SDG 6: Water and Sanitation

This module focuses on SDG 6 which aims to “ensure availability and sustainable management of water and sanitation for all.” The module includes stories highlighting initiatives like WaterAid's WASH program in Bangladeshi tea gardens and engineering solutions in rural East Africa. Activities such as water quality testing, a water conservation campaign, and a water treatment facility field trip engage students in practical learning and promote awareness of water issues globally and locally.

Link to Subjects	Science (Chemistry); Government; Social Studies		
Link to Indiana High School Core	TBD	Link to International Baccalaureate	TBD
Stories	#1: Wateraid’s WASH Work in Bangladeshi Tea Gardens #2: Engineering Solutions for Clean Water Access in East Africa #3: The United States Needs Its Own WASH Sector		
Activities	Activity #1: Water Quality Testing Lab	Activity #2: Water Conservation Campaign	Activity #3: Water Treatment Field Trip
Type of Activity	Lab	Community Engagement	Field Trip
Time of Activity	1 class	2 classes	Multiple classes (field trip)

Key Questions & Terms

Key Questions	Key Terms
How does access to clean water and sanitation impact health, education, and economic development? What regions or communities are most affected by water and sanitation issues? What factors contribute to water scarcity, water pollution, and inadequate sanitation? What actions can individuals take to conserve water and promote sanitation in their daily lives?	Sanitation Water Quality Water Scarcity Water Conservation Water Pollution Waterborne Diseases Wastewater Treatment

Story Summaries

Story #1: Wateraid's WASH Work in Bangladeshi Tea Gardens

The article discusses WaterAid and its local partner IDEA's successful initiation of a WASH (Water Access Sanitation and Health) program for tea pickers in Bangladesh's tea gardens. Facing challenges like restricted access and limited NGO presence, the program introduced innovative approaches, including context-specific hardware and hygiene promotion, to improve water, sanitation, and hygiene services for the marginalized community.

Full story here: Ahmed, S. (2018). Where no one has worked before: Innovations behind WaterAid's WASH work in Bangladesh tea garden communities. Towards Inclusive WASH. Retrieve from: https://bit.ly/3Xcywvg

Story #2: Engineering Solutions for Clean Water Access in Rural East Africa

In rural Tanzania, Mwamboli grapples with water scarcity and sanitation issues. A team of water engineers addresses these challenges by implementing boreholes, sanitation facilities, and community engagement initiatives. This integrated approach improves access to clean water, promotes hygiene practices, and empowers local communities, showcasing sustainable solutions for achieving SDG 6. (Full Story #2)

Story #3: The United States Needs Its Own WASH Sector

For six decades, US-based NGOs led successful water and sanitation projects globally, but ignored the crisis in the United States. Over 2.2 million Americans lack home water access. Despite challenges, a domestic WASH sector is feasible with coordinated efforts from funders, implementers, and learning groups, leveraging international experience to address the crisis.

Full story here: McGraw, G. (2020, June 29). The United States Needs Its Own WASH Sector. Stanford Social Innovation. Retrieved from: https://bit.ly/3xbMwL5

Opening Discussion:

1. Have students read one or both of the above stories. Working in pairs or small groups, students should respond to the the following questions
    a. What factors lead to problems with Access to Freshwater and Sanitation?
    b. What are the impacts of limited Access to Freshwater and Sanitation?
    c. What techniques are used to improve Access to Freshwater and Sanitation
    d. How do these stories about Access to Water and Sanitation relate to other SDGs?
2. Through the discussion, draw out the follow key ideas
    a. Ensuring that everyone has access to **safe and affordable drinking water** is essential. This includes access to water for drinking, sanitation, and hygiene.
    b. Populations in **rural areas**, **unplanned developments with high populations**, areas with high levels of pollution are at higher risk of suffering the impacts of limited Access to Freshwater and Sanitation.
    c. Promoting access to basic **sanitation services**, such as toilets and sewage systems, to improve **public health** and reduce the spread of **waterborne diseases**, is an essential part of ensuring access to clean water. Promotion of proper **hygiene practices** are crucial for preventing waterborne diseases and improving overall public health.
    d. Monitoring and maintaining **water quality standards** are important to ensure that water sources are free from **contamination** and safe for consumption.
    e. Developing and implementing **wastewater treatment systems** are essential to safely dispose of wastewater and prevent pollution of water sources.

