Future of Work Initiative

The Chemistry of Clean Water—Turning Low-Cost Materials into Lifesaving Science

Global STEAM & Leadership Challenges – Case Study

> *"When a child watches murky, contaminated water transform into clear water through a tool they built with their own hands, science stops being a distant concept on a chalkboard. It becomes an active tool for survival, health, and community empowerment"*
>
> —**Damilola Salawu**, STEAM educator and Teach for Nigeria fellow

A Community Transforms Adversity into Innovation

As a Teach for Nigeria Fellow working alongside a resilient cohort of young student innovators at Orile Imo High School in Lagos, I am constantly reminded that necessity is the mother of invention. Located in a peri-urban community where infrastructure often lags behind population growth-access to safe, potable drinking water is a tangible, daily challenge that deeply impacts community health, school attendance, and general well-being. Our school serves as a vibrant hub of curiosity amidst systemic resource gaps. It is within this setting that we launched our environmental science initiative, connecting classroom chemistry directly to the lifeblood of our neighborhood.

We did not start with a manual. Instead, our students began by interviewing local elders about traditional water settling methods and auditing their own households for reusable items. Through a collaborative classroom mapping session, the students themselves proposed utilizing crushed domestic charcoal—noting its common use in odor reduction—and paired it with stones and cotton wool salvaged from their school compound to co-design our primary filtration prototype.

The Engineering & Design Challenge

Unfiltered surface or well water frequently carries a complex profile of contaminants that make it hazardous for consumption:

- Suspended Solids: Coarse sand, clay, soil particles, and organic debris that cloud water and block light penetration.
- Volatile Organic Compounds: Dissolved matter causing deep discoloration and pungent, unpleasant odors.

- Microbial Pathogens: Invisible bacteria, viruses, and parasites that present severe biological health risks.

Students were tasked with an immediate engineering objective: to build a low-cost, classroom-proof-of-concept. Their goal was to design, assemble, and evaluate a multi-stage, layered filtration column capable of maximizing water clarity and eliminating odor using only salvaged materials, proving that complex chemical separations can be modeled without expensive lab gear.

The path to a clean sample was not without hurdles. During our initial trials, the students faced a frustrating setback: fine charcoal dust kept bypassing the barrier, turning the filtered water a murky gray. Rather than abandoning the design, the student teams engaged in an iterative engineering loop. They systematically adjusted the packing density of the bottom cotton wool layer and introduced a secondary fine-sand interlayer, successfully trapping the dust and maximizing final clarity.

Materials & System Architecture

The experiment relies entirely on accessible, zero-cost components, proving that high-level scientific experimentation does not require expensive laboratory infrastructure. The Materials Matrix:

- **The Column Housing:** To keep our proof-of-concept entirely accessible, we utilized a transparent plastic beverage bottle sectioned horizontally. The top inverted half acts as the gravitational filtration funnel, providing a clear visual window into the physical screening process, while the bottom half serves as the volumetric collection vessel.
- **Stage 1- Primary Matrix (Top Layer):** Small stones and smooth pebbles. This layer forms a coarse physical screen designed to mechanically trap large particulate matter, leaves, and heavy sediment.
- **Stage 2 - Chemical Interlayer (Middle Layer):** Crushed domestic charcoal. This serves as the chemical engine of the filter, utilizing its vast micro-porous surface area for **adsorption**—a process where contaminant molecules stick to the charcoal surface, removing color, organic odors, and certain dissolved toxins.
- **Stage 3- Polishing Matrix (Bottom Layer):** Dense cotton wool. Acting as an ultra-fine physical barrier, it retains minuscule suspended fragments and prevents charcoal dust from washing into the clean sample.

Investigative Procedure & Observations

Students active in the lab carefully constructed their design columns, paying close attention to the density and order of the filtration media. A heavily contaminated control sample—purposely mixed with dark topsoil, particulate debris, and decaying leaves—was slowly introduced through the top of the gravitational column.

The experiment yielded multi-dimensional transformations across the student cohort, shifting perspectives from passive consumption to active scientific inquiry:

- **Mastery of the Engineering Cycle:** Students moved beyond rigid, step-by-step recipe instructions. They learned to analyze constraints, observe material interactions, identify the limits of their designs, and recommend secondary optimizations—such as adding fine sand layers to increase mechanical efficiency.
- **Public Health Literacy:** The lesson drew a crucial line between *clarified* water (visually clean) and *purified* water (biologically safe). Students became vital community advocates, explicitly teaching their households that mechanical filtration must always be paired with boiling or disinfection (such as chlorination) to guarantee safety.

- **Scalable Visionary Thinking:** The classroom success sparked ideas for future development, inspiring students to think about how to scale up these individual prototypes into larger, community-wide sand-and-charcoal filtration units for rural neighborhoods lacking treated public water.

Reflection & Call to Action: From a Drop of Water to a Wave of Change

The water filtration column built by the students at Orile Imo High School is far more than a simple assembly of stones, charcoal, and cotton wool. It stands as a profound metaphor for equity-driven STEM education. In communities where systemic resource gaps exist, true education cannot afford to be passive or purely theoretical. When we present science not as a series of facts to memorize for an exam, but as a practical tool to dismantle real-world hardships, we shift the entire paradigm of the classroom.

The challenge of clean water access is global, but the spirit of innovation is entirely local. As educators, leaders, and students, the responsibility falls on us to bridge the gap between classroom theory and community survival:

- **For the Educator:** Look around your immediate community. What local challenge—whether it is water quality, waste management, or energy scarcity—can you transform into a low-cost, hands-on engineering design loop for your students? Challenge yourself to lower the physical barriers to science by utilizing everyday resources.
- **For the Student Innovator:** Never underestimate the power of an idea engineered from simple materials. Optimization begins with a single prototype. How can you take the principles of filtration and adsorption explored here and iterate upon them to create safer, scalable clean water systems for your own household or neighborhood?
- **For the Global Community:** True educational equity means ensuring that every student, regardless of geographic or financial constraints, has the opportunity to think critically, experiment boldly, and lead change. Let us share these open-source blueprints, support resourceful classrooms, and invest in place-based STEM pedagogy.

Our classroom at Orile Imo reminds us that we do not need expensive equipment to cultivate brilliant scientific minds. We only need the courage to look at a local crisis, see the value in what others cast aside as rubble or waste, and begin building.

For **more information** about the **Future of Work initiative**, visit the official website.
Join the **Global STEAM Community** through this link.
