being added to the water. (United States Department of Labor)

Geoscientist -
Geoscientists usually study and work in one of several closely related geosciences fields, including geology, geophysics, and hydrology. Geologists study the composition, processes, and history of the Earth. They try to find out how rocks were formed and what has happened to them since their formation. They also study the evolution of life by analyzing plant and animal fossils. Geophysicists use the principles of physics, mathematics, and chemistry to study not only the Earth's surface, but also its internal composition, ground and surface waters, atmosphere, oceans, and magnetic, electrical, and gravitational forces. Hydrologists study the quantity, distribution, circulation, and physical properties of water and the water cycle. (United States Department of Labor)

Hydrologist -
Hydrologists often specialize in either underground water or surface water. They examine the form and intensity of precipitation, its rate of infiltration into the soil, its movement through the Earth, and its return to the ocean and atmosphere. Hydrologists use sophisticated techniques and instruments. For example, they may use remote sensing technology, data assimilation, and numerical modeling to monitor the change in regional and global water cycles. Some surface-water hydrologists use sensitive stream-measuring devices to assess flow rates and water quality. (United States Department of Labor)

Civil Engineer -
Civil engineers design things. These might be roads, buildings, airports, tunnels, dams, bridges, or water supply and sewage systems. They must consider many factors in their designs, from the costs to making sure the structure will stay intact during bad weather. This is one of the oldest types of engineering. Many civil engineers manage people and projects. A civil engineer may oversee a construction site or be a city engineer. Others may work in design, construction, research, and teaching. There are many specialties within civil engineering, such as structural, construction, environment, and transportation. (United States Department of Labor)

Materials Engineer -
Evaluate materials and develop machinery and processes to manufacture materials for use in products that must meet specialized design and performance specifications. Develop new uses for known materials. Includes those engineers working with composite materials or specializing in one type of material, such as graphite, metal and metal alloys, ceramics and glass, plastics and polymers, and naturally occurring materials. Includes metallurgists and metallurgical engineers, ceramic engineers, and welding engineers. (United States Department of Labor)

Biological Scientist -
Study living organisms and their relationship to the environment. They perform research to gain a better understanding of fundamental life processes and apply that understanding to developing new products or processes. Research can be broken down into two categories: basic and applied. Basic research is conducted without any intended aim; the goal is simply to expand on human knowledge. Applied research is directed towards solving a particular problem. Most biological scientists specialize in one area of biology, such as zoology (the study of animals) or microbiology (the study of microscopic organisms). (United States Department of Labor)

Biomedical Engineer -
Apply knowledge of engineering, biology, and biomechanical principles to the design, development, and evaluation of biological and health systems and products, such as artificial organs, prostheses, instrumentation, medical information systems, and heath management and care delivery systems. (United States Department of Labor)

Agricultural Engineer -
Apply knowledge of engineering technology and biological science to agricultural problems concerned with power and machinery, electrification, structures, soil and water conservation, and processing of agricultural products. (United States Department of Labor)

Environmental Engineer -
Research, design, plan, or perform engineering duties in the prevention, control, and remediation of environmental hazards using various engineering disciplines. Work may include waste treatment, site remediation, or pollution control technology. (United States Department of Labor)

Section II: STEM Lesson Plan

Title of Lesson	**Day 1: Code of Cooperation and Engineering Design Challenge Introduction**
Time Required	50 minutes
Materials	Computer with Internet and projection capabilities Prezi Presentation: http://prezi.com/hav4mj3kkfav/water-a-precious-resource/?auth_key=5e432a3ed8b0de0f528d07aa85439ee736cf2420 Design challenge supply bag (one per team): 1 water bottle with lid 1 rubber band 1 coffee filter 1 12cm X 12cm piece of cheese cloth or burlap 3-5oz. pebbles (Dixie up works well for a scoop) 3-5oz. sand (Dixie cup works well for a scoop) 3-5oz. charcoal (Dixie cup works well for a scoop) Contaminated water (one per team) Suggested approximate containments: 1 teaspoon organic matter from outside (soil, shredded leaves, etc.) 1 teaspoon powered laundry detergent 1/4 teaspoon yeast 1 teaspoon sugar 1 tablespoon salt water bottle tap water Appendix A: Pre-test (one per student) Appendix B: Team Roles (one per team) Appendix C: Team Code of Cooperation (one per team) Appendix D: Engineering Design Challenge (one per team)
Objectives	Students will identify ways in which disruptions to abiotic and biotic components of and ecosystem impact the composition of an ecosystem and the formation of the Earth's surface. Students will work with peers to set rules for team collaboration and decision making and assign individual roles based on individual strengths. Students will be able to describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