Activity #1: Water Quality Testing Lab

In this hands-on activity, students learn to assess water quality using pH test kits, turbidity meters, and conductivity meters. Through testing various water sources, they explore the significance of water quality for human health and ecosystem integrity, aligning with SDG 6. Teacher preparation includes gathering equipment and providing background on water quality indicators.

Activity Learning Objectives

1. Understand the importance of monitoring water quality for human health and ecosystem integrity.
2. Develop practical skills in using pH test kits, turbidity meters, and conductivity meters to assess water quality.
3. Analyze and interpret water quality data in relation to established standards and guidelines.
4. Explore the implications of water quality on local ecosystems and communities.

Teacher preparation

1. Gather necessary equipment and materials, including pH test kits, turbidity meters, conductivity meters, sample containers, gloves, safety goggles, and instructional materials.
2. Identify various sources of water samples for testing, such as tap water, river water, lake water, and groundwater.
3. Prepare reference materials on water quality standards and guidelines from reputable sources, such as the Environmental Protection Agency (EPA) or World Health Organization (WHO).

Lesson Flow

1. Introduce the importance of monitoring water quality and its relevance to human health, environmental sustainability, and the achievement of SDG 6 (Clean Water and Sanitation).
2. Provide students with background information on pH, turbidity, and conductivity as indicators of water quality, explaining their significance and measurement methods.
3. Demonstrate how to use the testing equipment properly and safely, emphasizing the importance of following instructions and handling chemicals responsibly.
4. Organize students into small groups and assign each group a specific water sample to test, ensuring that they rotate through different types of water sources.
5. Instruct students to collect water samples from the designated sources using sample containers, ensuring proper labeling and documentation of sample locations.
6. Guide students through the process of conducting water quality tests, including pH measurement, turbidity assessment, and conductivity analysis, while encouraging them to record their observations and data accurately.

7. Facilitate discussions as students analyze their findings and compare them to established water quality standards and guidelines. Encourage critical thinking about the implications of their results for human health and ecosystem health.

Possible Enrichment

- See Water Filtration Lab in Advanced Approaches
- If surface water is being assessed, Biochemical O2 Demand can be included to study Organic Pollution.

Activity #2: Water Conservation Campaign

Challenge students to design a water conservation campaign for their school or community. Through creative mediums like posters, videos, and social media, they'll raise awareness about vital water-saving practices. By empowering students to take action, this activity fosters a sense of environmental responsibility and contributes to achieving SDG 6.

Activity Learning Objectives

1. Understand the importance of water conservation for sustainable development.
2. Develop creativity and communication skills by designing effective posters, videos, and social media posts to raise awareness about water conservation practices.
3. Foster a sense of responsibility and activism by engaging in practical efforts to promote water conservation within the school or local community.
4. Explore the role of individual actions in addressing global water challenges and contributing to collective efforts for environmental stewardship.

Teacher preparation

1. Print or share Student Worksheet (see Resources section below).
2. Gather design resources, whether technological (graphic design software) or physical (posterboard, markers, etc).

Lesson Flow

1. Introduce the concept of water conservation and its significance for sustainable development, emphasizing the importance of reducing water usage, preventing wastage, and protecting water resources.
2. Explain the objectives of the water conservation campaign activity, highlighting the opportunity for students to creatively raise awareness and promote action within their school or local community.
3. Provide background information on effective water conservation practices, such as fixing leaks, using water-efficient appliances, and implementing rainwater harvesting systems. Share examples of successful water conservation campaigns for inspiration.
4. Guide students in brainstorming ideas for their water conservation campaign, encouraging creativity and innovation in designing posters, videos, and social media content. Discuss the target audience, key messages, and communication channels for their campaign. Use student worksheet for guidance.
5. Allocate time for students to work in groups to develop their campaign materials. Provide access to design tools, technology resources, and relevant information to support their creative process.
6. Encourage students to incorporate engaging visuals, compelling messages, and accurate information into their campaign materials. Emphasize the importance of clarity, relevance, and effectiveness in communicating the message of water conservation.
7. Facilitate a peer review session where students can share their campaign ideas, receive feedback, and make improvements based on constructive criticism. Encourage

collaboration and collaboration among students to enhance the quality and impact of their campaigns.

8. Arrange for a culminating event or exhibition where students can showcase their water conservation campaign materials to the school or local community. Invite stakeholders, such as school administrators, community leaders, and environmental organizations, to view and support the students' efforts.
9. Reflect on the outcomes of the water conservation campaign activity, discussing the effectiveness of different communication strategies, challenges encountered, and lessons learned. Encourage students to consider ongoing opportunities for promoting water conservation beyond the classroom project.

