Title:	**Grade:** 6	**BIG Idea:**
Oil Spill Simulation	**Author**: Hope Phillips	Interpreting Relationships between Quantities that Vary

Real-World Connection:

The Gulf Oil Spill that occurred on April 10, 2010 was the worst in the nation. When BP's *Deepwater Horizon* well exploded, oil leaked into the Gulf for three months. In total, about 206 million gallons of oil leaked from the wellhead.

By the numbers:
Source: http://www.popularmechanics.com/science/energy/coal-oil-gas/bp-oil-spill-statistics

4.9 million: Barrels of oil (205.8 million gallons) leaked from the Deepwater Horizon well, about half the amount of crude oil the U.S. imports per day

19: Times more oil leaked from Deepwater Horizon than spilled from the Exxon Valdez in 1989 (10.8 million gallons)

62,000: Barrels leaking per day when the wellhead first broke day when the well was capped on July 15, roughly the amount of oil consumed in Rhode Island each day

397.7 million: Dollars' worth of the oil spilled at current market prices ($81.17 per barrel)

665: Miles of coastline contaminated by oil, roughly the amount of oil consumed in Delaware each day

53,000: Barrels leaking per

How Students will Experience the Connection: highlight in yellow all that apply

Video Clip	Photo	Podcast
Print Media (article, ad, etc.)	Vodcast	Other

GPS Standards:	**Objectives:**
M6A2. Students will consider relationships between varying quantities. a. Analyze and describe patterns arising from mathematical rules, tables, and graphs.	1. Given a volume of oil, students will calculate the area of the resulting circular spill. 2. Students will identify independent and dependent variables. 3. Given a scatterplot, students will describe

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M6P2. Students will reason and evaluate mathematical arguments. **M6P3.** Students will communicate mathematically. **M6P4.** Students will make connections among mathematical ideas and to other disciplines. **M6P5.** Students will represent mathematics in multiple ways.	the relationship between the volume of oil and the resulting spill area. 4. Students will use a scatterplot to predict the placement of data points not on the graph.

Materials:

Per Student
- Worksheets 1 and 2
- Pencil

Per Group of Two
- Dropper
- 8 toilet paper squares
- Large, thick paper (i.e. newspaper, legal-sized copy paper, etc.; large enough to hold 8 toilet paper squares)
- Calculator
- Centimeter ruler

Per Group of Four
- Small container filled with vegetable oil
- Paper towels for spills/clean-up

Teacher
- Overhead graphing calculator
- View Screen
- Overhead projector
- Video clip (see *Learn More* section below)

OR
- Online graphing application
- PowerPoint and/or video clip
- Regular or interactive whiteboard

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Related Task:

Ask students what they recall about the Gulf Coast oil spill of 2010. Lead a brief discussion and then show the PowerPoint and/or video clip. Allow students to comment/ask questions during/after the PowerPoint.

Today, we are going to simulate an oil spill using vegetable oil and droppers. Your job will be to describe the relationship that exists between the oil and the spill area. Look at Worksheet 1 so that you will know what you and your partner are required to do. You will work in pairs but will share some of your materials with your team of four (oil and paper towels).

Look at the table on Worksheet 1. What data will you collect, and what data will you calculate (*collect* --- measuring the diameter of the spill; *calculate* – radius from the diameter; area of spill using radius)? Why does the worksheet ask you for the *volume* of oil? Volume indicates a solid with three dimensions.

A *review* of volume and how to find diameter, radius, and area of a circle may be necessary. How does this relate to an oil spill (oil is actually three dimensional, having a thickness; most students will assume it is two dimensional)? We will indicate the volume of oil as the number of drops we use.

What shape do you think the oil from the dropper will form (a circle)? That is why one of the column headings on the table is *diameter*. You will measure the diameter using a centimeter ruler, rounding to the nearest tenth of a centimeter.

Be sure to locate with a pencil dot what will be the center of your spill area. This will be the center of your "circle." Label each toilet paper square with the numbers 1-8, and place a dot somewhere near the center of each piece.

Remember to be very careful when you release the oil from the dropper; make sure to count correctly, as well. Your data will only be as good as the care you take when completing the simulation.

When you are finished with the simulation, fill out the table on Worksheet 1.

Allow students time to complete the simulation as you walk from group to group observing, listening to the mathematical communication between partners, and fielding questions.

Ask a group who feels confident about their data to give you their area values to record on the x-y table on the board. Use this data to create a scatterplot on the graphing calculator, using the ViewScreen, for all students to see.

From the data you've collected, we will make a graph. The graph will be a

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scatterplot. When you think about a ***scatterplot***, think about the word ***relationship.*** A ***scatterplot*** is a collection of ordered pairs. This graph allows us to decide if a ***relationship*** exists among the ordered pairs. Create an x-y table on the board with labels *volume* and *area*, respectively.

Look at our tabular data. What did you notice about the area of the spill compared to the volume of oil? As the volume (number of drops) increased, the area (size of the spill) also increased. There is, then, a ***relationship*** between the area and volume.

Did any group have data in their tables that represented a relationship other than the one described OR *some* data values that did not follow this pattern? Some students may have spill areas that do not increase every time. Discuss with students why this may have happened. The following are examples of inconsistent data collection procedures: the size of the drops may not have been the same each time; the same person may not have been the "oil dropper" for all the releases of oil; someone may have miscounted the number of drops that were released. Remind students that this is real-world data and that it is not always "perfect."

