Water Systems Teacher Fellows Program
Community Curriculum Case Study

Stormwater Solutions

Middle School NGSS - Engineering Community Impact
Grade 6 Science

Problem Statement

What can we do as ICS 6th graders to reduce polluted stormwater runoff?

Teacher Design Team
Julia Vasiliauskas

Grade 6, Integrated Science
International Community School
Lake Washington School District, WA

About the Water Systems Teacher Fellows Program

Teacher Fellows (grades 6-12) are paid a stipend over a 12-month period to develop new or refine existing problem-based curriculum pathways that integrate water supply, wastewater, and stormwater management systems. Fellows integrate classroom rigor with community impact while advocating for district-wide adoption of the methods and resources they develop. Fellows are selected from the Lake Washington, Bellevue, Issaquah, and Tukwila School Districts. The Program is funded by Cascade Water Alliance and facilitated by Sustainability Ambassadors.

Peter Donaldson | Facilitator, Sustainability Ambassadors
206-227-9597, peterdonaldson50@gmail.com
Mike Brent | Water Resources Manager, Cascade Water Alliance
425-453-1810, mbrent@cascadewater.org

About Problem-Based Learning

Problem-based learning (PBL) is experiential learning organized around the investigation and resolution of messy, real-world problems. Teachers coach student thinking and guide student inquiry as a co-investigator. PBL increases student motivation through the pull of problem dissonance, intrinsically inspiring students to take on more and delve deeper as they make a personal investment in the outcome of their inquiry. Coupled with cognitive coaching strategies, PBL calls upon critical and creative thinking by suspending the guessing game of: "What's the answer that the teacher wants me to find?" PBL promotes metacognition and self-regulated learning as students generate strategies for defining problems, gathering information, analyzing data, building and testing hypotheses, comparing strategies with those of other students and mentors, and sharing results with real-world stakeholders. Source: http://bie.org/about/why_pbl

School District Context

The Lake Washington School District (LWSD) promotes student-centered learning in their framework for curriculum and assessment. Key goals of this framework include bridging student needs and interests with real-world applications in their communities and the world. Problem-based learning aptly fits the values that drive LWSD culture including being student-centered, results oriented, learning focused, and community connected. . (Source: http://www.lwsd.org/Parents/Teaching-Curriculum/Pages/Teaching-Framework.aspx)

The International Community School (ICS) is a choice-school within the Lake Washington School District. We have 450 students in 6th through 12th grades, who choose to attend our 7-year program instead of their home schools in Redmond, Kirkland, and Sammamish. The science curriculum is built from the Next Generation Science Standards (NGSS), though our scope and sequence may differ from other regular LWSD middle and high schools

City Context

The Lake Washington School District encompasses Redmond, Kirkland, and Sammamish. According to the National Pollution Discharge Elimination Systems Permit, each city must provide an education and outreach program concerning stormwater problems and solutions. ICS is located in the City of Kirkland, Washington. Source: http://www.ecy.wa.gov/programs/wq/stormwater/index.html

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Classroom Context

I teach 60-75 6th graders in an Integrated Science course each year. This is their first year of science in middle school, and their introduction to all of the disciplines and skills they will develop during their ICS science program.

In the first semester of 6th grade, we focus on Physical Science systems such as matter, energy, and motion. In the second semester we focus on Earth, environmental, and life science systems. Like all cohorts of ICS students, my 6th grade students come from a range of family backgrounds and educational experience, and are at a variety of cognitive and developmental stages at 10-11 years of age.

I teach the Stormwater unit in 3rd quarter, after my students have settled into their new school and learned a variety of learning and collaboration skills. Polluted stormwater runoff is introduced as a relevant local problem in which they can play a part in the solutions.

Project Summary (3 Weeks)

During the Stormwater unit, students are introduced to stormwater as a part of water systems, the problem of polluted stormwater runoff, and the local consequences of this problem. Students are pre-tested to help them recognize what they know and don't know about stormwater systems, and engage in research using local resources to discover and share new knowledge.

Once students understand a range of solutions to polluted stormwater runoff, they choose one solution to implement an impact project. Impact projects require them to make a measureable impact outside of the classroom (on peers, families, or the community), which contributes to solving the problem of polluted stormwater runoff. Through impact projects, student learning outcomes for improving science knowledge and engineering practices directly support city outcomes for reducing the impacts of polluted stormwater runoff.

