ENGINEERING - LESSON PLAN

Grade:	11 years old
Subject:	United in Biodiversity – Pollution
Lesson n°:	**1**
Topic:	DIY Water Filtration System 
Lessons focus and goals:	Lesson Focus This STEM activity focuses on teaching basic engineering principles and environmental science through a hands-on project. Students will learn about water pollution, the importance of clean water, and how engineers solve real-world problems by designing and building their own simple water filters. Lesson Goals - Understand Water Filtration: ● Learn how water gets polluted and why clean water is essential for health and the environment. ○ Water Pollution for Kids | Learn How to Keep Our Water Clean by Learn Bright ○ What is WATER POLLUTION? | What Causes Water Pollution? | The Dr Binocs Show | Peekaboo Kidz by Peekaboo Kidz ● Understand the basic concepts of water filtration and how different materials can remove contaminants. ○ Filtration by Science Projects ○ Turn Dirty Water into Clean Water! | Chirp Science Corner by Owlkids - Engineering Design Process: ● Introduce the steps of the engineering design process: Ask, Imagine, Plan, Create, and Improve. ○ Introduction to the Engineering-Design Process by STEM

	Education Works ○ The Engineering Design Process by Sarah Wood [MyEdTechWorld] ● Encourage students to think like engineers by identifying problems and brainstorming solutions. ○ Brainstorming Technique for Students that ACTUALLY Works by John Spencer ○ Group Brainstorming Techniques [Types of Brainstorming that Work] by Adriana Girdler - Hands-On Learning: ● Engage students in a practical activity where they design, build, and test their own water filtration systems using everyday materials (like sand, gravel, and cotton). ○ DIY WATER FILTER | WATER FILTER EXPERIMENT | HOW TO FILTER DIRTY WATER | Science Project by Hungry SciANNtist ○ Spark-Y At Home: Invent A Water Filter by Spark-Y: Youth Action Labs ● Develop problem-solving skills by experimenting with different filter designs and observing the results. - Teamwork and Collaboration: ● Promote teamwork by having students work in groups to build their filters, encouraging collaboration and communication. ● Emphasize the importance of sharing ideas and working together to improve their designs. - Critical Thinking and Reflection: ● Encourage students to think critically about their filter's performance, analyze what worked well, and identify areas for improvement. ● Reflect on the engineering process and how they can apply what they've learned to other challenges.
Learning objectives:	Scientific Understanding: ● Identify common sources of water pollution and their impacts. ● Learn how different materials filter out contaminants. Engineering Skills: ● Apply the engineering design process (Ask, Imagine, Plan, Create, Improve). ● Design and build a simple water filtration system. Practical Application: ● Test and evaluate the effectiveness of water filters. ● Improve designs based on test results. Collaboration and Communication: ● Work effectively in teams to build water filters. ● Communicate design processes and results clearly. Critical Thinking and Problem Solving: ● Analyze filtration efficiency and understand underlying reasons.

	• Reflect on the learning experience and its broader applications.

Materials	Here are some common materials you can use to build a simple water filtration system: Essential Materials: ○ Dirty water: This can be tap water mixed with dirt, sand, or food coloring to simulate polluted water. ○ Clear containers: For holding the dirty water and collecting the filtered water. ○ Filtering materials: These can vary, but common options include: ○ Sand ○ Gravel ○ Charcoal ○ Cotton balls or coffee filters ○ Activated carbon (optional) Optional Materials: ○ Funnel: To help pour water into the filter. ○ Rubber bands or tape: To secure the filtering materials. ○ Plastic wrap: To cover the top of the filter and prevent debris from falling in. ○ Plants: Some plants can help purify water, but this is a more advanced concept.
Structure and activities	Steps to Build a Simple Water Filtration System: ○ Prepare your containers: Set up a clear container to hold the dirty water and another to collect the filtered water. ○ Create the filter: Place layers of your chosen filtering materials (e.g., gravel, sand, charcoal, cotton) in the filter container. ○ Filter the water: Slowly pour the dirty water through the filter. ○ Observe the results: Compare the filtered water to the dirty water.
Digital Tools for Enhanced Learning	1. **Mobile/Web Applications** a) **Water Quality Simulation App** - Purpose: Create an interactive learning platform where students can: - Simulate different water pollution scenarios - Experiment with various filtration methods virtually - Track filtration performance in real-time - Example Implementation: - Drag-and-drop interface for selecting pollutants - Graphical representation of water clarity - Scoring system based on filtration effectiveness

- Comparative analytics showing different filter designs

b) **Filter Design Visualization Tool**
- Technical Features:
  - 3D modeling of water filtration processes
  - Computational fluid dynamics (CFD) visualization
  - Material property simulation
- Educational Benefits:
  - Help students understand microscopic filtration mechanisms
  - Demonstrate how different materials interact with water
  - Provide scientific visualization beyond physical experiment limitations

2. **Data Collection Technologies**

a) **Water Quality Sensor Integration**
- Technologies:
  - Smartphone-connected sensors
  - IoT (Internet of Things) water quality measurement devices
  - pH, turbidity, and contaminant detection tools
- Learning Objectives:
  - Real-world data collection
  - Understanding scientific measurement techniques
  - Connecting classroom learning to environmental monitoring

b) **Collaborative Data Sharing Platforms**
- Features:
  - Cloud-based data storage
  - Interactive maps showing water quality
  - Student-driven global water quality research
- Potential Platforms:
  - Custom STEAM education data hub
  - Integration with citizen science projects
  - Cross-school, cross-country data comparison

