International Journal of the Whole Child
2024, VOL. 9, NO. 2

Science, Technology, Engineering, Art, and Mathematics: STEAM Creek Play: A Gateway to STEM and Citizen Science

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I grew up in the hills of Northwest Arkansas during a time when children were expected to play outside from sunup to sundown. I was lucky enough to live on the top of one of the rolling Ozark Mountains. My backyard was both steep and endless. At the bottom of the mountains were a series of forest creeks fed by free-flowing cataracts after a good rain. These valley brooks were a fertile playground for my older brother, my younger sister, and me. We imagined forest homes on the moss-covered outcrops. We spent hours hiding from the summer sun wading, flipping rocks, catching crawdads, and constructing our knowledge of the creatures that called these seasonal waterways home.

Figure 1. Just below the rocks smoothed by years in the river one can find an entire world of creatures that spend most of their lives tucked away in the crevices at the bottom of a creek bed. The Buffalo National River at Steel Creek Campground, Ponca, Arkansas.

These informal explorations laid the foundation for my love of science and the outdoors and continue to inform my commitment to water education for both children and adults. Creek play is a natural way to hone science process skills, to model or integrate STEAM practices, and to initiate children and adults into citizen science.

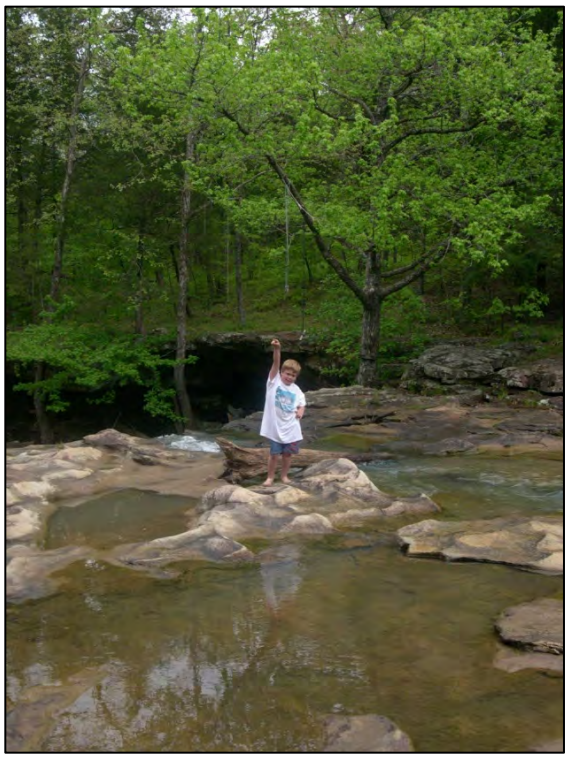

Figure 2. Five-year-old Orion looks for macroinvertebrates in the pools left during low water season at Falling Water Falls, Sand Gap, Arkansas.

Science process skills can be defined as a set of skills that can be transferred to many different science disciplines and that reflect how scientists engage in their disciplines. These skills are used by scientists regardless of their area and can be used by students both in and out of the classroom. Table 1 lists both basic and integrated process skills. Children of any age can practice their process skills while tromping through the waters of a nearby creek. Students can observe the changing seasons. They can sort a variety of artifacts found while exploring. These may include living and nonliving items to the classification of rocks or aquatic macroinvertebrates. My son, Orion, and I love sorting freshwater snails. Gilled snails open to the right while lunged snails open to the left. We were always delighted when we found gilled snails as they require well oxygenated water and indicate a much cleaner stream. Children can count the number of different creatures found from crane flies and dragonflies to water striders and water boatmen. We can make predictions about rainfall and water levels as well as inferences based on our previous visits to the creek. Encourage both children and adults to create models by making diagrams of the creatures they find, maps of the rivers and creeks they explore, or drawings of the artifacts they discovered. Keeping a nature journal is a great way to include modeling and communicating as well as collecting and interpreting data.