Instructional Process

1. Prior to beginning the lesson, prepare contaminated water and filtration supply bags.
2. Prior to beginning the lesson, create engineering teams of 4 students.
3. Administer Pre-Test.
4. Explain Code of Cooperation
   - Each team takes ownership in their work by making their own decisions regarding roles within the team and anticipated goals and consequences. The teacher is a facilitator and becomes a moderator only when absolutely necessary.
   - Handout Team Roles and Code of Cooperation. Allow teams time (15 minutes) to assign roles and complete the Code of Cooperation. It they are unable to complete in class, they may complete it during their own time or for homework.
5. Follow Prezi presentation through day one instructions.
6. View and discuss "After the Storm" http://www.youtube.com/watch?v=0fIXhs6DzIE. Explain that their filtration system materials and instructions could potentially be placed in the disaster relief kits for storm victims as a supplemental to this brochure.
7. Hand out the "After the Storm" brochure: http://water.epa.gov/action/weatherchannel/upload/2008_09_12_weatherchannel_after_the_storm-read2.pdf for raising awareness of the need and for teams to use during the design process.
8. Introduce and discuss the engineering design challenge (Appendix D) and allow teams to view their available supplies.

Differentiation

The Pre-Test can be modified to meet specific teacher or student needs as necessary.

Differentiation can be achieved through job role selection based on learning modalities and strengths.

Assessments

The Pre-Test should serve as a formative assessment, informing the teacher of student prior knowledge. This information should be utilized as a guide for modifying the unit as necessary for specific groups of students. Observation of team collaboration and brainstorming can be used as a method of formative assessment.

Section II: STEM Lesson Plan

Title of Lesson	**Day 2: Material Testing and Goal Setting**
Time Required	50 minutes
Materials	Computer with Internet and projection capability Prezi presentation Design challenge supply bag (one per team) Contaminated water (one per team) Appendix D: Engineering Design Challenge (one per team) Appendix E: Decision Analysis Matrix (one per team) Appendix F: Engineering Design Challenge Rubric (one per student)

Objectives

Students will evaluate the function of a prototype in the design process by creating an effective water filtration system for use after natural disasters.

Students will be able to methods for preventing and treating contaminated water while exploring connections to the hydrologic cycle.

Instructional Process

1. View "Water and You: The Water Treatment Process" in order to study how water is currently filtered. Remind students that their filtration system design will be used when water treatment plants are not operational due to a natural disaster. www.youtube.com/watch?v=tuYB8nMFxQA
2. Instruct teams to brainstorm and sketch a design for the SHELL only of their team's filter. They should decide how they will modify a plastic water bottle to hold filtration materials. The shell needs to provide ample space for layering materials and for allowing contaminated water to flow through it into a beaker.
3. After each team gains teacher approval for their filtration filter shell, have them modify they water bottle according to their sketch.
4. Allow teams time to test individual filtration materials for effectiveness.
5. Hand out the Engineering Design Challenge Rubric (Appendix F) so students are aware of expectations.
6. Explain the use and importance of using a Decision Analysis Matrix (Appendix E) to the class. The use of decision-making tools, such as the matrix, is an important component of the engineering design process.
7. Instruct teams to discuss the engineering design challenge goals and objectives and add those into their team's Decision Analysis Matrix.
8. Assign homework: Individually brainstorm and sketch an effective filtering system based on your team's goals.

Differentiation	Required filtration system objectives could be added to the Decision Analysis Matrix before photo copying.
Assessments	Informal observation of team collaboration and brainstorming Discussion

Section II: STEM Lesson Plan

Title of Lesson	**Days 3 and 4: Decision Analysis Matrix, Filtration System Build and Test**
Time Required	50 minutes each day
Materials	Computer with Internet and projection capability Prezi presentation Design challenge supply bag (one per team) Contaminated water (one per team) Graphing calculator with temperature probe and pH sensor (one or two per class) Turbidity Chart: http://www.learnnc.org/lp/media/uploads/2010/06/turbidity_chart.pdf microscope (one per team)

Objectives

Students will be able to describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

Students will evaluate the function of a prototype in the design process by creating an effective water filtration system for use after natural disasters.