Activity #3: Water Treatment Field Trip

In this half-day field trip, students journey into the world of water treatment with a field trip to a local water treatment facility. Students will explore the intricacies of water purification processes while gaining first hand insight into the vital role of these facilities in safeguarding public health and the environment.

Activity Learning Objectives

1. Understand the process of water treatment and its importance for providing clean and safe drinking water.
2. Learn about the role of water treatment facilities in protecting public health and the environment.
3. Explore the technologies and equipment used in water treatment processes.
4. Gain insight into career opportunities in the field of environmental science and water management.

Teacher preparation

1. Contact the local water treatment facility to schedule the field trip and confirm logistics.
2. Obtain permission slips and waivers from parents/guardians for students participating in the field trip.
3. Prepare a list of discussion questions and activities to engage students during the tour.
4. Coordinate transportation arrangements for students to and from the water treatment facility.
5. Ensure that students are dressed appropriately for the field trip (closed-toe shoes, weather-appropriate clothing).

Lesson Flow

1. Gather students in the classroom and provide an overview of the field trip objectives and itinerary.
2. Review safety guidelines and expectations for behavior during the field trip.
3. Discuss the importance of water treatment and its role in ensuring access to clean and safe drinking water for communities.
4. Board the bus or arrange transportation to the water treatment facility.
5. Use the travel time to review key concepts related to water treatment and discuss any questions or expectations students have for the field trip.
6. Upon arrival at the water treatment facility, meet with facility staff for a brief orientation.
7. Introduce students to the layout of the facility and explain the different stages of the water treatment process.
8. Take students on a guided tour of the water treatment facility, visiting key areas such as the intake, filtration, disinfection, and distribution sections.
9. Encourage students to ask questions and actively engage with the tour guide to learn more about the water treatment process and facility operations.

10. Provide opportunities for hands-on learning, such as observing water samples, testing equipment, or participating in demonstrations.
11. Gather students together for a debriefing session following the tour.
12. Facilitate a discussion on students' observations, insights, and questions about the water treatment facility.
13. Encourage students to reflect on how their understanding of water treatment has evolved as a result of the field trip.
14. Discuss the importance of water conservation and ways individuals can contribute to ensuring clean and safe water for all.
15. Board the bus or arrange transportation back to the school.
16. Use the return trip to allow students to share their experiences and discuss key takeaways from the field trip.

Possible Enrichment

Collaboration with the treatment facility staff may allow for teachers to obtain data or water samples that can be used in analysis (See Activity 1)

Advanced Approaches

Constructing a Water Treatment System:
In this hands-on lab, students will become environmental engineers as they design and construct water treatment systems using readily available materials. Through experimentation and innovation, students will explore various filtration methods to improve water quality, emphasizing the importance of clean water for human health and ecosystem preservation. You can find the full activity description in the Resources section below.

Case Study Analysis:
Objective: To analyze real-world water access, sanitation, and hygiene (WASH) issues by examining different case studies from around the world.

Instructions:

- Assign each student or group a different case study related to water access, sanitation, and hygiene (WASH) issues globally.
- Research the context, challenges, and interventions implemented in the assigned case study.
- Prepare a presentation summarizing the key findings to share with the class.

Debate on Water Rights:
Objective: To explore different perspectives on water rights, water privatization, and equitable access to clean water through a structured debate.

Instructions:

- Divide the class into groups representing different stakeholders involved in water rights issues.
- Research and gather evidence to support your stakeholder's perspective on water rights, water privatization, and equitable access to clean water.
- Participate in a structured debate, presenting arguments and counterarguments based on your research.

Virtual Water Footprint Activity:
Objective: To understand the concept of virtual water and its implications for global water resources by calculating individual virtual water footprints.

Instructions:

- Use online calculators or interactive tools to calculate your virtual water footprint.
- Reflect on the concept of virtual water and its significance for global water resources.
- Discuss findings with classmates and consider ways to reduce individual water footprints.

Policy Analysis Project:

Objective: To analyze water-related policies and legislation at various levels and propose recommendations for addressing water challenges.

Instructions:

- Analyze water-related policies and legislation at the local, national, or international level.
- Identify strengths, weaknesses, and areas for improvement in the policies.
- Develop policy recommendations to address water challenges based on your analysis.

Full Story Text

Story #2: Engineering Solutions for Clean Water Access in Rural East Africa

Source: This story was created by Ben Gillock with input from ChatGPT.