Through collaboration, planning, implementation, and measurement of impact projects, students learn valuable cross-curricular skills in engineering, research and citation, technology, communication and public speaking, as well as a range of real-world applications of science content.

Community Impact Statements

Evidence that we have measurably contributed to solving the problem.

GOAL: Students understand the problem of polluted stormwater runoff and various contributing solutions, and can apply these solutions to make impactful changes in their own actions, their families practices, or community members practices.			
Original conditions *What were the conditions before we took action?*	**Impact** *How did conditions improve as a result of our action?*	**Recommendation** *What do we think should happen next?*	**Stakeholders** *Who should know about our results and recommendations?*
Zero 6th grade families pledged to fix oil leaks in their cars.	Fifty-seven 6th grade families pledged to check for oil leaks, received information about where to get checked locally, and understand the impact of oil spills on stormwater runoff.	Organize free workshops to teach families how to check for car oil leaks themselves.	Parents Family members
Zero 6th grade families knew that washing cars in driveways contributed to polluted stormwater runoff.	Fifty-three 6th grade families pledged to wash their car at a commercial car wash or on natural permeable surfaces, and 40 received free Brown Bear car wash tickets.	Expand the pledge campaign to include their neighbors or other grade levels' families.	Parents Family members
Unclear if plans for rebuild of Peter Kirk elementary school included cisterns for rainwater collection.	Students proposed design plans for the rebuild to the LWSD Director of Support Services.	Get students on the planning committee for new construction in the district.	District administration School administration Cascade Water Alliance
1-5% of Community elementary school 3-5th grade students knew about cisterns, rain gardens, and bioswales.	100% of 3-5th graders know what these stormwater solutions are and their importance to help prevent polluted stormwater runoff.	Expand teaching of stormwater solutions to more elementary students; provide teachers with resources to include in curriculum.	Elementary school students and teachers
Zero Kirkland City buildings nor LWSD school buildings have Green Roofs.	Students presented Green Roof design proposal to ICS principal and Kirkland City Council.	Present Green Roof designs to LWSD district; get students on the planning committee for new construction; Follow-up with city officials.	ICS administration Kirkland City Council
ICS did not include composting as part of waste management	Year 1: Students assisted the ICS Green Team to implement composting at	Continue modeling waste management practices and	ICS students (grades 6-12) ICS teachers & staff

at school.	school & teach students. Year 2: Students proposed to PTSA to buy a compost bin for use in the school garden.	importance of including composting; ensure grant application for compost bin to receive next school year.	King County Green Schools Program ICS PTSA
ICS had no dog waste bag stations even though neighbors used fields regularly with dogs (multiple piles found in surveys of school grounds).	Year 1: Proposed to PTSA and got approval for purchase of dog waste bag stations. Year 2: Proposed to neighborhood association and got approval for hand-off of station management after 1 year; Installed and advertised stations to neighbors.	Continue monitoring fields for dog waste; check that neighborhood association is monitoring and refilling dog bag waste stations.	ICS students and parents ICS PTSA Houghton Neighborhood Association ICS neighbors
Unclear if rebuild plans for Peter Kirk elementary school included permeable pavement.	Students proposed design plans for the rebuild to the LWSD Director of Support Services.	Get students on the planning committee for new construction in the district.	District administration School administration
ICS does not have rain barrels and only 2% of 6th grade families have rain barrels at home.	Year 1: Students hosted a Rain Barrel and Stormwater Solutions information night for parents and community members. Year 2: Students proposed to the PTSA to buy gutters and connections to install rain barrels near school garden.	Collect pledges from families who intend to install rain barrels; map neighborhood rain catchment; ensure grant application for gutters/connections to receive next school year; install rain barrels.	ICS 6th graders ICS parents Community members PTSA
Local rain garden locations are unknown	Rain gardens in ICS neighborhood were mapped; 6th grade families took home brochures to teach their families how to make a rain garden; Weeding and mulching maintenance of ICS rain gardens.	Add rain gardens to 12,000 Rain Gardens site; expand mapping; assist elementary schools to install rain gardens; Conduct pledge campaign for families who will build rain gardens.	ICS 6th graders ICS 6th grade families ICS Neighbors
6th grade Pre-test scores on Stormwater systems were an average of 11 correct out of 25.	All 6th grade groups presented their projects to their class; 6th grade Post-test scores on Stormwater systems were an average of 21 correct out of 25.	Present projects to LWSD schools and district, as well as Kirkland City Council and other municipalities.	ICS 6th graders ICS 6th grade families