Students will quantify the total population of microorganisms and particulate matter in contaminated water by employing the use of a microscope to randomly sample the water and draw inferences.

Students will examine the diverse body plans of microorganisms and compare them to macroorganisms through random sampling of contaminated water.

Instructional Process

1. Instruct teams to discuss individual design plans while scoring them on the Decision Analysis Matrix.
2. Explain that each team will use the results of the Decision Analysis Matrix to choose a final team design, and sketch the design.
3. Remind students that they must have their design sketches approved before constructing the water filtration system. Teams may begin building their filter after approval. Remind them to measure and record the amount of each material they use so the same water filter can be reproduced during a natural disaster.
4. Inform students that before they filter the water, they must decide on what quantitative and qualitative data to collect in order to document changes in the water and effectiveness of their filter.
5. Provide microscopes for viewing of microorganisms and particulate material. Prompt students to decide on a method for using random sampling to calculate and infer the amount of microorganisms and particulate matter in their entire

contaminated water sample.

6. Provide each team with a beaker that will support their water filter and collect filtered water.
7. Instruct them to add filtration materials to their water filtration shell, and begin filtering the contaminated water. They may filter it a maximum of three times.
8. Have students collect and record qualitative and quantitative data regarding their filtered water.
9. Instruct students to place a sample of the filtered water into a small test-tube and seal it. This sample will be saved for comparisons between the contaminated water control sample, the filtered water, and the distilled water.

Differentiation	Monitor teams for understanding of data collection and recording as well as population sampling, and guide them in the proper direction when needed. Create a table ahead of time for students to record specific qualitative and quantitative data if needed.
Assessments	Formative observation of team collaboration, brainstorming, and designing Contaminated water data Engineering design challenge rubric

Section II: STEM Lesson Plan

Title of Lesson	**Day 5: Distillation and the Hydrologic Cycle**
Time Required	50 minutes
Materials	Computer with projection capabilities (one per class) Prezi presentation Appendix G: NASA-Water, Water Everywhere! Viewers' Guide http://www.youtube.com/watch?v=qyb4qz19hEk (6m31s) Appendix I: Teacher Resources Flask with rubber stopper, glass tubing, and ~50cm clear rubber tubing (one per class) Beaker covered by foil or cardboard with the rubber tubing inserted into the center (one per class) Bunsen burner or hot plate (one per class) Graphing calculator with temperature probe and pH sensor (one or two per class) Turbidity Chart: http://www.learnnc.org/lp/media/uploads/2010/06/turbidity_chart.pdf Microscope (one per team)

Objectives

Students will be able to create the hydrologic cycle and explain that thermal energy is transferred as water moves through the lithosphere, biosphere, hydrosphere, and atmosphere.

Students will be able to explain that contamination occur within any step of the hydrologic cycle and that groundwater is easily contaminated as pollution present in the soil moves into water sources.

Instructional Process

1. Prepare for distillation by placing a rubber stopper with a glass tube on a flask, place about 50cm of rubber tubing onto the glass tubing. Cover a beaker with foil and poke the other end of the plastic tubing into the center of the foil and tape into place. In order to keep the collection beaker cool and help the water vapor to condense, put ice into a container and insert beaker into it. (Appendix H)
2. Distill each team's filtered water by pouring the filtered water into the flask, boiling it, and watching it collect into the beaker. When the distillation is finished, salt and any remaining particulate matter will remain in the flask.
   If short on time: distilling one filtered water sample as a demonstration to the class works well. (Appendix H)
3. Have each team collect and record quantitative and qualitative data regarding the distilled water and left over salt and particulate matter.
4. Test each sample in a petri dish for bacteria (optional). A simple bacteria test can be done by boiling slices of potatoes until soft, placing slices in a petri dish, and

putting one drop of each water sample (contaminated, filtered, and distilled) onto a separate potato slice. Observe the slices for bacteria growth for 2-3 days. Dispose of the potato slices after 3 days or they will begin to smell rancid. A clear difference in bacteria growth between each sample will be observed.

