Reservoir Rescue: A Community-Connected Elementary Water Filtration Engineering Unit (Resource Exchange)

Dr. Chelsea J Andrews, Tufts University

Chelsea Andrews is a post-doctoral researcher at Tufts University and University of Massachusetts-Boston. She received a B.S. from Texas A&M University in ocean engineering, an S.M. from MIT in civil and environmental engineering, and a PhD from Tufts University in Engineering Education. Her current research includes investigating children's engagement in engineering design through in-depth case study analysis.

Nicole Alexandra Batrouny, Tufts University

Nicole Batrouny is a PhD candidate in Mechanical Engineering at Tufts University. Her engineering education research interests include upper elementary engineering education, integrated science and engineering, collaboration in engineering, and decision making in engineering. For her Master's thesis, she uncovered talk moves used by 4th grade students that fostered collaborative, disciplinary decision-making during an engineering design outreach program. For her dissertation, she intends to explore the ways in which team mental models function in teams of novice engineers and how novice engineers can be trained to collaborate more effectively on diverse teams.

Dr. Kristen B Wendell, Tufts University

Kristen Wendell is Associate Professor of Mechanical Engineering and Adjunct Associate Professor of Education at Tufts University. Her research efforts at at the Center for Engineering Education and Outreach focus on supporting discourse and design practices during K-12, teacher education, and college-level engineering learning experiences, and increasing access to engineering in the elementary school experience, especially in under-resourced schools. In 2016 she was a recipient of the U.S. Presidential Early Career Award for Scientists and Engineers (PECASE). https://engineering.tufts.edu/me/people/faculty/kristen-bethke-wendell

Dr. Tejaswini S Dalvi, Univeristy of Massachusetts, Boston

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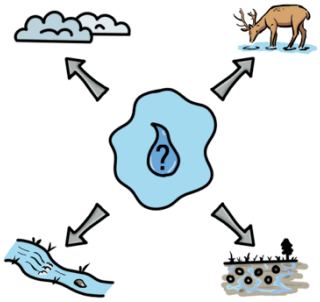
Grade level: 3-6 (meets 5th grade engineering and earth and space science standards)
Time: 12, 1-hour lessons. Final Design Challenge can also be a stand-alone design task
Standards: All NGSS 3-5-ETS standards are met, see full documentation for science standards

In the ConnecTions in the Making project, researchers and district partners work to develop and study community-connected, integrated science and engineering curriculum units that support diverse elementary students' science and engineering ideas, practices, and attitudes. In the units, students use human-centered design strategies to prototype and share functional solutions to a design challenge rooted in the students' local community while also exploring scientific explanations of the phenomena and mechanisms related to the challenge. In "Reservoir Rescue", students explore key concepts of the water cycle and environmental engineering in the context of a heavily polluted stream in their town that flows into a backup drinking reservoir. Their focus question for the unit is: How can we prevent pollution in the stream from entering the reservoir?

Days 1-2. Unit Launch
What do environmental engineers do?
How do they clean up polluted water?
Students read an article about a local water pollution problem: a very polluted stream empties into a drinking reservoir. Students discuss how to model this problem and solutions at classroom scale.

Days 3-4. Inquiry: Water cycle activities
What happened to the water?
Students engage in small-group inquiry activities and demonstrations to investigate evaporation, condensation, precipitation, surface run-off, and groundwater flow.

Day 5. Inquiry: Project WET Incredible Journey
What are the different journeys water droplets take through the water cycle?
Students learn about the stochastic nature of the water cycle by participating in the Project WET activity called "The Incredible Journey". Activity information and downloads available at: www.projectwet.org



Day 6. Inquiry: Human impacts
How do humans impact the water cycle?
How can humans help clean up and prevent water pollution?
Students analyze photos of pollution and discuss how that water came to be polluted and how to mitigate the effects of pollution.

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Project Team: Dr. Kristen Wendell (PI), Dr. Tejaswini Dalvi (Co-PI), Nicole Batrouny
Link to full curriculum: https://bit.ly/connectionsengineering
The ConnecTions in the Making project is supported by the NSF, ITEST-1657218

Design Challenge: Reservoir pollution filtration

In the final design challenge, students design, build, test, and iterate on a scale model solution to the pollution filtration problem in a long clear plastic bin. When done as part of the unit, the design challenge typically spans 6 days, but it also works as a 1-day stand-alone design task.

Day 7: Planning	*What are important things to consider when solving a design challenge?* Groups sketch and discuss initial ideas, begin fabricating initial design, but do not test.
Day 8: Building & testing	*How do we know if our design works? How can we use failures to improve our designs?* Groups build and test their designs. Nearly all the initial designs fail the test; groups iterate and continue testing, trying to improve their designs.
Day 9: Peer review	*How can we improve our designs by generating and receiving peer feedback?* Groups self-evaluate their own design and design process, then pair up with other groups to offer feedback, help troubleshoot, and brainstorm solutions to common issues.
Day 10: Final tests & review	*What can we learn by looking across all our design attempts?* Groups reflect on their design attempts, teacher facilitates a whole class discussion comparing across designs.
Day 11-12: Design conference	*How do engineers share their ideas through speaking and writing?* Groups prepare for and engage in the conference, where they share their designs and design process with other students and members of the school and greater community.

DESIGN BRIEF

Goal: ***Stop pollutants (various sizes of beads, glitter, and oil) in the stream (elevated end of your bin) from entering the drinking reservoir (lowered end of your bin)***

Criteria: Your system MUST:

- Filter out as much pollutants as possible
- Allow water to flow into reservoir

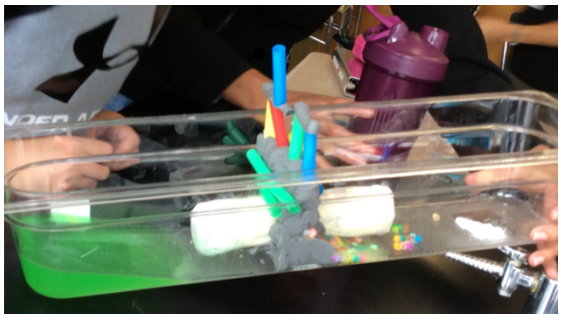
Constraints:

- Can use only materials provided
- Only 3 class periods to build, test, and revise

Building materials:

- Plastic mesh
- Cotton balls & squares
- Gauze
- Cheesecloth
- Coffee filters
- Sponges
- Straws
- Oil-based clay
- Tape

Example student solutions, during and after testing with model polluted water (colored water with oil, beads, and glitter)



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