A SPLASH! A Boxerwood Lesson Sampler

Background: Boxerwood created these four modules to strengthen science interest and skills in a small group of middle school students. The focus was creating and implementing placed-based investigations related to the watershed, as assisted by local STEM experts (guest scientists in the field). Per plan, each week students took more ownership of the investigations, moving from Boxerwood-provided questions to those we co-created with them. Each week we followed the same method (question-prediction-plan-gather evidence-conclusion-share) using different topics. We emphasized development of comparative questions as these provide data for definitive conclusions. This was the same approach we took each day during the 4-days of our elementary summer camp to great effect. With each iteration of this inquiry process, we definitely noted an increase in student facility in posing and pursuing testable, investigative questions—as well as increase in student engagement.

Boxerwood SPLASH! MRMS Afterschool Module 1

Date(s)	Friday, March 31, 2017 (3:30 – 5:40 p.m.) field Thursday, April 6, 2017 (4:40 – 5:40 p.m.) at MRMS
MWEE Topic	Impact of land use on water quality
Investigative Questions	How does water quality of Woods Creek **change** as the stream runs through town (as measured by conductivity)? (Boxerwood designed question)
Guest Expert	Dr. Paul Low, chemical geologist, Washington & Lee Univ.
STEM Skills	• Designing an investigation using scientific method • Using hand-held probeware (conductivity) for data-gathering • Mapping
Learning Goals	Concepts • What happens on land impacts water quality • Conductivity measures dissolved solids, a proxy for pollution • Scientists (such as ourselves) follow a method for answering questions • What is a watershed; Our MRMS watershed address Experiences • Working as a scientific team (nature of science) • Field: Visiting many sites along Woods Creek • Learning how to use probeware • Connecting with a professional scientist •
Materials	Conductivity probeware, aerial map of Lexington/Woods Creek, 10 – 12 sample bottles, use of computer lab
Activities	Session 1: Plan & Carry Out Investigation Students prepare for their investigation (review map, concept of watershed, meet question, make prediction, create plan for gathering data in the field), then ride bus to sample sites for data-collection. Upon return they test conductivity levels in samples.

	Session 2: Analyze Data, Act (Map) Students meet Dr. Low, learn about his own conductivity research for Woods Creek and analyze/discuss their results with him.
Outcomes	Session 1: Students were interested in the large map and in the questions. Of the sampling sites proposed, they decided to visit all of them. We rode the bus to the 7 sites and kids worked in groups of 2-3 to gather their samples. I had to get the last sample as we ran out of time. It was a nice afternoon and students and their 2 staff enjoyed being out and exploring the various sites. Back at school, students tested each sample with their conductivity probes, writing the results on post-it notes. We did not have time to share. Session 2: I returned with the giant map and site-specific post-it results. Students placed the post-it notes on the map specific to their location. We noticed patterns: conductivity scores rose as the stream flowed through town. Dr. Low helped students think about why that was. We then went to the computer lab where Dr. Low showed them a 3-D digital map of Woods Creek watershed he had created; students shared their scores with him to create a 3-D profile of their findings. Students were a bit shy with Dr. Low but actively participated in this mapping activity and liked seeing their results. (Dr. Low has now made this link available to the school science team for future use). This unit worked well. It would have been ideal to have more time to map/discuss with Dr. Low but we only had 45 min.

Boxerwood SPLASH! MRMS Afterschool Module 2

Date(s)	Thursday, April 20 (3:30 – 5:40 p.m.)
MWEE Topic	Impact of land use on water quality
Investigative Questions	Is the water in the parking lot puddles healthier than the water in the MRMS drinking fountain? (jointly designed question with students and Boxerwood)
Guest Expert	N/A
STEM Skills	• Designing an investigation using scientific method • Following protols for abiotic testing for N, P, pH, plus conductivity
Learning Goals	Concepts • Scientists use many parameters to test water quality, not just conductivity. • Scientists (such as ourselves) follow a method for answering questions Experiences • Working as a scientific team (nature of science) • Using test-tubes and following writing directions
Materials	Conductivity probeware, Plastic test-tubes, sampling cups, basters, and test kits for N, P, pH, etc., dry erase board/markers, paper/pencil/clipboards for recording results
Activities	Students divided into two teams of 3 each. They agreed they wanted to compare water quality of puddles in the parking lot to that in the water coolers at MRMS. They went outside, gathered the parking lot samples, and tested the samples. They then went inside and did the same for the water coolers. At the end of class, they shared their results on a white board to answer their question.
Outcomes	Students enjoyed doing the sampling. Using the given metrics, they determined the puddle water was actually "healthier" than the cooler water. Students built on previous knowledge about conductivity from last week and theorized its lower conductivity was because it had just rained and the rainwater had not yet had time to pick up dissolved solids in the parking lot. We noted however we hadn't tested for pathogens/bacteria and thus the safer water for drinking was the treated water. Students are intrigued about the health of their own school water; we could have tested different coolers, different sections of the school, or used drinking water tests (which we didn't have) instead of stream water tests.