5. Continue Prezi presentation and project and discuss photo of the water cycle ohiodnr.com\portals\7\pubs\pdfs\fctsht18.pdf (on Prezi presenation). Then play "Water Cycle Rap" http://www.youtube.com/watch?v=F9Yi4dAzHsc
6. Instruct students to complete the "NASA-Water, Water Everywhere!" Viewers' Guide as the video plays.
7. Instruct teams to begin preparing a summary of their filtration results, proving the effectiveness of the water filter, while waiting to distill their water. The summary must explain how the hydrologic cycle acts as a natural filter and water is only contaminated when it comes into contact with contaminates in the atmosphere and lithosphere. If the filter was not effective, they should also include how they could improve their design for better effectiveness.

Differentiation	Provide a scaffold for recording observations and taking notes.
Assessments	Informal observation of team collaboration Contaminated water data Engineering design challenge rubric Connection between water cycle rap and distillation process notes Summary of filtration results

Title of Lesson	**Day 6 and 7: Instructional Guide**
Time Required	50 minutes
Materials	Computer with projection capabilities Prezi Presentation Computers (one per team) Software for creating an instructional guide (Google Docs, Publisher, Word, etc.) Appendix F: Engineering Design Challenge Rubric Appendix H: Peer Evaluation Appendix A: Post-Test

Objectives

Students will reflect on their engineering process, identify successes and failures, and brainstorm methods for future water filtration system improvement.

Students will develop, publish, and present an instructional pamphlet that will allow others to replicate a water filtration system.

Instructional Process

1. Instruct teams to create an instructional guide to be included with the filter supply kits. Remind students that their filtration materials and instructions could potentially be place in the disaster relief kits along with the EPA "After the Storm" pamphlet. Therefore, it should be similar in appearance and quality.
2. Have each team present their filter, instructional guide, and reflection including successes, failures, and methods for future improvement to the class.
3. Wrap up the unit with a discussion about natural disasters' affect on fresh water, how human pollution affects fresh water, and how the hydrologic cycle is affected by natural disasters as well as humans. Refer to: http://ga.water.usgs.gov/edu/earthwherewater.html for information about the availability of fresh water on the Earth.
4. Administer Post-Test.

Differentiation

Modify Post-Test based on individual student needs.
Provide an instructional guide scaffold for individual students as needed.

Assessments	Engineering Design Challenge Rubric Instructional Guide Post-Test

Section III: Unit Resources

Materials and Resource Master List

Appendix A: Pre-Test and Post-Test (one per student)
Appendix B: Team Roles (one per team)
Appendix C: Team Code of Cooperation (one per team)
Appendix D: Engineering Design Challenge (one per team)
Appendix E: Decision Analysis Matrix (one per team)
Appendix F: Engineering Design Challenge Rubric (one per student)
Appendix G: Peer Evaluation

Computer with Internet and projection capabilities

Prezi Presentation: http://prezi.com/hav4mj3kkfav/water-a-precious-resource/?auth_key=5e432a3ed8b0de0f528d07aa85439ee736cf2420

Design challenge supply bag (one per team):
- 1 water bottle with lid
- 1 rubber band
- 1 coffee filter
- 1 12cm X 12cm piece of cheese cloth or burlap
- 3-5oz. pebbles (Dixie up works well for a scoop)
- 3-5oz. sand (Dixie cup works well for a scoop)
- 3-5oz. charcoal (Dixie cup works well for a scoop)

Contaminated water (one per team) Suggested approximate containments:
- 1 teaspoon organic matter from outside (soil, shredded leaves, etc.)
- 1 teaspoon powered laundry detergent
- 1/4 teaspoon yeast
- 1 teaspoon sugar
- 1 tablespoon salt
- water bottle
- tap water

Microscope (one per team)
Computer (one per team)
Graphing calculator (one or two per class)
Temperature probe for graphing calculator (one per class)
pH sensor (one per class)
Turbidity Chart: http://www.learnnc.org/lp/media/uploads/2010/06/turbidity_chart.pdf
Beaker (one per class)
Bunsen burner or hot plate (one per class)
Flask (one per class)
Aluminum foil or cardboard to cover beaker
Rubber stopper for flask
Clear rubber tubing about 50cm long to fit snuggly onto glass tube in rubber stopper

Software for creating an instructional guide (Google Docs, Publisher, Word, etc.)

