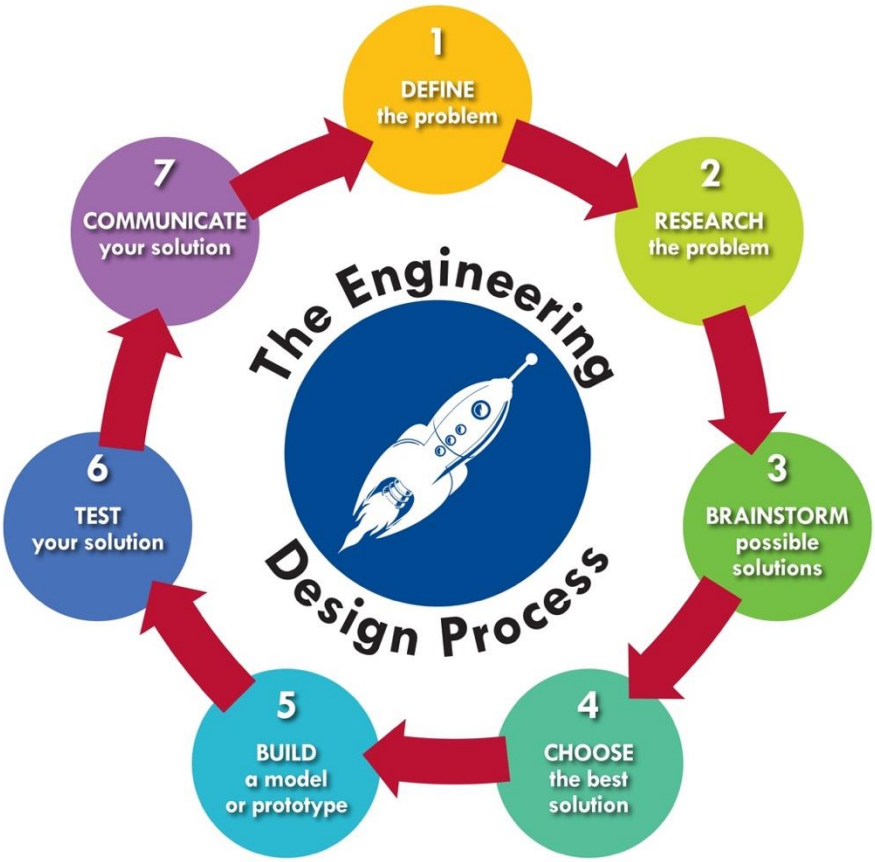
Solve It: A Student STEM Challenge



Topic: Drought and Water Conservation

Challenge:
To design a solution for how your school would operate if they were given 1/3 less water to use during a drought.

Materials:

- Computers for research
  - Graph paper
  - Piece of wax paper
  - Piece of plastic wrap
  - Piece of paper towel
  - Small container of water + a pipette
- Initial Exploration: Pouring water down a string
  - 2-feet of cotton string (thicker than thread)
  - Two cups
  - Water
- Water's capability to hold together:
  - Around a 100 pennies
  - Container (Petri dish, 100ml beaker, or small clear cup)
  - Water
  - Pipette
  - Toothpick
  - Liquid soap
- Water's ability to climb
  - 2-4 transparent straws of different diameters
  - Container of water (Petri dish, 100ml beaker, or small clear cup)
  - Optional (food coloring – to make it easier for students to observe)

	• Piece of paper towel
	• Marker
	• Pencil, pen, rod, or something similar
	• Two books, boxes or something similar
	• Piece of tape
	• Water's capability to stretch
	  • Water Race worksheet
	  • A piece of wax paper that can be laid on top of the worksheet
	  • A small container of water + a pipette
	  • Stopwatch or access to a clock with a second hand
	• Optional extension: Pouring water down a string
	  • 2-feet of cotton string (thicker than thread)
	  • Two cups
	  • Water

Real World Connection:

