Leveraging Student Interest and Community Partnerships to Drive Learning in Meaningful Watershed Educational Experiences

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Abstract

This high school project, supported by NOAA Planet Stewards, developed a learning community with shared goals of explaining a phenomenon and finding a solution to a local watershed problem. Students completed community environmental inventories, identified strengths and weaknesses in their community, selected an issue in need of a solution, and then researched and planned a stewardship action project to address the issues identified. Questions that students needed to answer were recorded and investigations were planned to help them design a solution to the problem they identified. We sought out community partnerships to provide learning experiences that helped answer those questions and the deeper questions that also emerged. We sought out cross-curricular and cross-grade partnerships within our school and district to draw the attention and interest of a wider range of students. Students presented their work within the district by creating videos for the morning announcements, presenting at school board meetings, and hosting groups of 5th grade classrooms for a field trip. Additionally, students reached beyond our district by presenting their work at conferences, submitting grant proposals, and entering journalism competitions.

Introduction

Professional learning: In the summer of 2017 I attended several transformative professional learning experiences. The first was the B-WET funded 3-day Great Lakes Watershed Field course where I was introduced to the Earth Force framework to authentically engage students in stewardship action. I also attended the week-long “Learn While Teaching” workshop at Northwestern University where I gained understanding about creating units of instruction that are coherent from the students’ point of view while also thinking deeply about how to make my classes more equitable by creating lessons where ALL students are part of the knowledge building. (National Research Council, 2012) and (Berland et al, 2015). Lastly, I attended another NOAA B-WET Program – “Promoting Healthy Watersheds and Communities by Integrating Ecosystem Science, Transportation Networks, and Stewardship,” hosted by Michigan Natural Features Inventory with support from River Raisin Institute. This heightened my awareness of many invasive species impacting our watershed and how they spread; this workshop also introduced...
me to the Vernal Pool Patrol (https://vernal-pool-patrol-mnfi.hub.arcgis.com/). These combined experiences gave me the content knowledge and pedagogical confidence to apply for funding from NOAA Planet Stewards and to facilitate this authentic, student-led stewardship action project. The Earth Force framework gave clear guidance for how to help students work through this process and come to a consensus on the action project to undertake. The first two steps served as an extended anchoring phenomenon routine (https://www.nextgenstorylines.org/) and ensured the experience met the qualities of a good anchor (Penuel & Bell, 2016).

School: Lee M. Thurston High School is in Redford, MI which is a suburb that borders Detroit. Most students that attend this school live in Redford, and many students live in Detroit and other surrounding areas as well. The socioeconomic makeup of our school is such that 62% of students received free or reduced lunch during the 2018-19 school year.

Student Learning: The Earth Force framework makes space for students to practice thinking about what they need to consider when undergoing any large design project; defining a problem, research existing solutions, working within criteria and constraints, and identifying and reaching out to stakeholders. I used ideas I learned from NGSS Storyline design to ensure students were using the science and engineering practices to uncover important science ideas necessary and developing and using the Cross Cutting Concepts to construct detailed explanations of the phenomena underlying the issues they identified to design an effective solution. Typically, when designing a unit, first choose the performance expectations you want to build toward, then unpack the DCIs (disciplinary core ideas) to understand the ideas that students will need to figure out. Then, think about candidate phenomena that may get students to figure out these ideas (Reiser, 2014 and Reiser et al. 2015). If students are in charge of choosing the phenomenon/problem the instructor needs to be purposeful in determining a way to facilitate learning that provides three dimensional experiences that help students dig deeper and discover new connected ideas. Instead of unpacking the DCIs first, the teacher needs to work backwards from the phenomenon to the ideas necessary to explain the phenomenon or solve a related problem. These ideas inform the performance expectations that are selected to build toward for the unit.

Community Environmental Inventory and Issue Selection to Identify the Problem

The purpose of the anchoring phenomenon routine in the storyline process is to ensure all students have a way to directly engage with the phenomenon or problem, voice their initial ideas publicly, think about related problems or phenomena, and finally record questions they have that will drive their learning throughout the unit. This process brings the class together as a learning community with shared goals of explaining a phenomenon and/or finding a solution to a problem. (Reiser et al., 2017)

Students completed the community environmental inventory by walking around outside the school, on the roof, through the hallways, in classrooms, and in the cafeteria. While there wasn’t yet a specific problem that would lead
to our project development, these inventories helped students begin
to explore all the phenomena related to human activity and connect
these to their own lives. They valued this experience more than I
anticipated. Several students made comments such as “I’ve learned
more in the first two weeks of this class than I have ever learned in
any class for the whole year”, which I attribute to the fact that these
activities made students feel personally connected to this learning.