In rural Tanzania, communities like Mwamboli face significant challenges in accessing clean water and adequate sanitation facilities, perpetuating cycles of poverty and disease. This case study examines the efforts of a team of water engineers to design and implement sustainable water and sanitation solutions in Mwamboli.

Mwamboli is a rural village located in a semi-arid region of Tanzania, characterized by limited access to clean water sources and inadequate sanitation infrastructure. The majority of residents rely on shallow wells, rivers, or unprotected springs for their water needs, exposing them to waterborne diseases such as cholera, typhoid, and diarrhea. Additionally, the absence of proper sanitation facilities contributes to environmental pollution and public health hazards.

Several challenges hinder efforts to improve water and sanitation conditions in Mwamboli:

- Limited Access to Clean Water Sources: The existing water sources are often contaminated with pathogens, chemicals, and other pollutants, posing serious health risks to the community.

- Inadequate Sanitation Infrastructure: The lack of proper sanitation facilities, such as latrines and wastewater treatment systems, leads to open defecation and the contamination of water sources.

- Sustainability: Previous attempts to provide water and sanitation solutions in Mwamboli have been unsustainable due to factors such as lack of community involvement, inadequate maintenance, and unreliable funding sources.

To address these challenges, the team of water engineers proposed and implemented the following solutions:

- Construction of Water Supply Systems: The team conducted hydrogeological surveys to identify suitable locations for boreholes and groundwater extraction. They installed hand pumps and constructed water distribution networks to provide reliable access to clean water for drinking, cooking, and hygiene purposes.

- Implementation of Sanitation Facilities: Collaborating with local communities, the engineers built community-managed latrines equipped with handwashing stations and waste disposal facilities. They also promoted hygiene education and behavior change campaigns to encourage proper sanitation practices.

- Capacity Building and Community Engagement: Recognizing the importance of community ownership and participation, the engineers facilitated training workshops on water management, maintenance techniques, and income-generating activities such as water vending and irrigation farming. They established water user committees to oversee the operation and maintenance of water infrastructure and promote sustainable practices.

The implementation of these engineering solutions yielded several positive outcomes:

- Improved Access to Clean Water: The construction of boreholes and water supply systems significantly increased access to clean and safe drinking water for the residents of Mwamboli, reducing the incidence of waterborne diseases.

- Enhanced Sanitation Facilities: The provision of community-managed latrines and hygiene education initiatives led to a reduction in open defecation and improved sanitation practices, contributing to public health and environmental sustainability.

- Empowerment of Local Communities: Through capacity-building activities and community engagement initiatives, local residents gained the knowledge, skills, and resources necessary to manage and maintain water and sanitation infrastructure independently, ensuring the long-term sustainability of the project.

The story of Mwamboli shows that by employing a holistic approach that integrates technical expertise with community engagement and capacity building, water engineers can contribute to achieving SDG 6 and improving the quality of life for millions of people worldwide.

Resources

Worksheet: Water Conservation Campaign

Objective: Design a water conservation campaign to raise awareness in your school or local community.

1. Define Your Audience:
   - Identify who your campaign is targeting (e.g., students, teachers, local residents).
   - Consider their age, interests, and level of understanding about water conservation.

2. Choose Campaign Mediums:
   - Decide on the formats for your campaign materials (e.g., posters, videos, social media posts).
   - Consider which mediums will be most effective in reaching your target audience.

3. Brainstorm Key Messages:
   - Brainstorm ideas for the main messages you want to convey about water conservation.
   - Think about what actions you want your audience to take as a result of seeing your campaign.

4. Develop Content:
   - Create engaging content for your chosen mediums that communicates your key messages.
   - Include facts, statistics, and visuals to make your campaign materials informative and impactful.

5. Design Campaign Materials:
   - Use design tools or software to create visually appealing posters, videos, or social media graphics.
   - Pay attention to layout, color schemes, and fonts to ensure your message is clear and attention-grabbing.

6. Review and Revise:
   - Review your campaign materials to ensure they effectively convey your messages and are free of errors.
   - Seek feedback from peers or teachers and make any necessary revisions.

7. Plan Distribution:
   - Decide how you will distribute your campaign materials to reach your target audience.
   - Consider posting posters in high-traffic areas, sharing videos on social media platforms, and organizing awareness events.

8. Implement and Evaluate:
   - Launch your water conservation campaign and track its reach and impact.

- Collect feedback from your audience and evaluate the effectiveness of your campaign in raising awareness and promoting action.