Boxerwood SPLASH! MRMS Afterschool Module 3

Date(s)	Friday, April 28 (3:30 – 5:40 p.m.) at Boxerwood (field) Thursday, May 4 (4:40 – 5:40 p.m.) at MRMS
MWEE Topic	Aquatic Habitats (Wetlands)
Investigative Questions	Will we find more species of amphibians in the Boxerwood stream, wetland, or woods? (jointly designed question with students and Dr. Marsh)
Guest Expert	Dr. David Marsh, biologist, Washington & Lee Univ.
STEM Skills	• Designing an investigation using scientific method
Learning Goals	Concepts • Aquatic environments provide habitats for many forms of wildlife, including those who depend on water for part of their life cycle • Scientists (such as ourselves) follow a method for answering questions Experiences • Working as a scientific team (nature of science) • Field: Exploring varied habitats at Boxerwood Nature Center • Learning how to find and safely handle amphibians • Connecting with a professional scientist •
Materials	Session 1: Small hand-nets, plastic bags, clipboards & paper/pencil, timer, camera Session 2: MRMS Chromebooks & VoiceThread link
Activities	Session 1: Plan & Carry Out Investigation Students rode a bus to nearby Boxerwood Nature Center and met Dr. Marsh. He shared some information with the students about his research work with salamanders and we reviewed photos of types of frogs found at Boxerwood. We then all worked together to devise a comparative investigative question (see above). Students made their predictions and broke into 3 small groups. They decided each group was responsible for data at one site, but that all would help search for amphibian at those sites after a hunt of 10 min. Dr. Marsh reviewed methods for safe capture and handling (then release). Students followed their plan and visited 3 sites, recording their data. Dr. Marsh also helped them identify different species. Session 2: We introduced students to a new tech-tool on their school-issued Chromebooks: VoiceThread. Students were able to click a link to a VoiceThread we had created that showed 12 photos of the investigation, accompanied by embedded audio/typed questions posed by Ms. Sheffield. We taught students how to reply to these questions by type, audio, or video within the VoiceThread site, thereby creating a publicly viewable group collage of reflections.
Outcomes	Session 1: Students enjoyed adventuring with Dr. Marsh, loosing their shyness as the very hands-on hunt for amphibians proceeded. They had several occasions to remember they

	were following an agreed upon plan, following procedures, recording data, etc., all re-inforced by the engaging and well-named Dr. Marsh. <u>Session 2</u>: There was more multi-day delay in our schedule than we would have preferred for processing the results of the investigation and introducing the students to the VoiceThread technology. Doing the latter took longer than anticipated, but once students were "in" and understood the technology, they were intrigued. They went off topic as they explored the audio & video aspects, but to be expected exploring a new technology. We would have liked to have had more time in this session, and to have built more opportunity for Voice Thread into the SPLASH! spring program.

Boxerwood SPLASH! MRMS Afterschool Module 4

Date(s)	Thursday, May 11 (4:40 – 5:40 p.m.) at MRMS Thursday, May 18 (4:40 – 5:40 p.m.) at MRMS Friday, May 19 (3:30 – 5:40 p.m.) MRMS then field
MWEE Topic	Impact of land use on water quality
Investigative Questions	Will e-coli levels be greater in the upper or lower region of the urban part of Woods Creek? (Student-designed question)
Guest Expert	Mr. Jim Kvach, retired microbiologist
STEM Skills	• • Designing an investigation using scientific method • Following protocols for e-coli testing
Learning Goals	Concepts • What happens on land impacts water quality • Scientists (such as ourselves) follow a method for answering questions • E-coli is an illness-causing bacteria potentially present in water from animal or human inputs, especially cows in streams. • The state has identified Woods Creek an impaired stream due to unacceptably high e-coli levels from time to time. Experiences • Working as a scientific team (nature of science) • Learning how to prepare water samples for bacterial sampling • Connecting with a professional scientist
Materials	Sterile water samples from multiple sites along Woods Creek, 9 easy-gel coliscan test kits, bleach wipes, sharpies, incubator, camera, large map of Woods Creek, coli-scan data table, camera.
Activities	Session 1: As weather problems prevented students from gathering their samples the week prior, I brought 9 samples from Woods Creek sites to their school. They met Mr. Kvach and learned a little bit about his work and research interests. We reviewed basic concepts about e-coli and bacterial testing. Students then placed the water samples on the map, along with photos of the sites, and then worked together to develop a comparative question about Woods Creek, and discussed their predictions. Mr. Kvach then helped us follow sterile protocols for labeling then preparing the petri dishes with the medium. We placed 9 petri dishes in the portable incubator, which I took back to Boxerwood. I took photos of each petri dish after 36 hours, so we could share visual results with the students the following session. Session 2: I provided photos of the 9 petri dishes to the students as well as a color guide for distinguishing colonies of e-coli from other benign bacteria. Students devised a

	common method for counting the colonies and worked in teams to do so. They wrote the raw scores on a classroom whiteboard on which I had drawn a simple map of the creek, its tributaries, and its sample sites. We then used calculators to convert the raw scores to standard metric of CFUs (colony forming units). Students determined several sample sites exceeded safe e-coli limits. Given several options for the last student-action day, they decided they wanted to share these results with the City of Lexington officials. Session 3: I created a data table for the CFU scores for each site; students used calculators to calculate CFUs for each of the raw scores generated by their count. We then circled the sites whose CFU's exceeded state water quality standards (4 of 9) in preparation for visiting City engineers. We also briefly reviewed their original comparative question and looked at the data to see whether the evidence supported their conclusion or not and why that might have been the case. We then drove to the City offices, met by appointment with two city engineers, and students shared with the engineers what they had done and what they had found, showing photos and the data table. Session ended by driving to the nearby river where the Creek enters, and completing some reflection activities. (e.g. Find a stick, write a wish for the water and a wish for yourself on the stick, fling it into the flow on the way to the Chesapeake Bay).
Outcomes	Session 3: This was the last day of the afterschool program for the year and only two of the remaining girls were able to come, but both had dressed up for the meeting with City officials. They were shy, but ably explained their study, their results, and their recommendations. Both parties suspect the pollution is coming from cow fields just outside City limits. The City officials genuinely appreciated their input related to their own concerns and actions related to the Creek and discussed with the afterschool director possibility of continued work together.