

Final Project Report: “Water Treatment and Microbiology”

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The goal of this project is to introduce kids at a young age about environmental engineering, water quality, water treatment, and microbiology. This educational module has three components: 1. Raise inquiry about how kids get clean tap water. 2. Let kids develop understanding about how engineers clean water by performing coagulation, flocculation, settling, and water filtration, 3. Have kids discover microbes using microscopy.

The educational outcomes are age-dependent. For kids 5-7 years old, these outcomes are: (1) Describe very generally that water is cleaned by steps that first settle dirt out, and then poured through a filter that lets clean water come through, (2) Show awareness that bacteria are super tiny living things that live everywhere, some of which make us sick which is why we want them out of our drinking water, but most of which are perfectly fine, (3) Recall that environmental engineers do things to keep people healthy like clean water so it doesn't make us sick. For 8-10 year olds, these outcomes are more detailed: (1) Describe with some detail that a chemical is used that helps dirt stick together with mixing, and these clumps become heavy enough to fall out of solution, (2) Demonstrate that success in filtering water is design-dependent, (3) Identify broad relationships between human impacts on the environment and water quality in everyday life, (4) Describe bacteria under a microscope (i.e. distribution on particles or clumps, and differences in morphology), (5) Recall that environmental engineers identify solutions for environmental problems, including cleaning water in step-by-step processes to become drinkable.



Figure 1. The 5-year-old group discusses what filtration materials they want to try out next.

The funds from the AEESP Foundation grant were used for the procurement of microscopes and activity materials (small buckets, stir rods, alum, and various filtration materials to clean water from coagulation through filtration). This outreach activity was initially carried

out in the Stillwater (OK) YMCA summer camp program, during the “Wacky Water” themed week. This program contained 70 children ranging from kindergarten to fifth grade who participated in the project. The YMCA summer camp program contains a broad cross-section of the community, with approximately 30% of children from underrepresented STEM minorities, and approximately 30-40% on state or tribal assistance programs.

After a brief introduction and with the help of YMCA counselors and graduate student from the PI’s lab, the elementary age students in small groups performed the processes of alum coagulation, flocculation and sedimentation (after given a scoop of alum in water, students stirred for 5 minutes, saw the floc particles form, and then let them settle). Once they had settled water, the students built their own filtration units using their choice of sand, wood chips, cotton balls, and coffee filters, and then proceeded to filter their water. Each table built at least two filtration units, and were encouraged to experiment with different designs and materials.

Students were quite impressed at how well these simple steps cleaned what was very dirty pond water. The visual confirmations of seeing floc particles settle out sparked further curiosity about what was happening – and students learned that a little bit ‘chemistry’ and a little bit of ‘physics’ are needed to clean dirt out of water. With filtration, student groups at the same table chose different materials, and most found that the type of filter built mattered. The younger groups, who were initially disappointed when their first filters did not work all too well, decided to take their water and try out new filters with better success. The older students, in the meantime, decided to build very carefully thought out, multi-layered filters that performed very well on the first try.

After treating water, student groups took turns to explore the source water (among other objects of curiosity) under the microscope. The students were very curious about the different magnification levels and what they were seeing. Most were successful at finding tiny microbes wiggling around in the water amongst giant grains of dirt and debris in the source water. The youngest group of kids took to drawing and coloring



Figure 2. PI Mark Krzmarzick discussing the results, while the 10-year-olds wait in turn to view a sample in a microscope.



Figure 3. The 5-6 year olds decide to draw and color images to reflect on what they see under the microscope.

what they saw. The older kids (7-10 years old) were very interested in seeing other things under the microscope – water from the drinking fountain (to quote one kid: “there’s nothing!, oh, I supposed that’s good, we don’t want bacteria and dirt in our drinking water”), water from a puddle outside, the detailed structure of filter paper, etc. The older students also raised many questions about how this works in the ‘real world’ at a water treatment plant, where else are microbes living, and many other questions about water, diseases, chlorination and science.

All age groups expressed high levels of engagement and inquiry for this activity. This module will next be incorporated into classrooms at local elementary schools with more in depth age-appropriate curriculum development, and will be used again at the YMCA summer camp program during the next few years. In these later installments, formalized assessments will be used to evaluate retention, as groups of students in these later outreach groups will contain a mix of students both with and without previous exposure to the activity. This module will expand such that over time, local elementary school teachers become trained to independently provide this activity and curriculum in their classrooms, thus expanding its reach year after year.