We need to graph our data as a *scatterplot*. The independent variable is placed on the x-axis. The dependent variable is placed on the y-axis. Think about these labels. What do you think they mean in the context of our oil simulation? Volume (the number of drops) is the independent variable because the number of drops does not depend on anything. The area (size of the spill) is the dependent variable because it depends on the volume, or number of drops.

Even though we are graphing our data electronically, and not by hand, we still need to set a scale for each axis. Tell me what values to enter into the WINDOW of our graphing calculator. Ask questions that help students understand minimum and maximum "x" and "y" values and what increment would be the best for each axis.

What do you predict will be the shape of the graph? Answers may vary. Make the graph appear *after* students answer this question.

Describe the graph. Answers will vary. It should show evidence of being linear. Earlier we predicted from our tabular data that as the volume increased, the size of the spill increased. How does the graph show evidence of this? Data points should rise from left to right in the first quadrant. Most should appear to fall on or near an "invisible" line.

Since our data appear to be linear, or form a line, I am going to tell the calculator to graph the line. If using a hand-held graphing calculator, find the linear regression equation. Make the line appear on the screen and discuss whether or not it goes through a few, most, or all of the points.

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This is a good time to link the tabular data with the graphed data points. In the table, identify any data points from the graph that did not fall on or near the line. These data points will not follow the general trend of the area increasing as the volume increases.

Are you surprised by how many points were exactly on, near, or off of the line? Answers will vary. Link this discussion to the earlier discussion about inconsistent data collection procedures. What would be a good title for the graph? Answers will vary. One example would be, "How the Volume of Oil in a Spill Affects the Size of the Spill."

What other relationships can you think of that involve two variables that, generally, as one increases the other increases? Examples include: as education increases, income increases; as overtime work increases, paycheck amounts increase; as height increases, weight increases (Remind students that these are general trends and exceptions may exist.)

A relationship where an increase in one variable causes an increase in the other variable is called a *positive correlation*. Our scatterplot is an example of a *positive correlation*. We can use our positive correlation to predict where more data points would lie.

If I had a volume of 12 drops, where do you think the data point would lie? (Ask a volunteer(s) to come to the board to draw where this data point would lie.) Volunteers should place the dot to the right and above the data point for a volume of 8.

Why were you able to place a data point on the graph for a volume of 12 drops even though there are no numbers on the "x" or "y" axes? This scatterplot shows us the relationship between the two variables and the trend of the data. We know that as the volume increases, the area of the spill increases, so we can place the data point for 12 drops somewhere close to the data point for 8 drops but not right next to it because there are also data points for 9, 10, and 11 drops that we did not include.

Learn More:

http://rentcalculators.org/stheli.html
Click on link entitled "Free online graphing calculator"

Video Clip -
http://video.scholastic.com/services/player/bcpid1842760475?bctid=86097427001

Running time 1:51

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Your Name: _____
Your Partner's Name: _____

Oil Spill Simulation – Worksheet 1

MATERIALS: oil dropper; centimeter ruler; large sheet of paper; vegetable oil; 8 squares of toilet paper

DATA COLLECTION: Simulate an oil spill. Follow the steps below.

1. Label your toilet paper sheets with the numbers 1 – 8.
2. Place a pencil dot at the center of each toilet paper square.
3. Place the toilet paper squares in numerical order on the large sheet of paper.
4. Carefully place 1 drop of oil on the pencil dot on toilet paper square #1; 2 drops on the pencil dot on toilet paper square #2; continue until you have placed 8 drops on toilet paper square #8.
5. Measure the diameter of each oil spill to the nearest **tenth of a centimeter**.
6. Find the radius from the diameter.
7. Calculate the area of each spill. Round your answers to the nearest tenth.

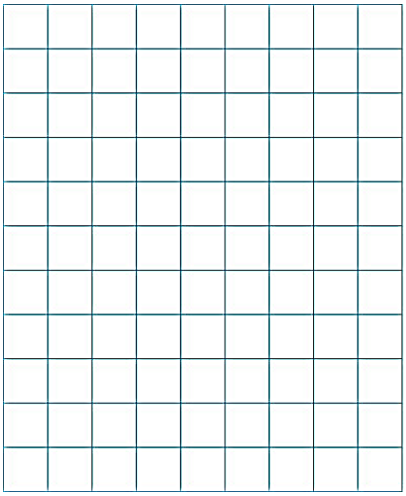
FILL IN THE TABLE BELOW FOR ALL EIGHT SIMULATIONS

Volume (drops)	Diameter (cm)	Radius (cm)	Area (cm^2)	Area/Vol.

Oil Spill Simulation – Worksheet 2

Directions: Answer the questions below using complete sentences. Your answers should relate to the simulation we did today in class.

1. Graph your data on the coordinate plane. What do the data points on the graph represent?



2. Explain the relationship between the volume of oil and the area of the spill.

3. Describe the graph of this relationship.

4. Why is “area” the dependent variable – the variable that goes on the “y” axis?

5. Explain why the graph of this relationship is a positive correlation?

6. Describe another relationship between two variables that would be a *positive correlation*. Do not use any of the examples we discussed in class.