There were several problems that students identified as they
discussed the data they collected from their inventories: Food
waste in our cafeteria, electricity/energy waste throughout the
building, lack of convenient recycling opportunities for both
plastic and paper, several areas on campus where water pooled, lots
of impervious surfaces that ran directly into the sewer, a human-
made pond that was in disrepair and covered in duckweed and
algae, and a retention pond/drainage ditch that was overrun by
invasive Phragmites. Students presented information about poten-
tial solutions, the impact of the solution, and logistics involved
with project implementation. Once all solutions were presented,
the class discussed the options and came to a consensus on the
project they would adopt.

Students split into groups to research these issues and possible
solutions so they could present their findings to the whole class.
The class worked together to formulate a list of criteria and
constraints that could help them decide which project to choose
and each group agreed to consider and address each of these
criteria and constraints when presenting their group proposals:

Each group presented their ideas to their classmates, and the class
came to a consensus on finding a solution for the Phragmites-infested
retention pond. They noticed it had low biodiversity which did not support pollinators, there were
reports that the dense reeds were providing habitat for undesirable mammals (namely rats), the reeds
were also trapping a lot of trash which was an eyesore, and the water was “dirty”.

Students formulated some goals for this project that went beyond solving the environmental prob-
lems they identified. Several times since the start
of this project, and again during this consensus
discussion, different students brought up the idea
that they couldn’t believe they were not aware of
“any of these issues in their environment” and they
were upset that they were not learning about this
until they were 11th or 12th grade. Another student
responded with “right, but we’re the only people in
this class – the rest of our school probably doesn’t
know about these problems either”. Project goals
allow for coherence from the students’ perspective.
At any point during these learning experiences if
students are asked “Why are you doing that?” they
would be able to answer by listing one of their goals.

![Figure 3. Small groups worked together to do preliminary research on one of the identified issues to present to the class.](Photo Credit: Holly Hereau)

Table 1. Criteria and constraints that the class considered to inform project selection.

<table>
<thead>
<tr>
<th>Criteria and Constraints</th>
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</thead>
<tbody>
<tr>
<td>• REALISTIC will students be able to complete the project given the available resources?</td>
</tr>
<tr>
<td>• PRECEDENT have others tried doing this before, and how well did it work?</td>
</tr>
<tr>
<td>• RELEVANCE how much will the project actually address the problem we identified?</td>
</tr>
<tr>
<td>• SIMPLICITY how easy or difficult will the project be to carry out?</td>
</tr>
<tr>
<td>• IMPACT how likely is it that the project will have a lasting impact?</td>
</tr>
<tr>
<td>• OPPORTION how much opposition will you likely get from other people or organizations?</td>
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</tbody>
</table>

![Figure 4. The project goals were identified and are listed next to the additional personal goals I had for this project.](Image Credit: Holly Hereau)
By the same token, if an observer asked me “Why are they doing that” I would be able to list something from each list (Berland et al, 2015).

**Creating the Driving Questions Board and Listing Ideas for Investigations**

As students added questions to the Driving Questions Board, they realized there was still a lot of information they didn’t know and would need to figure out before forming a plan.

- What do we need to figure out to be able to do this?
- What plants do we want?
- Why do we need a pond there? What does it do? Where would the water go otherwise? What are all these big things that look like drains?
- What made the pond show up? Where is the water coming from? (several teachers told students that the pond is “new” and that area used to be a dry field).
- Retention pond/rain garden design - How big will it have to be? Where are all the areas the water drains from, and how much water enters after rain events? Is there a way to figure out how much water needs to be held there?
- How will we find the information? Are there others in the community we can partner with?
- How will we know if our project works?
- Do we need permission to do this? If so, who do we need to ask? Where do we start?
- How can we involve more people in our project?

