Lesson Title:	**Robo Wheel**
Subject Area:	Math
Grade Level:	6th
Duration:	2 days
Format (#students/group):	Students will be collaborating at table groups of four, but creating an individual product.
Overview:	Students will design a robowheel to travel the farthest distance possible. Variables include: the size and material of the bowls uses, the length of string uses, the use of weight in the wheel. Students may make design adjustments prior to the final challenge. Students will record data regarding string length, weight, material used, and distance traveled.
Educational Standards:	6.SP.1 I can recognize a statistical question , 6.SP.3 I can recognize that a single number can represent the center of a data set, 6.SP.4 I can make a graph that represents data appropriately, including number lines, histograms, box and whiskers plots and dot plots 6.SP.5 I can describe the unit of measure in the data collection.
Unit Question:	How does the math content we learn in 6th grade relate to the manufacturing experience?
Focus Question/ Purpose:	How do design variables (length of string, bowl size and material, weight) impact the distance that the robowheel travels?
Desired Outcomes:	Students will make predictions about the optimal design prior to creating their robowheel. Students will design robowheels and make design adjustments in order to increase distance traveled by the robowheel. Students will record data and draw conclusions regarding the best design to achieve the greatest distance. Students will use problem solving skills to design a robowheel that will travel the farthest distance.
Activity Details/ Instructions:	Prior to this activity students will: Have been introduced to the manufacturing experience through learning about my experience at Michigan Sugar. Students will collaborate but each create his/her own robowheel. Students will use a variety of household products to create a robowheel that will travel the greatest distance. Students will be introduced to the robowheel by watching a short video. As a class, we will discuss possible reasons robowheels were able to travel great distances and some of the variables that would play a role in determining which robowheels would travel the farthest. Students will then decide the optimal design for farthest travel. Students will record data about materials and design as well as distance traveled on the challenge day. Students will be able to make design adjustments on building day while trying their robowheels in the classroom/hallway. After challenge day, students will draw conclusions about the design and materials used based on the data.
Safety:	Students will be seated behind the moving robowheels during the challenge day. Students will not run their robowheels in the path of any oncoming pedestrian.
Potential Cost:	Cost of paper bowls, string, tape, washers for weight
Supplies (sources):	• 2 paper bowls (small and large)

Lesson Title:	**Robo Wheel**
	• 2 rubber bands • 3 feet of string (no more than) • Pushpin or thumbtack • Tape (duct or masking) • Sharp pencil • Washers to be used as weights (optional)
Developed by:	Julie Licavoli
Date:	Fall 2015
Key Words:	STEM,
Other Resources:	Build a Robo Wheel [http://pbskids.org/designsquad/build/robo-wheel/]

Name: _____ Date: _____ Hour: _____

Robo Wheel Challenge

1. Robo Wheel Challenge- Your job is to design a robo wheel that will travel the farthest distance possible. The following video and pictures will give you an idea of how a robo wheel works and some guidelines for creating your own robo wheel. You can decide how long to make the string loop (no more than 3 feet long), what size plates to use, and whether or not to add weight to the inside of the robo wheel in order to maximize the distance your robo wheel travels. You will only be given one set of materials, but you can make adjustments to your design up until the time of the challenge.

2. After viewing the video, what factors do you think impact the distance your robo wheel will travel?

3. Here are some guidelines to creating your robo wheel. You are free to make adjustments to string length, weight, and paper plate size.
    a. Note – In Step 1, it is optional to use pennies to weight the inside of the plate.
    b. Note – In Step 8, if desired, place pennies inside the bowl, anchoring them with tape prior to closing the bowls.

PBS KIDS GO!

DESIGN squad Nation

Dream It. Build It. Live It.
pbskids.org/designsquadnation

Robo Wheel

1

Here's what you need to make your Robo Wheel!

- 2 paper bowls
- 2 rubber bands
- 3 feet of string
- Pushpin or thumbtack
- Tape (duct or masking)
- Sharp pencil

2

Find the center

- Nest the bowls together. Wrap a rubber band around the bowls.
- Slide it right and left until it divides the bottom circle of the bowl into two equal halves.
- Make an "X" with the other rubber band. The four quarters make four "pizza slices."
- Move the rubber bands until all four "pizza slices" are of equal size.
- The center of the circle is where the rubber bands cross.