3. **Augmented Reality (AR) Experiences**

a) **AR Microscope**
- Functionality:
  - Use smartphone/tablet cameras
  - Overlay digital information on real-world water samples
  - Show microscopic contaminants
  - Interactive learning about water microorganisms
- Educational Value:
  - Make invisible processes visible
  - Engage students through interactive technology

- Develop scientific observation skills

b) **Virtual Water Ecosystem Exploration**
- Immersive Learning Environment:
  - 360-degree water ecosystem simulations
  - Interactive pollution impact scenarios
  - Biodiversity preservation visualization
- Learning Outcomes:
  - Systems thinking
  - Environmental cause-and-effect understanding
  - Emotional connection to environmental challenges

4. **Coding/Programming Extensions**

a) Python Data Analysis
- Technical Skills Development:
  - Data cleaning and preprocessing
  - Statistical analysis of filtration results
  - Creating visualizations (graphs, charts)
- Code Example Concepts:
  ```python
# Hypothetical water quality analysis
def analyze_filtration(water_samples):
    clean_water_percentage =
calculate_purification_rate(water_samples)
    identify_most_effective_filter(water_samples)
    generate_performance_report()
```

b) **MIT App Inventor**
- Student-Centered Learning:
  - Block-based programming platform
  - Create custom water tracking apps
  - Design user interfaces
  - Develop basic mobile applications
- Skill Development:
  - Computational thinking
  - Problem-solving
  - Basic software development concepts

c) **Block-Based Programming Projects**
- Accessible Coding Environments:
  - Scratch-like interfaces
  - Visual programming blocks
  - Create interactive water quality games
  - Design educational simulations

	Implementation Strategy for Teachers: 1. Start with simplest technologies 2. Provide scaffolded learning experiences 3. Encourage student exploration 4. Create safe, guided technological environments Potential Challenges: - Technology access variability - Teacher technological comfort levels - Need for professional development - Cost of advanced technologies

Assessments:

#1 - Filter Effectiveness:
Objective: Evaluate the ability of the filter to remove contaminants from the water.
Rubric: Filter Effectiveness

	Initiating	**Developing**	**Excelling**
Description of performance Contaminant Removal	Removes some large particles, but water remains cloudy.	Removes most large particles, water is less cloudy, but some contaminants remain.	Effectively removes most contaminants, water appears clear.
Filtration Rate	Filter is slow, takes a long time to filter water.	Filter has a reasonable filtration rate, but can be improved.	Filter has a fast filtration rate without compromising effectiveness.
Filter Durability	Filter structure is weak and easily damaged.	Filter structure is reasonably sturdy but could be improved.	Filter is strong and durable, able to withstand multiple uses.
Data Collection	Difficulty collecting and recording data.	Collects some data on filter performance but lacks detail.	Accurately collects and records data on filter performance, including comparisons.
Analysis and Reflection	Struggles to explain filter performance.	Provides basic explanation of filter performance based on observations.	Offers detailed analysis of filter performance, considering factors affecting results.

Sample student response	Initiating	Developing	Excelling
Contaminant Removal	My filter didn't really work. The water was still really dirty after going through it.	My filter made the water a little clearer, but there's still some stuff floating around.	My filter did a great job! The water came out really clear. I couldn't see any particles at all.
Filtration Rate	It took forever for the water to go through my filter.	My filter was okay, it didn't take too long, but it could be faster.	My filter was super fast! The water went through really quickly.
Filter Durability	My filter fell apart when I tried to pour the water.	My filter held up okay, but it got a little messy.	My filter was really strong and didn't break at all.
Data Collection	Difficulty collecting and recording data.	Collects some data on filter performance but lacks detail.	Accurately collects and records data on filter performance, including comparisons.
Analysis and Reflection	Struggles to explain filter performance.	Provides basic explanation of filter performance based on observations.	Offers detailed analysis of filter performance, considering factors affecting results.

#2 - Material Selection
Objective: Assess students' understanding of the properties of different materials and their suitability for water filtration.
Rubric: Material Selection

	Initiating	Developing	Excelling
Description of performance Material Knowledge	Demonstrates limited knowledge of material properties (e.g., size, porosity, absorbency).	Shows basic understanding of some material properties relevant to filtration.	Demonstrates in-depth knowledge of material properties and their impact on filtration.
Material Selection	Makes random choices of materials without considering	Selects some materials based on general knowledge,	Selects materials based on a clear understanding of

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	their properties.	but choices may not be optimal.	their properties and how they contribute to filtration.
Explanation of Choices	Unable to explain reasons for material selection.	Provides basic explanations for material choices, but lacks depth.	Clearly articulates the rationale for material selection, citing specific properties.
Experimentation	Does not modify material choices based on results.	Makes minor adjustments to material choices based on initial results.	Actively experiments with different materials and iteratively improves filter design.
Sample student response	**Initiating**	**Developing**	**Excelling**
Material Knowledge	"I don't know much about the stuff we used."	"I know sand is good for filtering, but I'm not sure about the others."	"I know that sand catches big stuff, gravel lets water through, and charcoal helps with smells."
Material Selection	"We just used what the teacher gave us."	"We used sand and gravel because they looked like they would work."	"We chose sand, gravel, and charcoal because sand catches big stuff, gravel lets water flow, and charcoal cleans the water."
Explanation of Choices	"I don't know why we used these things."	"We thought sand would stop the dirt."	"We used sand to catch big stuff, gravel to let water through quickly, and charcoal to clean the water."
Experimentation	"We didn't change anything."	"We added more sand when the water was still dirty."	"We tried different combinations of materials to see what worked best."

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