Water Systems Teacher Fellows Program
Community Curriculum Case Study

Water Systems Solutions

Middle School NGSS - Engineering Community Impact
8th Grade Science

Problem Statement

How do we use the relationship between clean water abundance and scarcity in the past to help design solutions for water systems in the future?

https://ecomediaproject.files.wordpress.com/2013/05/water-drip.jpg

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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.

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

City Context

The Lake Washington School District encompasses the cities of Redmond, Kirkland, and Sammamish. Redmond and Kirkland are members of the Cascade Water Alliance and the City of Sammamish is served in part by the Sammamish Plateau Water District which is also a member of Cascade.

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Classroom Context

I teach 60-75 8th graders in an Earth Science course each year. This is the third science course at our school, and its curriculum is built from the Next Generation Science Standards, specifically Earth Systems and Engineering. It is a combination of the middle school and high school Earth science standards. This year I worked with our 8th grade International Studies teacher to create a cross-curricular, water systems, problem-based learning unit with our shared students. We saw our 8th graders during different periods and in different combinations, but were able to team teach over a period of a several months. The total time dedicated to their projects was about 3 weeks, but we interspersed this project between other curricular topics.

Project Summary (3 Weeks)

During the Water Systems unit, students are engaged in recognizing the local and global problems associated with water supply, scarcity, and pollution. They make connections to historical contexts as well as current events. Students are pre-tested to help them recognize what they know and don't know about water systems, and engage in research using local and global resources to discover and share new knowledge.

Once students understand a range of solutions to water systems problems, 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.

Impressive impacts that students achieved included facilitating the replacement of over 100 household water fixtures to low-flow alternatives, motivating the City of Kirkland to place 5 informational signs along the Lake Washington waterfront to inform the public how to report pollutant spills, and the receipt of personal pledges of our school's neighbors to stop using artificial fertilizers on their lawns after being educated on the detrimental effects of runoff by students. *All Impacts achieved and future plans are detailed below in the next section.*

Through collaborative 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

GOAL: Students understand water systems challenges and can design solutions to make impactful changes in their own behavior, family practices, or community-level stewardship.

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 need to do next?*	**Stakeholders** *Who needs to know about our results and recommendations?*
Zero 8th grade families pledged to change to low-flow water faucets and showerheads	55 low-flow faucets and 52 showerheads were ordered and received from Cascade Water Alliance, as well as 51 pledges to change toilets, washing machines, dishwashers, and/or install landscape rain sensors.	Continue conservation audits and orders each year in 8th grade; campaign to other schools	ICS 8th graders Parents Family members
154 pieces of (mostly plastic) trash were collected from ICS grounds.	Educational signs and campaign reduced trash to 32 pieces in 3 weeks.	Collaborate with ASB & PTSA for prevention and pick up campaigns.	ICS students Parents Teachers
Docks on Lake Washington in Kirkland had no information about spill response.	5 signs were placed at sites along Lake Washington, teaching the public about pollution spills and providing contact info if spills are seen. Oil spill volunteering information shared with PTSA (for those over 18).	Communicate student-advocated improvements in community news, and to city council.	City of Kirkland Department of Public Works Public who use waterfront for recreation ICS PTSA
30% of ICS neighbors polled use artificial fertilizers on their lawns.	80% (of those that use artificial fertilizers) pledge to use natural composts or no fertilizers in their lawns after being educated about eutrophication/dead zones.	Expand education to more neighbors and ICS families; obtain coupons for organic compost	ICS neighbors
3 area farms transparently discussed their composting and use of animal manure on site to prevent runoff.	21 area farms were contacted and offered a factsheet on agricultural waste problems and solutions to guide wise use of animal manure. 8 Washington State government officials contacted about improving agricultural pollution regulations.	Work with one willing farm to advertise positive effects; continue to contact government about strengthening regulations.	King County farms WA state government
$5,397 donated to	$5,514 total donations	Increase campaign to	ICS students & parents

ICS Wellness Project to benefit Good Neighbors well creation in Africa	(+$117) after change campaigns at ICS as well as educating 32 Community School students and having them bring information home to their parents.	other schools or community groups and businesses	Community School students & parents
~40% of students who bring their lunch to ICS use plastic disposable utensils	64% of these students pledged to bring reusable utensils when educated about plastic pollution	Collect data from school cafeteria supplies to determine decrease in use; campaign for reusable, recyclable, or compostable materials for lunches.	ICS students
Other student projects with less measurable or pending impacts: • Generated an easily translatable resource on cholera prevention/treatment for Haitians • Designed a temperature-based shower timer • Designed a marine plastics collector to eliminate ocean trash • Created a website to educate about industrial pollution and solutions: http://industrialpollution.github.io/ • Improved upon a water sanitation design (2 solutions) • Improved desalination design			CDC American Standard NOAA Save our Shores NRDC Janicki Bioenergy Washington Department of Ecology

Unit Guiding Questions

- What are our local sources of drinking water and what role does conservation play in maintaining this supply? How does this compare with areas of major water scarcity globally?
- What are the current major causes of water pollution locally? Globally?
- What solutions exist to conserve or increase water supply?
- What solutions exist to prevent, reduce, or clean up water pollution?
- Who needs to know about your impact and be involved in future progress?