3

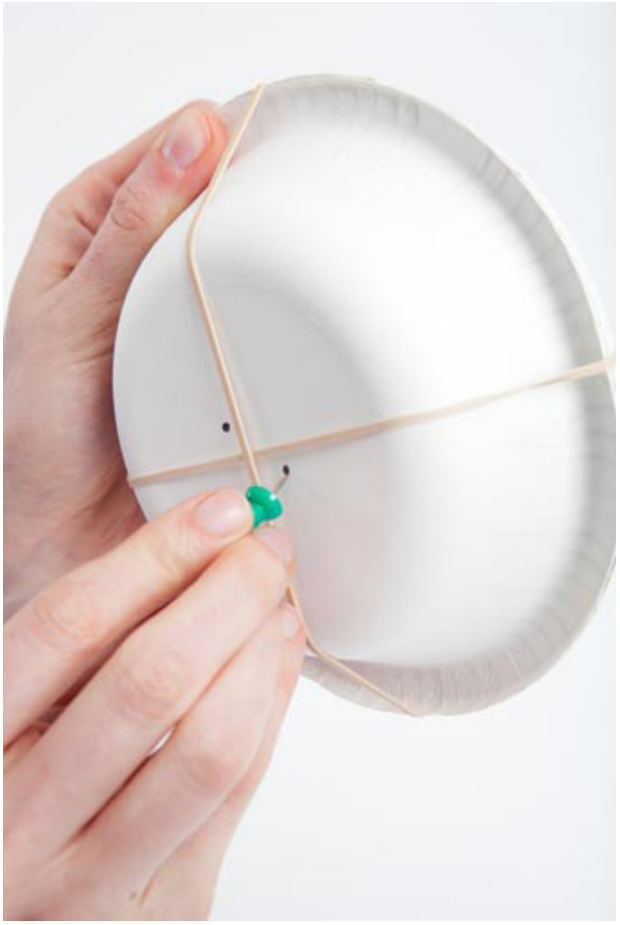
Mark the spot

Mark two dots on each side of the center. Make them equal distance from the center and about a half inch apart. (About the width of your index finger).

4

Make the holes

With your dots as a guide, use the pushpin to poke holes in the bowls.



5

Widen the holes

- Remove the rubber bands and separate the bowls.
- Poke a sharp pencil into a pushpin hole. Twist it and push gently. Stop when the hole is just a bit bigger than the string. That's usually around where the wood part of the pencil starts, just after the black lead.
- *TIP: If your two holes get larger and become one big hole… Make two new holes in the two other "pizza slices" near the center. Keep them small. Set them a finger's width apart.*

6

Thread the string

- Begin by threading the string through the bottom of Bowl 1, starting from the outside.
- Next, thread the string through one of Bowl 2's holes, coming from the inside.
- *TIP: If threading the string through the holes is hard to do… Try doing one of these:*

  a) Wet the end of the string.

  b) Wrap the tip in clear tape to stiffen it (like the hard tip of a shoelace).

  c) Push the string through the hole with the pencil.

