Authentic Teaching Alliance

Geodesic Dome

Santa Fe South High School — Spring 2003

Lesson Information

- **Grade Level**

  10-11

- **Subject areas**

  Geometry

- **Duration**

  (65 minute class periods)
  1-3 periods to build the models
  1-2 days to take measurements and complete problems

- **Setting**

  Classroom

- **Vocabulary**

  Circumference
  Surface area

- **Materials (per group of 2-3)**

  Paper cutter or scissors
  Minimum 120 colored plastic drinking straws (not flexible)
  (note: 30 yellow, 40 blue, and 50 red straws)
  61 pipe cleaners
  One roll of masking tape
  One freezer bag (to store materials)

- **Background Knowledge**

  Be familiar with using a ruler or tape to measure a line.

  Know the formulas for the area of a triangle, square, and a circle.

- **Additional Resources**

  Web sites consulted to create this lesson:
  Pictures, building instructions, and dome calculator
  www.desertdomes.com
  (see Appendix A, B, and C)
  (Note: the model is based on the 5/8 3-frequency dome from this website.)
  Blake, Trevor. "How to Build a Geodesic Dome Model."
  http://architecture.about.com/library/ucdome.htm
  "History of Geodesic Domes."
  http://www.domeincorporated.com/history.html
  "Geodesic Dome." http://pbskids.org/zoom/sci/geodome.html

Summary

Geodesic domes are unique building structures that are used throughout the world due to their many efficient benefits. This activity is designed to allow students to research geodesic domes using the internet and construct a scale model. From the models the students will be able to fully understand the geometric properties of the dome structures that make them unique. Students will measure the height, surface area, and footprint of their scale model domes. After taking measurements, the students will compare the surface area of the domes to a standard square building style surface area.

The students of Santa Fe South High School construct scale model geodesic domes from colored straws.

Objectives

Students will:

- Research geodesic domes on the internet
- Construct a scale model geodesic dome
- Take measurements of the dome (height, surface area, and footprint)
- Compare the surface area of the dome to a standard square building style surface area

Oklahoma Priority Academic Student Skills Objectives

Process Standards, Grades 9-12
I.A: Apply a wide variety of problem-solving strategies (identify a pattern, use equivalent representations) to solve problems from within and outside mathematics.

V.D: Use a variety of mathematical representations as tools for organizing, recording, and communicating mathematical ideas (e.g., mathematical models, tables, graphs, spreadsheets).

Geometry Content Skills, Grade 9-12
II.B.1: Use properties of 2- and 3-dimensional figures to determine unknown values (e.g., given the perimeter/circumference, find the area).

Procedures

Day 1: Research and Preparation

Research:

- Have students search the internet to answer the following questions concerning geodesic domes (see Appendix E for reference)
- What is a geodesic dome?
- What are the benefits to building a geodesic dome?
- Who uses geodesic domes?

Preparation:

- Cut the straws to the appropriate lengths given below.
- Using the actual length of the straw for strut C will save cutting that length. (most straws are 7.75" in length)

Straw Lengths Used:

A = 6.55" (30 yellow)
B = 7.58" (40 blue)
C = 7.75" (50 red)

These lengths were determined using the 3 frequency reverse calculator, located at: www.desertdomes.com/rev3calc.html
(see Appendix A and C)

Use pipe cleaners to make 4-way, 5-way, and 6-way connectors.

Number of pipe cleaners used:

4-way connectors = 15(cut 15 pipe cleaners in half and twist together to make an X)
5-way connectors = 6 (cut 6 pipe cleaners in three parts and twist together)
6-way connectors = 25 (cut 40 pipe cleaners in three parts and twist together)

Day 1-3: Beginning to Build

- After the students have cut their colored straws and assembled connectors, you should give each group a color copy of the dome diagram (see Appendix B) and a roll of masking tape.
- Tell each group to build the dome using the picture, straws, and pipe cleaners.
- Use tape to secure the dome as the students build (be careful to not use too much tape, it can weigh down the dome).
- You may want to have a completed dome on hand to show them the final product.
- Students should be given minimal help during this period. Tell them to figure it out.
- When the domes are almost complete, they will not fit together properly unless the diagram is followed. You may want to assist students in finding any mistakes they might have made earlier.
  Note: The domes will be used for assessment purposes.

Procedures cont.

Taking Measurements

- After students complete their domes, they should measure the height of their dome and estimate the covered area using a circle that fits inside the dome's footprint.
- They should also measure the dome's surface area by counting the number of RRB (red,red, blue) and BYY (blue, yellow , yellow) triangles.
- The area of each type of triangle should be found (RRB or BYY), and then multiply that area by the number of triangles of each type.
- Add the two totals for RRB and BYY triangles to get total surface area.

(To make counting easier: Students may want to use tape to mark the triangles they have already counted.)

For teacher reference, in this dome there should be 30 BYY and 75 BRR triangles.

Analysis

- After taking their measurements, you should have the student groups compare their height, surface area, and footprint to other groups' domes.
- You may want to have the students take the average of all their measurements, and ask them if there are any numbers that should be thrown out as outliers. (this will identify groups with large errors)
- After a final number is decided, the teacher should construct the dimensions of a square building. Use the same footprint area of the dome for the base, and make the building perfectly square. (example: dome base is 36', and your square building is 6' x 6' x 6'.)
- Ask the students how many sides are on your square building, not including the floor (5), and then ask them to calculate the surface area of the square building.
- Ask them which building covers more space (footprint) for less outside building materials (surface area).
- Have students complete the geodesic dome worksheet (Appendix D)

Possible Extensions

- Students can build a full size dome using conduit.

  See www.desertdomes.com for full instructions. Again, this is a 3/8 3-frequency dome.

Assessment

- Quality of work on their model dome. (used all materials and dome fits together)
- General accuracy of measurements and calculations on the dome. (radius should be 18.8 inches, height should be 18.8 inches, surface area should equal 2220 in^2.)
- Worksheet (See Appendix D)