- Interactive Community Water System Map: http://gisweb2.azwater.gov/cws
- Water Footprint Calculator: https://www.watercalculator.org/education/teaching-conservation-with-water-footprint-calculator/
- Precipitation Conservation: https://pmm.nasa.gov/education/lesson-plans/water-conservation
- Water Use It Wisely: https://wateruseitwisely.com/teachersandeducators/
- Colorado River Drought Plan: https://www.azcentral.com/story/news/local/arizona-environment/2019/04/08/congress-passes-colorado-river-drought-plan-cutbacks-protect-lake-mead-lake-powell/3405315002/
- Water Olympics: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5391175.pdf
- Arizona Department of Water Resources: http://www.azwater.gov/azdwr/
- Water Pathway Sample Water Audit: https://www.nwf.org/Eco-Schools-USA/Become-an-Eco-School/Pathways/Water/Audit
- Google Earth: https://www.google.com/earth/
- STEM Pro Live! with Department of Arizona Water Resources: https://schoolsup.org/stemprolive/

Define the Problem:	
Guided Questions	Teacher Notes
• What do you have available to work with when designing your solution? • What would a successful solution look like? How will you know if your design is successful? • What are your constraints or limitations?	• Begin by trying to understand what the opportunities for improvement at your school are: • Start by collecting some data and making observations of the school by completing a Water Audit.

	• A sample audit with instructions can be found here: https://www.nwf.org/Eco-Schools-USA/Become-an-Eco-School/Pathways/Water/Audit • You can have your students use sites like Google Earth to make a scaled map of your school and identify the location and number of sinks, faucets, toilets, and showers are at your school and make a data table. Suggested symbols for coding are: • **A** = Automatic (equipment that must be turned on manually but turns off automatically) • **S** = Sensors (equipment that turns on and off based on the movement of a person) • **M** = Manual (equipment that must be physically be turned on and off by user) • **GPM** = Gallons per minute (faucets and showers) • **GPF** = Gallons per flush (urinals and toilets) • Take a look at the water bills for the school and determine how much water is used each year. • Create a graph showing the type and amount of water sources on your school campus. • Establish your parameters (groups, roles, time limit, # of trials, amount of material allowed to use, etc.).
Research the Problem:	
Guided Questions	Teacher Notes
• What is already known about the problem? • What are some current solutions that can be built upon/improved? • What technology is available to help you understand the problem better? • What are some obstacles, challenges connected to your problem?	• Have students research how much water other schools, of similar size, are using. • Look at what other schools, communities, families, businesses and companies are doing to monitor and reduce their water usage. • Have the students research current innovative ideas for how individuals, families,

	universities, etc are reducing their water usage.
Brainstorm Possible Solutions:	
Guided Questions	Teacher Notes
• How many ideas can you come up with individually? • How many ideas can you come up with as a group? • How can you use/build on the groups ideas to refine your own?	• Have students individually come up with at least 4 possible designs that they could use in their solution • Have students share designs with a group. **Encourage a variety of ideas and a safe environment.* • Encourage reflection and refinement of ideas
Choose the Best Solution:	
Guided Questions	Teacher Notes
• Which solution(s) could you build using the materials/time you have available? • Which solution(s) could you build considering the constraints/ limitations? • Which solution do you think has the best chance to be successful?	• Have students choose an idea to design and make a plan to build/create (*even if you have no intention to actually build). • Have students draw a model of their prototype and label the parts (*if applicable). • List the materials that will be needed to build (*if applicable). • Describe how the materials will be used.
Build a Model or Prototype:	
Guided Questions	Teacher Notes
• What materials will you need? • Does your design meet the lesson objective? • Does your design clearly communicate your selected solution to the problem?	• Revisit the objective and make sure the student's design matches what they chose for their solution to the problem.
Test your Solution:	
Guided Questions	Teacher Notes
• Did you record your observations? • How will you know if your design worked as intended? • How will you know if your design was successful?	• Have students make and record observations during their trial(s). • Encourage students to stay true to their design and not make modifications while testing.
Communicate your Solution:	
Guided Questions	Teacher Notes

• Did your design work as intended? How do you know? • Did it solve the problem that you identified? How do you know? • Do you still think your solution is the best one for the problem? Why or why not? • What would you different if you could do it again? Why?	• *Have students reflect individually first and record responses.* • *Have students share responses with their group then whole class.* • *To make iterations, you will want to re-enter the Engineering Design Process and begin thinking about defining the problem(s) they had with the initial idea.* • *The purpose is to provide a process for them to formalize their thinking and not rely on trial and error to merely accomplish a task.* • *Share your students' designs and ideas with us at: info@mcesa.maricopa.gov*