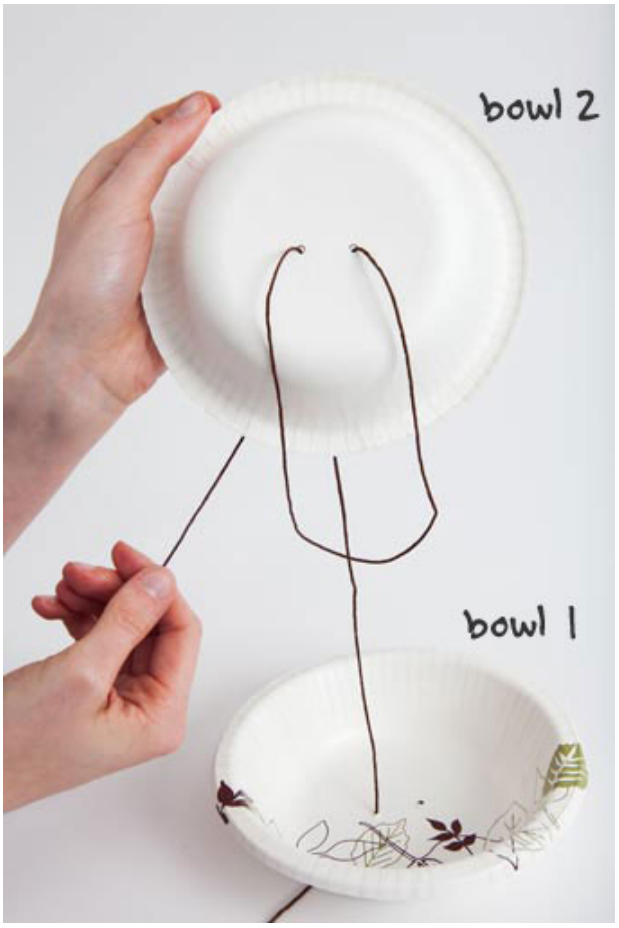
  d) Re-poke a hole so its little paper rim is bent in the direction the string is going.

  e) Make the hole a little bigger.

7

Thread the string (cont'd)

- Then thread the string through the bottom of Bowl 2, coming from the outside.
- Finally, thread the string through the open hole in Bowl 1, coming from the inside.
- Tie the ends of the string together with a knot.



8

Thread the string (cont'd)

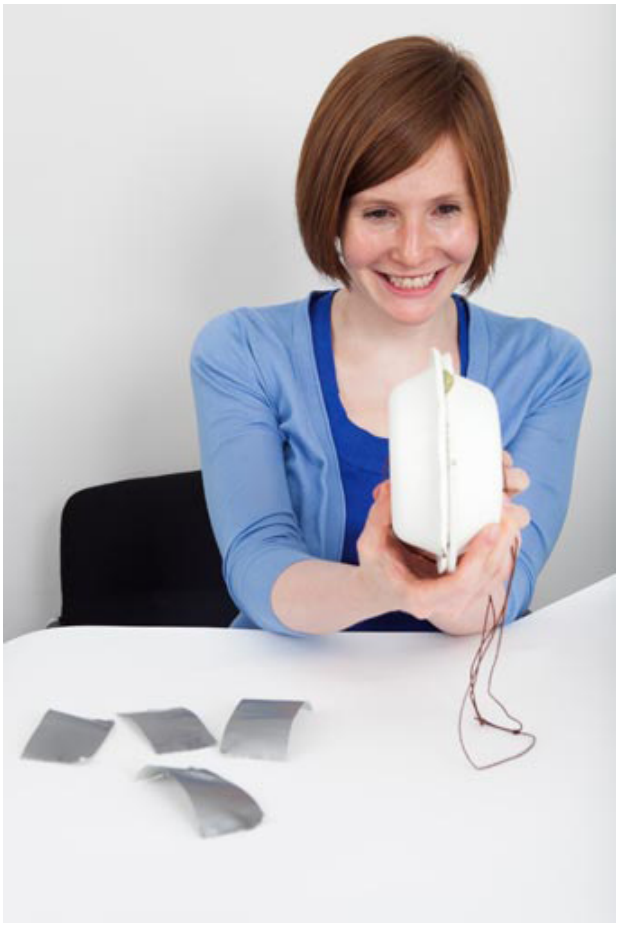
The two bowls should face each other, with the string looping through them.

9

Tape the bowls

- Tear off four 2-inch squares of tape. For now, stick them where they will be easy to grab.

- Line up the bowls so the holes are even with each other.