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.
- **HS-ESS3-4 –** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

- **HS-ETS1-3 –** Evaluate a solution to a complex, real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

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

King County Surface Water Management Fee School Discount program:

- Students learn how to protect and appreciate water resources.

King County Strategic Climate Action Plan (K4C) 2015:

- **Educational Partnerships: Strategy A:** Provide educational programs and materials to unincorporated area customers on green building and sustainable development practices and resources.
- **Net-Positive County Buildings and Infrastructure: Strategy B:** Increase water efficiency and conservation, and reduce drinking water consumption through appropriate reuse of wastewater effluent, reclaimed water, stormwater, and harvested rainwater.

King County Wastewater Treatment Division's Strategic Plan:

- **Build a Sustainable and Resilient Future:** King County contributes to the long term viability and health of environmental, social, and economic aspects of our communities. We anticipate, prepare for and respond to changing conditions.
- **Educate and Engage Customers:** King County listens to and engages all customers and stakeholders, to develop an increased understanding of and satisfaction with our products, services and rates.

Assessment Strategies/Learning Artifacts

- Water 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 to peers and invited Community Stakeholders
- 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 is about 4-5 students. Smaller groups may result in too much workload per student, and in larger groups it become 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 with students working 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 about producing 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 including: critical thinking, creativity, collaboration, and communication. Students have to struggle through and practice collaborative problem-solving, vital for their future careers.

Student Testimonials of Learning, Motivation and Application

"I think that my group did an amazing job due to us not knowing what to do at the start of the project but later evolving to work as a group and create a real impact." ~Arvind N.

"This was amazing! I can't believe [a city of Kirkland Director] listened and met with me! And they put up our spill response signs!" ~Sofia R.

"I still look forward to explaining our cause to them and educating people about our cause." ~Ritesh B.

Really Helpful Resources

1. Cascade Water Alliance: http://cascadewater.org/

2. Seattle Public Utilities – Watershed resources: http://www.seattle.gov/util/EnvironmentConservation/OurWatersheds/index.htm

3. Seattle Public Utilities – About the Cedar River Watershed: http://www.seattle.gov/util/EnvironmentConservation/OurWatersheds/CedarRiverWatershed/index.htm

4. Excellent video on the story of Seattle's drinking water: http://www.sustainabilityambassadors.org/apps/videos/videos/show/18927259-the-source-a-story-about-seattle-s-tap-water

5. Sustainability Ambassadors – Short videos featuring water systems experts talking about local issues: http://www.sustainabilityambassadors.org/apps/videos/channels/show/4243207-water-systems

6. Sustainability Ambassadors – Library links on Puget Sound: http://www.sustainabilityambassadors.org/puget-sound-ecosystem

7. Sustainability Ambassadors – Library links on Stormwater issues: http://www.sustainabilityambassadors.org/stormwater-library-links

8. Calculate your personal and family water footprint and choose one or more behavior changes to reduce your direct and indirect water consumption. http://environment.nationalgeographic.com/environment/freshwater/change-the-course/water-footprint-calculator/

9. For a higher level, world-wide calculator with excellent resources on the "embedded" water footprint of different consumer products see: http://waterfootprint.org/en/

10. Review the action ideas at "Lazy Person's Guide to Saving the World" and establish a plan for taking 3-5 actions with your family. http://www.un.org/sustainabledevelopment/takeaction/

International Water Systems – Library Links

11. United Nations website on the 2030 Agenda for Sustainable Development. Read selected sections of the full 2030 Agenda. Includes an inspiring preamble as well as sections on each of the 17 goals and their individual targets. Goal #6 is on Water Systems: https://sustainabledevelopment.un.org/post2015/transformingourworld

12. United Nations website on Sustainable Development. Find Goal #6 on Water Systems and click on Facts | Targets | Links: http://www.un.org/sustainabledevelopment/

13. United Nations website with infographic on each of the 17 Sustainable Development Goals for 2030 https://sustainabledevelopment.un.org/sdgs

14. World Water Day http://www.unwater.org/worldwaterday

15. Water.org http://water.org/

16. Water 1st International http://water1st.org/

17. Splash.org http://splash.org/

18. World Toilet.org http://worldtoilet.org/ (World Toilet Day, November 19)

19. WaterAid.org http://www.wateraid.org/us

20. Walk for Water http://walkforwatermission.org/

21. Gates Foundation- Reinvent the Toilet Challenge http://www.gatesfoundation.org/What-We-Do/Global-Development/Reinvent-the-Toilet-Challenge

22. WorldVision.org http://www.worldvision.org/

23. World Bank Water and Sanitation Program http://water.worldbank.org/related-topics/water-and-sanitation-program

24. Water Supply and Sanitation Collaborative Council http://wsscc.org/

25. End Open Defication.org http://opendefecation.org/news/

26. UNICEF's initiative to break taboo on Open Defecation http://unicef.in/PressReleases/13/Take-Poo-to-the-Loo-the-New-Youth-Mantra-against-open-defecation-has-people-marching-to-the-tune-of-India-s-First-Poo-Song

27. Singapore leads the world in Integrated Water Systems Management: https://www.pub.gov.sg/watersupply