Engaging Youth in NGSS Science and Engineering Practices in Water Science Summer Camps (153-1)

Clare Bunton, Jovaughn Carver, Kathy Garneau, Keelin A. Markou, Diamond Norlien, Cora Paul, Brianna Salome, Heather Petcovic, Lauri E. Mackelburg-Davis, Valerie Long, Paul Vellom, Kevin Koch

Project Purpose

The *Pathways to Science Teaching* Program provided undergraduate science and preservice educators with authentic research and hands-on science focused teaching experiences. In the first 5 weeks of the 10-week summer program, preservice educators conducted research on water quality in Kalamazoo River tributaries, Kalamazoo County, Michigan. The final 5 weeks were focused on preparing lesson plans and educating 3rd-9th grade summer campers about water quality utilizing research the group conducted. Lesson plans used a "5E" design (Bybee et al., 2006), were based on NGSS performance expectations with an emphasis on science and engineering practices (NGSS Lead States, 2013), and highlighted careers in earth and environmental science.

Project Context

Preservice educators designed and led three summer camps on water quality over two weeks in summer 2021.

What's In Your Water?
Week 1, 9am-12pm
Day 1: Exploration of freshwater
Day 2: Human impact on watersheds
Day 3: Use of macroinvertebrates to determine water quality
Day 4: Water filtration
Day 5: Presenting week challenge results

Water In, Water Out
Week 1, 1pm-4pm
Day 1: Water availability and the water cycle
Day 2: Erosion through stream tables
Day 3: Aquifers and Drainage
Day 4: Filtration and Human Impact
Day 5: Revisiting day 1 findings with new context

WIRE
Week 2, 9am-12pm
Activity 1: Water Quality
Activity 2: Erosion Management
Activity 3: Watersheds and human impacts
Activity 4: Aquifers and Groundwater
Activity 5: Macroinvertebrate exploration

Project Outcomes

Throughout the two weeks of camps, there was visible growth in the preservice educators' abilities to connect with the campers, along with gaining a better understanding of how to keep the campers involved and curious. During the water quality research, the preservice educators gained first-hand experience in scientific practices such as thinking critically, developing questions from phenomena that they observed, and determining how to carry out large scale research. They were successful in translating these experiences to NGSS science and engineering practices in the summer camps. Lesson plans focused on six practices, including utilizing models, analyzing and interpreting data, engaging in argument from evidence, constructing explanations, scientific communication, and planning and carrying out investigations. By the end of each week, the campers left excited to learn more about water and had a newfound appreciation for our freshwater resources.

Developing and Using Models

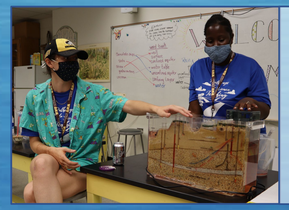

Figure 1. Campers were introduced to a variety of models, including a groundwater model, and were asked to gather and use evidence to create their own models to help explain water quality features and processes. Students used models to create predictions and support their arguments, demonstrating the ability to explain their understanding of the phenomenon.

Figure 2. Campers created a model of a topographic map by crinkling paper to simulate elevation. After color coding mountain peaks, slopes, and rivers with washable markers, water was added to the model. As the water ran down the slopes of the mountains, campers used the models to explain how erosion occurred throughout watersheds.

Figure 3. Campers created models out of available resources. Using the evidence they gathered, students had the opportunity to modify or change their model. In the "edible aquifer" model, for example, campers were able to show their understanding of the relationships among variables that contribute to the natural or designed system of observable or unobservable scales.

Figure 4. Campers played a game that modeled human impact on a watershed. Each camper represented a drop of rain in the watershed. As they progressed, they drew activity cards describing various scenarios which had students either add or remove pollution beads. When they finished, students could use the game model to explain how each activity contributed to the pollution of their watershed.

Analyzing and Interpreting Data

Figures 5 & 6. Campers sorted and tallied macroinvertebrate species from local creeks by pollution tolerance. Campers then constructed a group chart. They analyzed their findings to determine which creek had the cleanest water.

Engaging in Argument from Evidence

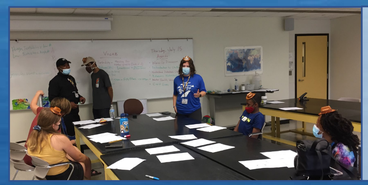

Figure 7. Campers tested water samples for parameters such as pH, turbidity, nitrates, and temperature. They used these data plus additional quantitative and qualitative evidence to engage in a discussion, ultimately reaching agreement about which watershed that each water sample came from.

Constructing Explanations and Designing Solutions

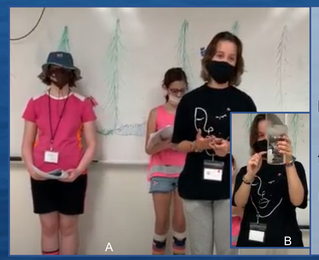

Figure 8. Campers created dirty water, then brainstormed ways to filter out the contaminants using natural resources. Campers were challenged to apply their scientific ideas, principles, and evidence to construct a diagram of a filtration system portraying how their ideas would be effective. Once students created and tested the efficiency of their filters, they attempted to optimize the performance of their filters by making revisions before retesting their filters. **8.A**. Campers share their findings. **8.B.** Campers demonstrate their filtration systems.

Obtaining, Evaluating, and Communicating Information

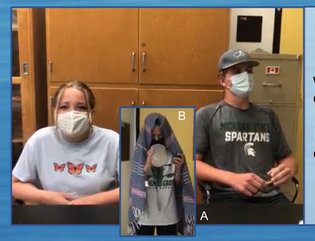

Figure 9. Campers gathered and recorded information about where to find local clean water sources, how to determine whether water is clean, and how to filter water. They obtained new information each day while at camp. **9.A**. Campers then evaluated which information was the most essential for their camp challenge. **9.B.** Campers constructed a creative and informative video to relay to friends and family how they would locate, identify, and clean drinkable water.

Planning and Carrying Out Investigations

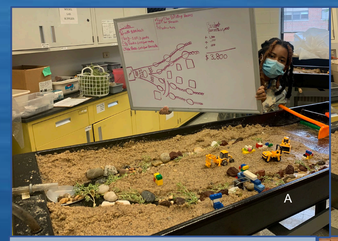

Figure 10. Campers observed how sand was eroded by moving water using a stream table model. They then worked as "erosion management planners." They planned, carried out, and improved an erosion management strategy that would protect LEGO waterfront property against the eroding force of the pre-carved stream. **10.A & 10.B.** Campers show their erosion management plans. **10.C.** Campers work from their previously drawn plan to build, test, and revise their structures.

We wish to thank and acknowledge the following people and organizations for their contributions to the program: Lewis Walker Institute for Race and Ethnic Relations (WIRE), WMU Academically Talented Youth Program (ATYP), Mallinson Institute for Science Education, and the Biological Sciences Department.

This work is supported by the National Science Foundation under Grant No. GEO-1701007. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.