10

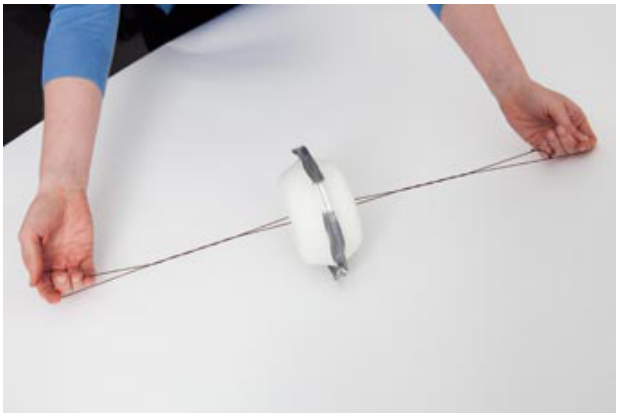
Tape the bowls (cont'd)

Stick the tape so the pieces are across from each other.

11

Wind up the string

- Slide your wheel to the middle of the string loop and hold both ends.
- To twist the string, push the wheel across the table or floor or ask a friend to help you spin the wheel to wind up the string.



12

Spin the wheel

- Pull outward on the string. The wheel will spin as the string untwists. Pull hard.
- Stop pulling just before all the twists unwind.

13

Spin the wheel (cont'd)

- Bring your hands together so the string is loose and the wheel sags down a bit. The Robo Wheel will keep spinning and will twist the string in the other direction.
- When the wheel stops spinning, pull out again, hard.
- *TIP: If you're having trouble revving up the wheel…The Pull-Relax technique takes a moment to master. Just like a yo-yo or pumping on a swing, it's about getting the timing right. Soon you'll have the wheel spinning quickly.*

14

Practice revving up

- Now that you've practiced spinning the wheel, try releasing it.
- Hold the string with your thumbs in the loop. Hold the wheel just above where you want to launch it.
- Spin the wheel forwards and backwards a few times to get it revved up.

15

Release the wheel

- Wait until the wheel is spinning away from you to begin your release.
- Let the string unwind until it is almost completely untwisted. (At this point, there will be lots of room for your thumbs to release the string.)
- Drop the string, and watch your wheel go!

16

Did you know?

Ever spin a top? A top is a **flywheel**, a spinning disc that stores energy. Once a flywheel gets going, the stored energy keeps the spin going for a long time. The Robo Wheel is a flywheel. Like a top or a tire rolling down a hill, once it gets rolling, it keeps going until a force interferes with its spin.

17

Try this next!

- **Mini golf.** Make up stations, like side-by-side racer, knocking over dominoes, leaping a big gap, jumping off a ramp, and hitting a target.
- **Massager.** Add yarn along the edge. It will fling out. Massage your face. Or swat mosquitoes.
- **Color wheel.** Add color with markers. Watch the colors merge when the Robo Wheel spins.
- **Rain stick.** Put dried peas or a bell inside to clatter about as the Robo Wheel slows down.
- **Disco ball.** Add shiny stickers or rhinestones. Shine a focused beam of light from a flashlight and make disco-ball patterns on the wall.

MAJOR FUNDING NSF PROJECT FUNDING NORTHROP GRUMMAN Foundation S. D. BECHTEL, JR. FOUNDATION STEPHEN BECHTEL FUND ADDITIONAL FUNDING

DESIGN SQUAD NATION is produced by WGBH Boston. Major funding is provided by the National Science Foundation. Project funding is provided by Northrop Grumman Foundation and S.D. Bechtel, Jr. Foundation. Additional funding is provided by United Engineering Foundation (ASCE, ASME, AIChE, IEEE, AIME). This DESIGN SQUAD NATION material is based upon work supported by the National Science Foundation under Grant No. EEC-1129342. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. 131021

4. Record design data here:

Size of paper plate	
Length of string loop	
How many pennies did you use to weight the robo wheel? Where did you locate the pennies? (draw a sketch of the weight placement)	
Any other variables that may affect the distance your robo wheel travels	

5. Distances traveled:

Trial	Distance traveled in feet
1	
2	
3	

Find the mean distance traveled: _____

6. Based on the race results, what conclusions can you draw about the robo wheel design and its relationship to distances traveled?

7. How can you modify your robo wheel so that it could travel even further?

8. What did you like about this activity?

9. How does this activity relate to the manufacturing process?

10. How does this activity connect to math content that you have learned or will learn this year?

11. What could have made this activity better?

12. In addition to distance traveled what other challenges could you attempt using your robo wheel?