SUPERMATH

Introduction To Geometric Shapes

GOAL(S) OF THE UNIT: For students to learn that geometric shapes are important in the real world, both in the natural world and in the man made parts of the world.

Duration	1-2 days
Approach	Use geometric shapes to design the strongest possible bridge
Supermath software	Bridgit
Pre/Corequisite skill	None

Overview of the software:

In the BRIDGIT program students use geometric shapes to design a bridge. A design consists of a shape for the span and then a pillar. The goal is to design the strongest possible bridge given the available shapes capable of supporting the largest weight of vehicles.

Different designs will have different carrying capacities. The forces exerted on a bridge are both shear (horizontal and vertical forces) and bending (twisting forces) as expressed in kpf, or thousand pound feet. The forces are generated both by the weight and movement of the vehicles.

The process of using this program is to: a) design a span, b) choose a pillar, and c) test the bridge.

To test the bridge choose a selection of vehicles (busses, cars, and trucks). The goal is to get the bridge to stand up for the largest possible weight.

Starting discussion with students:

Each geometric shape has special properties that make it desirable for different applications. What are some objects in the everyday world that is made up of more than one geometric shape and what are the shapes? Entertain student responses. Then say:

Sometimes a shape is important for making something look beautiful, like trapezoids in a snowflake or in jewelry. In other cases the shape is important for making something function better. For example, the oval shape of a dolphin's head makes it able to swim faster. Indeed, many designs made by humans are based on shapes found in a related object in nature. For example, the front of submarines are designed to look like the front of a fish, as are professional bicycle helmets. The next few days we are going to explore the benefit of using different geometric shapes in the design of a common object designed by humans—bridges. What is the most important characteristic of a bridge? (Strength)

You are going to design and test the strength of bridges you design using geometric shapes. Strength is measured in terms of the shear and bending force. Just follow the direction for adding the parts of the bridge and then add vehicles to test its strength. Your goal is to find the bridge design that can support the most weight. You will see on the screen the bending and shear force capacity of the bridge that you design as well as the force that the vehicles exert on the bridge. What will happen if the capacity of the bridge is less than

the bending and shear forces exerted by the weight of the vehicles? (It will collapse.)

TEACHER NOTE: The bending force is a vertical force and the shear force is the horizontal force.

I want you to keep track for each bridge you design: The weight on the bridge, and, if it collapses, which force caused it to collapse and what the difference was between capacity and actual force.

Pedagogical technique:

Have students keep track of the maximum weight that they have been able to support over three straight tests, as well as analyzing which data are indicating the cause of collapse (i.e., usually the problem is that the maximum bending force capacity of the bridge is less than the bending force exerted). Have them call you over to show you the results of each test. Get them to notice the differences between force capacity and the fotce exerted for each of the forces.

Discuss with students the design they have tried. Once students think that they have a solution for the design that will support the most weight, they have to test it three times. The shear and bending forces exerted by a given group of vehicles will vary, depending on how closely together they are driven. The vehicles are not driven exactly the same each time. Therefore, a bridge may stand up for one pass of a specific mix of vehicles one time, but not the next. The closer that the vehicles are driven together (determined by the computer), the higher the forces the same group of vehicles will produce. As a result, students cannot really be sure that a particular design will stand up until it has been tested at least three times.

Teacher solution (Do not show this to students):

The maximum weight for the bridge to carry is using 1 bus and 7 trucks for a total weight of 41,800 lb. The best design is for using an 'arc' for the span, and the thick rectangle for the pillar, and to use one bus and 7 trucks.