Key Vocabulary

Aquifer
an underground water reservoir

Concentration
the amount of one substance in a certain volume of another substance

Condensation
the process by which water vapor in the air is changed into liquid water

Contaminant
any substance that has a negative effect on water or the living things that depend on water

Distillation
the volatilization or evaporation and subsequent condensation of a liquid, as when water is boiled in a retort and the steam is condensed in a cool receiver.

Drought
dry weather for a long period of time because the average rainfall drops far below the normal range for a specific region

Evaporation
the process by which water changes from a liquid to a gas or vapor

Filtration
the process of passing water through a series of screens that allow the water to pass, but not the solid particles

Groundwater
water in underground soil and rock layers

Hydrologic Cycle
the natural sequence through which water passes into the atmosphere as water vapor, precipitates to earth in liquid or solid form, and ultimately returns to the atmosphere through evaporation.

Impermeable
materials that do not allow materials to pass through easily
Infiltration – the process of water entering the soil

Non point source pollution
a widely spread source of pollution that cannot be tied to a specific origin, such as runoff from roads (many sources)

Permeable
materials that allow water to pass through easily

Point source pollution
a specific source of pollution that can be identified, such as a leaking pipe (one source)

Precipitation
water released from clouds in the form of rain, freezing rain, sleet, snow, or hail

Sludge
the residual, semi-solid material left from industrial wastewater or sewage treatment processes

Transpiration
a process similar to evaporation…the loss of water from parts of plants

Watershed
the land area that drains water to a common waterway, such as a stream, lake, estuary, wetland, aquifer, or even the ocean

Water Quality
the measurements of substances in water other than water molecules

Technical Brief

Aquifers are underground reservoirs whereas lakes, streams, and oceans are surface reservoirs. A watershed is a land area that drains water to a common surface reservoir. Groundwater runoff feeds aquifers, watersheds, and surface reservoirs. The water that reaches an aquifer is usually much cleaner than the water in surface reservoirs because many of the pollutants are filtered out as the water passes through the layers of soil, clay, sand, gravel, rock, etc. Almost no bacteria live in aquifers. Unlike surface reservoirs there is no silty mud to cloud the water, no pollution from boaters, and no evaporation of the water supply by the sun. Many communities obtain their drinking water from aquifers or surrounding lakes or rivers. Water suppliers or utility officials drill wells through soil and rock into aquifers to supply the public with drinking water. Homeowners who cannot obtain drinking water from public waters have private wells that tap the groundwater supply. Unfortunately, groundwater can become contaminated by improper use or disposal of harmful chemicals such as lawn care products and household cleaners. These chemicals can percolate down through the soil and rock into an aquifer—and eventually into the wells. Such contamination can pose a significant threat to human health. The measures that must be taken by well owners and operators to either protect or clean up contaminated water supplies are quite costly, but necessary.

Law of Conservation - There was the Law of Conservation of Matter and the Law of Conservation of Energy. Once nuclear fission and fusion disproved them as separate laws, they were combined into the Law of Conservation of Matter and Energy which states that you cannot create or destroy matter or energy, but you can convert one to the other. For example, with nuclear fission you convert matter to energy, and with nuclear fusion you convert energy to matter.

Safety and Disposal

Proper use of equipment should be discussed before project is started.

Students will be working with glassware and should take special care when using equipment.

Goggles and aprons should be made available to students during filter project.

Have containers available to deposit materials after testing of projects. A container for gravel, charcoal, and other materials should be labeled and students made of aware of proper disposal.

Teacher may want to pre-cut the plastic bottles for students or monitor the students when they cut the plastic bottles.

Teacher may want to heat the flask as each team observes during the distillation process.

Remind students not to drink from any of the science glassware or taste the dirty water being used in the project.

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Curriculum Developers

Patty Deaton: Contributing Author
Nicole Erwin: Contributing Author
Diane Fox: Contributing Author
Jeanette McNally: Contributing Author, Editor
Heather Nianouris: Contributing Author, Editor
Margaret Pinnell, PhD: Contributing Author
Sandra Preiss: Contributing Author, Editor
Bonnie Thompson: Contributing Author

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