Students formed task committees to attempt to answer some of these preliminary questions by investigating:

- Soil type and characteristics
- Native plant selection to ensure staggered and overlapping flowering times to support pollinators
- Equipment budget – determine best vendors for tools and other materials we will need.
- Effective and safe methods for *Phragmites* removal and disposal
- Meeting with the Superintendent for project approval

As students began to dig deeper into these investigations, they discovered they had even more questions. Their research also uncovered some organizations in our community that could help us learn more about our watershed. Partnering with different community groups in our county and state also allowed students to contribute data to different long term monitoring projects. We partnered with Friends of the Rouge (https://therouge.org/rouge-education-project/) and worked with the Rouge Education Project to help learn how to collect physical, chemical, and biological data that indicate the health of streams and rivers. We used this knowledge and skill set

![Figure 5. Students collecting more data on the area overgrown with *Phragmites* to help figure out a solution. Photo Credit: Holly Hereau](image-url)
to collect data along a section of the Rouge River near our school to help with the Friends of the Rouge long-term monitoring project. Then students used what we learned to help decide what data we would need to collect and keep track of in our body of water.

Students also identified the need to visit a wetland that was more similar to our wetland, rather than a river that has quickly flowing water to learn about the differences between still and running water to define target values for our ecosystem. We partnered with the Michigan Natural Features Inventory (https://mnfi.anr.msu.edu/) and folks from Nankin Mills (http://www.nankinmills.org/) to collect data about the health of the vernal pools located there. Students learned about the importance of these wetlands for biodiversity and wondered if our target ecosystem would ever be able to support so many different species. Finally, students worked with Inland Seas Education Association to apply what we learned from monitoring streams and pools to collect data aboard Schoolship on Lake Michigan in Suttons Bay (https://schoolship.org/).

The students studied wetlands and open bodies of water to compare their vastly different size and important characteristics. However, students successfully used patterns in data to figure out that similar phenomena have similar causes in these systems - and that all these systems are connected. Students also wrestled with scale and the kinds of allowances we need to make to account for scale, proportion and quantity when investigating these different bodies of water, especially considering
the differences we noticed in areas way upstream in the Rouge river compared to downstream. Students consistently used NGSS Science and Engineering Practices to uncover Disciplinary Core Ideas and were also developing the ability to use the Cross Cutting Concepts to fully explain the complex interactions that contribute to the problems they noticed. (Schwarz, et al. 2017)

To get more students in our school aware and involved, we reached out to the video productions teacher and co-wrote a grant proposal to support the addition of environmental journalism and reporting to our project. We were awarded the grant from Michigan State's Knight Center for Environmental Journalism (https://knightcenter.jrn.msu.edu/) and began planning ways to draw more students to this project who may not have initially been interested in the science alone. This provided an avenue to create media to share with students and others in our school and beyond. A student wrote a grant proposal and was awarded the prize from kidsgardening.org which allowed us to move forward with the work we planned to include hosting 5th grade students in learning stations and inviting them to join us when we finally installed our plants. Another student won 2nd place in the “hard news” category of the Michigan Association of Broadcasters student awards for a submission about the stewardship action project and how it has a positive impact on student learning, and a group of students presented their work at an Environmental Journalism conference at Michigan State University.

Data Collection and Results

As the project continued into the following year, new students had the same opportunity to complete the community environmental inventory and issue selection process. They also came to a consensus on continuing this project. They worked to develop protocols for data collection and then began to record and collect baseline data. (James Hutton Institute, 2011) Students used the iNaturalist (https://www.inaturalist.org/projects/ths-rain-garden) app to collect information for our project, and also used the Midwest Invasive Species Information (MISIN) app (https://www.misin.msu.edu/) to help identify and report native and invasive species they found in the different areas we investigated. The ArcGIS app (https://www.arcgis.com/features/apps/) enabled students to collect and enter real-time information about the vernal pools we studied into a state database. The information they learned and the data they collected during these experiences helped them understand more about wetlands and our watershed overall and helped contribute data to the body of information researchers use to notice new patterns and identify areas of concern.

Each year, students answered several open-ended survey questions before we started this class and again after the class was completed. For the 2018-19 school year, the survey showed that only 24%
of student answers reflected a positive attitude about Participation in Environmental Stewardship and at the end of the class 53% of student answers reflected a positive attitude about Participation in Environmental Stewardship.

