Dive In! An Integrated Design Thinking/STEM Curriculum

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Shelley Goldman is a learning sciences researcher studying how design thinking and technologies can create better access and success for K-16 learners. Current work includes bringing broadening participation in STEM inside and outside of school. A professor at the Stanford Graduate School of Education and by Courtesy, Mechanical Engineering-Design Track, Goldman is on the faculty of the Learning, Design & Technology master's program and the Learning Sciences & Technology Design doctoral program.

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Aaron graduated from Stanford's Learning, Design and Technology Master's program in 2012. He is currently the Principal of Commonwealth Secondary School, an innovative public school in Singapore. As an educator with more than 10 years of experience as a teacher, policy maker and school leader, Aaron is interested in redesigning public education through the use of technology and new pedagogical approaches. In particular, he believes that design thinking has the potential to reconnect students and educators with authentic and meaningful learning, and can nurture the empathy and creativity that they need to succeed in the 21st Century. Aaron also holds a bachelor's degree in English from the University of Cambridge, and a Masters in English and American literature from Stanford University.

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Water Purification through Filtration

Grade Level: 6-8

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Next Generation Science Standards: MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

Activity Summary: Introduces students to the concepts of natural and man-made water treatment and purification as they engage in prototyping working water filters from a variety of natural materials.

OBJECTIVES

1. Students plan and carry out an investigation of water purification using natural materials.
2. Through design, prototyping & analysis, students identify the materials and design of effective water filtration systems.

MATERIALS

(10 teams of 2-4 students)

- 10 Sharpies
- 10 Cups Sand
- 10 Cups Fine-grained Gravel (very small rocks & sand)
- 10 Cups Rough Gravel (small rocks, pebbles, and/or marbles)
- 50 Charcoal Bricks (place bricks into plastic bag & use a hammer to break into small chunks)
- 30 Coffee Filters
- 20-30 Pre-cut 1 Liter Plastic Bottles (cut each bottle at the halfway point & nest the tops inside of the bottoms, with the spout down)
- 100 Cotton Balls
- 2 Gallons Dirty Water (contaminated with glitter/confetti, dirt, oil, or any solid or liquid that is not extremely soluble in water)

TIP: Clear bottles allow for an easy comparison of filtered water. Tinted bottles make observing difficult.

ACTIVITY

1. Build Background Knowledge: Show students one or both of the following videos. These videos provide context for the experiment. Each video describes an approach to filtration; together, they offer different frames in terms of scope & scale of filtration systems.

- Water Treatment Plant:http://goo.gl/gfgCn3
- Portable Filter: http://goo.gl/w8XZjA

2. Get Organized: Organize class into lab groups of 2-4 students. Give each team 2-3 pre-cut bottles with 1 coffee filter & 10 cotton balls for each bottle. Instruct students to layer coffee filter & cotton balls within the spout of the bottle. This should be the same for all filters & all groups.

3. Plan the Investigation: Show students the dirty water & remaining materials. Explain that each team will be filtering the water by making thick layers of combinations of these materials. Ask students to brainstorm & sketch filter designs, encouraging teams to hold most layers constant & vary only 1 or 2 variables between their team's designs.

Ex: "Here are paper filters & materials. You need to layer materials inside of the filters to create a water filtration system. Use any combinations of the materials here & layer/sandwich them with the goal of creating the system that will trap the most pollutants from the dirty water."

4. Getting Feedback: Teams submit designs for teacher/peer feedback. Ensure that teams can articulate which design parameters they are holding constant & which they are varying between designs. After receiving feedback, students can improve upon & iterate on their designs, and collect the materials needed for their filtration systems.

5. Building Prototypes: Each team uses the materials to build prototypes of their designs. When prototypes are complete, teams should label each filtration system with team name & the defining characteristic of the bottle (ex. Team 2, no gravel).

6. Evaluating Prototypes: Pour dirty water into each filtration system. Compare the outcomes within & between groups by ordering the designs from least to most clean water (based on the visually observable aspects of cloudiness & color).

7. Coming to Consensus: Through class discussion, determine the materials & design of the most effective water filters. Use results to design 1-2 more filtration systems as a whole class. Build, test, evaluate, & discuss experimental outcome.

8. Reflection: Students reflect in writing on the prompt: "Describe the process & outcome of building a water filtration system. What 3 recommendations would you make for others doing this for the first time?"