"What a Drag!"

Teacher: Deborah Peters

Subject / grade level: Mathematics and Science 6th-7th

Materials:
Article http://m.fleetowner.com/running-green/nacfe-report-targets-trailer-aerodynamics
Picture of vintage car and modern car (see attached).
See evaluation section for other supplies needed.

Prerequisite Knowledge: Students should have a basic understanding of rates, ratios and proportions.

Florida Standards
SC.6.N.1.3 Explain the difference between an experiment and other types of scientific investigation, and explain the relative benefits and limitations of each.

SC.7.N.1.3 Distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation.

SC.7.N.1.4 Identify test variables (independent variables) and outcome variables (dependent variables) in an experiment.

MAFS.7.RP.1.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction 1/2/1/4 miles per hour, equivalently 2 miles per hour.

Science and Engineering Practices:
1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Lesson objective(s):

To recognize the interconnectedness of the trucking industry to our everyday life.
To recognize our dependency on the trucking industry.
To explore how technology has changed in the trucking industry.
To design and test a way to decrease air resistance/drag on a tractor-trailer.
To compute unit rates and use those rates to make real world decisions.

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ENGAGEMENT

Write 3 abiotic (non-living) things you depend on weekly, 2 foods you eat regularly, and 1 abiotic thing you cannot live without. Discuss with shoulder partner or team 3-4 ways each item above made its way to your home.

Note: *Students should conclude that trucks and other transportation are very important to our everyday lives.*

Teacher may want to discuss the following with students:

How many items on your list have traveled by truck to get to you?
What is the ratio and percent of trucked items on your list? How does this compare to your team member?
How might your life be different if trucks did not exist?
How many days do you think you could survive without truck deliveries?

EXPLORATION

Project picture of vintage car and modern car and have students discuss the following:

How are these 2 cars alike and different?

Note: *Students may make the connection that safety, fuel, fuel efficiency, aerodynamics, brake systems, electronic/automation, etc.*

Tell students that just like with cars, tractor-trailers have changed technology over the years.
Have students research the following topics (1 per group):

1. Safety features
2. Diesel fuel and engine efficiency
3. Break types and break times for tractor-trailers
4. Electronic systems and automation
5. Aerodynamics and fuel efficiency
6. Future technology – platooning, drones, space shuttle delivery, unmanned trucks, etc.

EXPLANATION

Students present their findings from above to the class.

ELABORATION

-- Read article - http://m.fleetowner.com/running-green/nacfe-report-targets-trailer-aerodynamics and discuss pros and cons to investing in technology that improves the aerodynamics of trucks.

-- Find the volume of the trailer and tractor and compare calculations between classmates.

-- Imagine that your tractor weighs 8,500 pounds. The maximum amount of weight allowed is 80,000 pounds.

1. How many gallons of milk could you haul if the average weight per gallon is 8.6 pounds?
2. How many gallons of fuel could you haul if the average weight per gallon is 6.3 pounds?
3. How many bags of cement could you haul, if the average bag is 50 pounds?
4. If you can fit 40, 50 pound bags per pallet, and each pallet takes up 48" x 40" how many pallets can you fit into a 53 foot trailer and still be under the weight limit? Justify your position.
5. How many bags of mulch could you haul, if the average bag is 20 pounds?

-- Research the price of diesel gasoline per gallon and the rate of miles per gallon at different weights. Using these rates, identify the independent variable (I.V.) and dependent variable (D.V.), and create a table and graph showing the relationship between the I.V. and D.V.

EVALUATION

1. Create model tractor trailers using similar base design.
   Main body of tractor should be 10.2cm x 7.5cm x 5cm
   Engine of tractor should be 8.1cm x 5cm x 3.4cm
   Note - Longest side should be parallel with axles and next longest side should be parallel with wheels

2. Add design features to make the truck more aerodynamic.

3. Test trucks and see which truck moves back the least in the wind tunnel when facing forward.

Suggested Supplies (per 2-3 students):

Wheel and Axle
- 10 bottle caps
- 5 skewers
- 5 popsicle sticks
- 5 straws (larger than skewers)
- 10 cm masking tape (to secure popsicle stick to straw)
- 1 small amount of modeling clay or playdough (to secure wheels to skewers)
- 1 pair scissors

Tractor and Trailer
- ½ gallon milk/juice carton (trailer)
- 1 manila folder (tractor)
- 1 sheet copy paper (for modifications)

Wind Tunnel - create according to file:///C:/Users/143836/Downloads/Newsletter252.pdf

Follow-Up Questions:

1. Explain the science and/or math behind why a tractor trailer would need so many wheels (most have 18 wheels)?
2. Explain why aerodynamics could be an important issue in the trucking industry?
3. How does the idea of aerodynamics relate to your everyday life?
4. Would you recommend adding the features you designed to a trucking company? Why or why not?
5. What challenges did you have to overcome during the design process?
6. After observing your teammates designs, which would you recommend to a trucking company? Why or why not?
7. How would you have designed your truck differently?

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Image retrieved from -- http://keywordsuggest.org/gallery/191241.html