Table 1
Process Skills

Basic	Integrated
Observing	Making Models
Classifying	Defining Operationally
Measuring	Collecting Data
Inferring	Interpreting Data
Predicting	Identifying & Controlling Variables
Communicating	Formulating Hypotheses
Using Number Relationships	Experimenting

Source: The American Association for the Advancement of Science

STEAM education refers to the teaching and learning of multiple disciplines in an integrated fashion. These disciplines include science, technology, engineering, and mathematics. A common misconception regarding STEAM is that all five disciplines must be present and in equal amounts. Another misconception regarding STEAM education is that technology must be something fancy, rare, sophisticated, or expensive. Technology can be defined as the "application of scientific knowledge for practical purposes" (Britannica.com) or the equipment or tools used by scientists in their various fields. When investigating a stream, we may use items like hand lenses or magnifying glasses, bug viewers, and kick nets. If we wish to take it further and collect data on water chemistry we may include items like thermometers, dissolved oxygen tablets and vials, Ph strips, and Secchi disks. Some of these items may sound fantastical but are often available locally. Secchi disks are a circle divided into quarters with alternating black and white sections. This can be printed and laminated and allows us to estimate the turbidity of the water.

Figure 3. A juvenile smooth softshell turtle found at the confluence of Town and Lytle Creeks in the heart of Murfreesboro, TN.

Citizen science is known by many names. It has been referred to as crowdsourcing or community science and even participatory science. It is quite simply, when the public participates voluntarily in the scientific process by collecting and analyzing data for scientific projects. Citizen science projects regarding freshwater and water monitoring have become increasingly popular across the globe. National Parks, environmental agencies, and state and local agencies have been relying on volunteers for data collection, data analysis, and water health monitoring.

As mentioned earlier, gilled snails indicate a cleaner water source than their lunged cousins who are able to breath by pocketing air in their shells. Aquatic macroinvertebrates can be used as bioindicators of stream health. Learning to identify and report these creatures can help scientists identify streams that are in good health or that may be at risk of being compromised. The Izaak Walton League of America has phenomenal resources for learning which macroinvertebrates are pollution sensitive (gilled snails and caddisflies) to those that are pollution tolerant (lunged snails and tubifex worms). They also have several opportunities to become engaged as citizen scientists.

Citizen science projects can vary from short term to long term projects. Participants can be anyone from individuals and families to classrooms or entire schools. Citizen sciences offers participants hands on, real life, opportunities to engage in science process skills and STEM. The benefits of engaging in citizen science are multifaceted. Benefits to the agencies engaging in research include volunteers to assist, increased data collection, and data analysis and monitoring. A benefit to participants is that we have firsthand experience engaging in the processes of science. Participating in citizen science has shown to increase scientific knowledge, awareness, and stewardship among volunteers. If you are interested in learning more about engaging in citizen science either as an individual, family, or classroom, consider investigating some of the ongoing projects listed in Table 2.

Table 2
Citizen Science Opportunities for Schools & Families

Izaak Walton League Stream Monitoring
https://www.iwla.org/water/stream-monitoring
Help ILW collect data on stream health through simple chemistry checks or through a survey of creek critters.

FreshWater Watch
https://www.freshwaterwatch.org/
Help monitor freshwater resources across the globe!

Project Hero
https://herofortheplanet.org/mnquest/teach/extending-your-quest/
Whether or not you live in Minnesota or are just visiting, there are a dozen different citizen science projects you can help with. From zebra mussel monitoring to lake level and lake ice reporting. You can find a list here!

CitizenScience.Gov
https://www.citizenscience.gov/catalog/#
Here you will find a list of 503 citizen science projects from gardening to stormwater management. With over 200 active projects across the United States, there are plenty to choose from. You can filter by agency (e.g., National Parks, NASA), by field or topic (e.g., Archeology, Biology), or status (e.g., active or complete).

National Phenology Network
https://www.usanpn.org/nn
Discover and document changes in nature near you!

Environmental Protection Agency
https://www.epa.gov/participatory-science/participatory-science-water-projects
Citizen science projects at this site are listed as "participatory science projects". You can find projects related to air and water quality as well as other environmental issues.

Figure 4. Eight-year-old Orion checks his live trap for small fish including darters, shiners, and chubs. The Buffalo National River at Steel Creek Campground, Ponca, Arkansas.

Regardless of whether or not you choose to engage in citizen science or to model science process skills I encourage you to visit a local creek for exploration. Playing in a river or creek can have many benefits to young children. Walking on the uneven gravel of a creek bed promotes stability and balance. Rivers are a cornucopia of sensory opportunities from the slippery, silty mud to the rocks tumbled smooth by the moving water. Children are drawn to water and they are naturally curious and the experiences and conversations they have while investigating a riparian habitat can be foundational to their future endeavors in STEAM.