<table>
<thead>
<tr>
<th>Type of Data</th>
<th>Data Collection Method</th>
<th>Results Fall-Spring of 2017-18</th>
<th>Results Fall-Spring of 2018-19</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aquatic Macro-invertebrates</strong></td>
<td>D-nets, hand picking from sampling pans and jars with mud</td>
<td>Abundant: daphnia, mosquito larvae, midges, Ostracods (seed shrimp), Copepods, leeches, unidentified flatworms (Planaria).</td>
<td>Abundant: daphnia, mosquito larvae, midges, Ostracods (seed shrimp), Copepods, leeches, unidentified flatworms (Planaria).</td>
</tr>
<tr>
<td><strong>Terrestrial Invertebrates</strong></td>
<td>Scouting, sweep nets, pitfall traps</td>
<td>Abundant: earthworms, mosquitoes, midges,</td>
<td>Abundant: earthworms, mosquitoes, midges, Rare: ground beetles, Field slugs, yellow-legged Mud-dauber Wasp, Spotted Lady Beetle, Hoverfly, various unidentified ant species, various unidentified spiders, field cricket (Gryllus), Spur throated grasshopper, banded wing grasshopper, Horse Fly, eastern yellowjacket, Sowbugs, unidentified beetle larvae/grubs, Monarch butterfly, cabbage white butterfly, common Whitetail dragonfly, Eastern forktail dragonfly, red admiral</td>
</tr>
<tr>
<td><strong>Protozoa and Algae</strong></td>
<td>Water sample observation using microscopes</td>
<td>Vorticella, amoeba, unidentified ciliates, paramecium (some of these were a result of my students extended study of pond water succession into the winter.)</td>
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</tr>
<tr>
<td><strong>Amphibians, Reptiles, Birds, and Mammals</strong></td>
<td>Direct observation</td>
<td>Red wing blackbirds, European starlings, Canada geese, rabbit, brown rat, field mice</td>
<td>Red wing blackbirds, European starlings, robins, Canada geese, Mallards, kildeer, green frogs, a garter snake, rabbits, brown rat, field mice, deer (reported by early morning custodian) painted turtle (the superintendent told me he “transplanted”). I did not observe the turtle and asked Brian to refrain from any other “rehoming” activities.</td>
</tr>
<tr>
<td><strong>Water quality</strong></td>
<td>Chemical tests and E. coli plates</td>
<td>High nutrient levels, high levels of harmful E. coli, high particulates</td>
<td>High nutrient levels, high levels of harmful E. coli, high particulates (no change)</td>
</tr>
<tr>
<td><strong>Measurements of area of runoff pond is catching</strong></td>
<td>Direct measurement and Google Maps</td>
<td>Roof is 31.25m x 38.5m, Roof often gathering area for Canada Geese, and some even build nests up there</td>
<td>Roof is 31.25 m x 38.5 m, Roof often gathering area for Canada Geese, and some even build nests up there (no change)</td>
</tr>
<tr>
<td><strong>Measurements of Retention area</strong></td>
<td>Direct measurement</td>
<td>North side “dry side” – deepest part ranged from 10-18 cm in fall measurements (dry for much of last spring/summer). South side “pond side” – deepest part ranged from 42-49 cm in fall measurements.</td>
<td>North “dry side”– never dried throughout the entire spring before school ended. Still 25cm deep in the center. Water disappeared over summer for about a week before heavy rains caused it to fill again. Standing water remained still all through the summer and fall. There were no days this year where that side of the “pond” was dry. South “pond side” – Measurements in the spring were as high as 90 cm after the heavy rains caused it to fill again. Standing water remained still all through the summer and fall. There were no days this year where that side of the “pond” was dry.</td>
</tr>
</tbody>
</table>

*Due to the removal of all aquatic emergent species there is less vegetation to absorb water. This is a temporary problem that will hopefully be solved as more natives are re-established. We did anticipate this, but due to the wetter than normal spring water was present all summer and prevented us from planting the species we intended.*
Conclusion: Designing and Facilitating Units of Instruction with a Student-Chosen Phenomenon or Problem

The long-term success of our project will be determined from seasonal biodiversity audits and water quality monitoring results downstream of our site. Our initial inventory revealed very low species diversity, and the *Phragmites* provided habitat for an undesirable population of rats in addition to other invasive plants and animals. As the garden matures, we expect to see an increase in diversity and abundance of bees, butterflies, and other insects as well as amphibians, songbirds, and small mammals. Additionally, students hope to see the restored wetland used by students and members of the community of all ages for learning and enjoyment. The real success however is the level of engagement from students. Using a process that ensures each student’s voice is heard as they participate in the planning and decision-making increases students’ interest in this project and provides them a strong scaffold to broaden their environmental awareness and increase the likelihood to seek out other stewardship experiences.

References