9. Reflect and Share:

- Reflect on the process of developing and implementing your campaign.
- Share your experiences and lessons learned with your classmates and teachers.

Lab: Constructing a Water Treatment System

In this hands-on lab, students will become environmental engineers as they design and construct water treatment systems using readily available materials. Through experimentation and innovation, students will explore various filtration methods to improve water quality, emphasizing the importance of clean water for human health and ecosystem preservation

Learning Outcomes:

- Understand the principles of water treatment and purification methods.
- Apply scientific knowledge to design and construct a functional water treatment system.
- Analyze the effectiveness of different filtration techniques in improving water quality.
- Develop problem-solving skills and critical thinking through hands-on experimentation.

Teacher Preparation:

1. Gather materials (see list below) for constructing water treatment systems, including sand, cloth, banana peels, containers, and testing equipment.
2. Prepare a dirty water sample with a standardized level of turbidity and contamination.
3. Set up stations with turbidity meters, conductivity probes, and other testing equipment.
4. Provide safety guidelines and ensure appropriate supervision during the experiment.

Lesson Flow:

<u>Introduction (15 minutes):</u>

1. Review the objectives of the previous water lab and discuss the importance of water treatment in ensuring access to clean and safe drinking water.
2. Introduce the challenge: students will design and build their own water filtration systems using provided materials.
3. Briefly explain different filtration techniques and their effectiveness in removing contaminants from water.

<u>Design and Construction (35 minutes):</u>

1. Divide students into small groups and provide them with materials for constructing their water treatment systems.
2. Encourage students to brainstorm ideas, sketch designs, and allocate tasks within their groups.
3. Assist students as needed and facilitate discussions on the selection and arrangement of filtration materials.

<u>Testing and Evaluation (30 minutes):</u>

1. Once the water treatment systems are constructed, provide each group with a sample of dirty water.
2. Instruct students to run the dirty water through their treatment systems and collect the filtered water in clean containers.
3. Use turbidity meters and conductivity probes to measure the turbidity and conductivity of both the dirty and filtered water samples.
4. Guide students in recording their observations and analyzing the data to evaluate the effectiveness of their filtration methods.

Discussion and Reflection (15 minutes):

1. Reconvene as a class to share findings and discuss the results of the experiment.
2. Facilitate a discussion on the factors influencing the performance of different filtration techniques.
3. Encourage students to reflect on their design choices, identify areas for improvement, and consider real-world applications of their water treatment systems.

Conclusion (10 minutes):

1. Summarize the key takeaways from the lesson, emphasizing the importance of water treatment for public health and environmental sustainability.
2. Encourage students to further explore water treatment technologies and their impact on global water security.
3. Provide opportunities for students to present their findings and share their experiences with the class.

Materials list for Filter Construction

- Sand: Fine sand is often used as a primary filtration medium to remove large particles and sediment from water.
- Gravel or Pebbles: Coarse gravel or pebbles serve as a secondary filtration layer to trap larger particles and improve water flow.
- Activated Carbon: Activated carbon filters can adsorb organic contaminants, chemicals, and odors from water.
- Cloth or Fabric: Cloth filters can effectively remove suspended solids and debris from water.
- Banana Peels: Banana peels contain natural compounds that can help absorb impurities and improve water taste.
- Containers or Bottles: Containers are needed to hold the filtration materials and collect filtered water.
- Tubing or Hoses: Tubing or hoses may be required to connect different components of the filtration system.
- Clamps or Fasteners: Clamps or fasteners can secure the filtration materials in place within the containers.

- PVC Pipes or Funnels: PVC pipes or funnels can be used to direct water flow through the filtration system.
- Activated Charcoal: Similar to activated carbon, activated charcoal can adsorb contaminants and improve water quality.
- UV Light Source: UV light can be used for disinfection purposes to kill bacteria and microorganisms in water.
- Filter Cartridges: Commercially available water filter cartridges can be used for more advanced filtration or to compare with DIY filters.
- pH Test Kit: pH test kits are essential for measuring the acidity or alkalinity of water.
- Turbidity Meter: Turbidity meters measure the cloudiness or clarity of water caused by suspended particles.
- Conductivity Probe: Conductivity probes measure the ability of water to conduct electrical currents, which is indicative of dissolved solids.
- E Coli and Coliform Water Test Kit: Provide quick results showing where E Coli and Coliform bacteria are present in the water sample. These microbes cause significant health problems, and eliminating them is one significant objective of water treatment.