Experimenting with Polynomial Models

An Italian physicist named Evangelista Torricelli observed that water flows faster out of a nearly full tank than out of a nearly empty tank. He noticed that the relationship between time and the volume of water in the tank is quadratic. Can a quadratic model that represents the flow of water out of a container be applied to a smaller container?
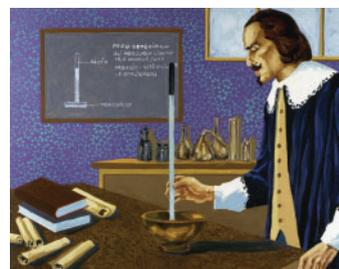
? **How does a quadratic model change when an experiment is changed?**

In 1643, Evangelista Torricelli invented the barometer, a device for measuring atmospheric pressure.

Part 1: Generate the Data

A. Work in a small group. Find two containers that are different shapes or sizes. Each container must be made from a material that allows you to puncture it with a nail to create a drainage hole. You may use plastic cups, water bottles, juice boxes, or any other containers that can hold from 500 mL to 1000 mL of water. The containers must have an open top.

B. Start by marking a 50 mL scale along the inside of each container, using a graduated beaker or measuring cups. This scale will help you measure the volume of water as the containers empty.

C. Puncture the side of each container, near the bottom. Use a nail, 2 or 3 mm in diameter, to make holes that are approximately the same size.

D. Cover the hole in the larger container, and fill the container with 500 mL of water. Use a basin to collect the water that will drain out.

E. Before uncovering the hole, decide who will watch the water and indicate when it reaches each 50 mL increment on the scale, who will read the time, and who will record the time.

F. Uncover the hole, and allow the water to drain into the basin. Collect and record your data.

Part 2: Analyze the Model

G. Using technology, create a scatter plot and perform quadratic regression for your data. Relate the coefficients and constant in the equation of the regression function to the characteristics of the data in the scatter plot.

H. Using your model, predict when a smaller container will be half full and when it will be empty.

I. Repeat steps D to F using a smaller container.

J. Were your predictions accurate? If not, repeat step G using your data for the smaller container. How do the two models compare?

Task | *Checklist*

✔ Did you label your graphs?

✔ Did you show your work?

✔ Did you provide appropriate reasoning?

✔ Is your reasoning clearly presented?