Curriculum Rigor meets Community Relevance

Unit Guiding Questions

- What is stormwater runoff and how does it function as part of the water cycle in natural areas?
- What are the human activities that contribute to polluted stormwater runoff?
- What are the effects of polluted stormwater runoff on our local bodies of water, ecosystems, and our communities?
- What solutions exist to reduce the amount or impact of polluted stormwater runoff?

NGSS Standards met

- **MS-ESS3-3** - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- **MS-ETS1-1** – Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Technology Standards met

- Research & Citation - Using a variety of search strategies; Using digital tools to plan and manage a project; Conducting original research using digital tools; Producing digital works to convey learning from research; Citing all sources.
- Collaboration - Using digital tools to appropriately communicate with peers and adults; Managing changes of files when edited by multiple users
- Data Gathering and Analysis - Selecting and using the appropriate type of graph
- Digital Presentations - multiple practices within Design as well as Formatting & Presenting

Community Standards met

City of Kirkland Stormwater Management Plan
King County Surface Water Management Fee School Discount program
Washington State Department of Ecology - Aligns with goals of the following programs:

- Washington Waters Ours to Protect
- Puget Sound Starts Here

Assessment Strategies/Learning Artifacts

- Stormwater Systems Pre & Post-Test
- Research & Resource Summaries
- Solutions' Criteria compare and contrast
- Impact Project Plan
- Needs Document (Know/Need to Know/Need to Do)
- Benchmark Data to show achievement of impact
- Project Summary Presentations
- Self and Peer Evaluations (during and after project implementation)
- Reflections of learning

Teacher Reflection

Impact projects are not traditional ways of teaching and learning content. Teachers will guide discovery, assist in finding resources, and facilitate collaboration, but the projects should include student choice and direction. I've found that ideal group size for impact projects are 4-5 students. Smaller may result in too much workload per student, and more becomes difficult to manage equitable collaboration and discussion. Projects can be managed in a variety of ways: One specific problem can be chosen per class/grade and student work on similar solutions (i.e. raingardens), or students can be allowed to choose the solution and the classroom has many different concurrent projects. Teachers should use their knowledge of students and professional judgement to decide the scope and timeline for projects.

Students may or may not have ever done projects like this in the classroom, and will need guidance depending on age and experience. I emphasize that this project is about making a difference in their community, not the producing of an artifact of their learning (i.e. Power-point), nor their scores on an assessment. Student motivation is high once they realize they are engaging in solving a real-world problem and using real-world resources, but that doesn't mean that there won't be management needs for their behavior, task completion, and collaboration.

The best parts of problem-based learning are the integrated, real-world skills that students build. They all learn cross-curricular content, improving content knowledge and skills in science, math, social studies, reading, and writing. The complex nature of these projects allows for the flexibility of involving more subject teachers in collaborative projects, as well as the natural evolution of solutions implementation with multiple years of students. Students are immersed in using technology for research, communication, and producing artifacts, both learning and teaching each other vital 21st century skills. Students have to struggle through and practice collaborative problem-solving, vital for their future careers.

Student Testimonials of Learning, Motivation and Application

"All in all we all had a laugh at times, and were serious at times to, this was a stressing and fun project at the same time." ~Shravani
"Before, I always thought that the water that went down the sewer went straight to the Puget Sound. I learned otherwise… It's really interesting how a tiny detail like a convex parking lot could help with the storm water problem." ~Jolie
"Whenever I finished my assigned task, I was able to help my other group members with their task. I know that group projects depend on everyone's contribution to the finished product." ~Rhys

Really Helpful Resources

- https://www.imsa.edu/extensionprograms/problem-based-learning
- http://www.sustainabilityambassadors.org/stormwater-education