Science Days
Cambridge Summer Tour 2008

Lesson Plan: Marshmallow towers!

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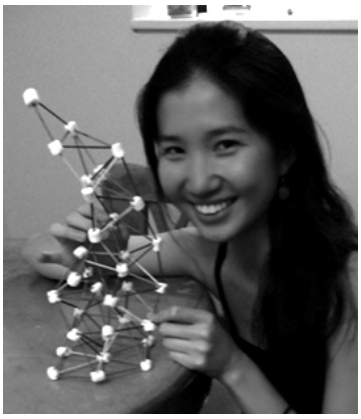


Introduction: Hey kids, have you ever wondered what architects and civil engineers do? Do you ever think about what goes into constructing a building? Do you recognize these buildings? [Use visual aids 1,2] Do you know what the world's tallest buildings are? [Use visual aids 3,4]

The concepts of the lesson: principles of structural engineering, including force, geometry, statical determinacy. And of course, teamwork!

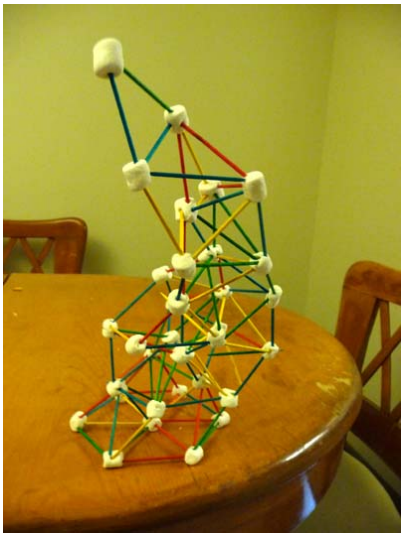
Materials used:

- Bags of marshmallows (Shaws, $1/bag)
- Colored toothpicks (Shaws, $1/ 250 toothpicks)
- For demonstration: Bigger marshmallows ($1/bag) and spaghetti ($1.69/bag)
- Ruler or measuring tape (for determining the winning group!)

Starter questions:

- What shape can you make with four equal sides? [A square! A rhombus! A diamond… you can make an infinite number of shapes with four sides]
- What shape can you make with three equal sides? [Equilateral triangle!]
- What shape would be stronger? [Demonstrate with big marshmallows and spaghetti] A triangle, or a square?

Goal of lesson: A competition to see who can build the *tallest* structure out of a limited number of toothpicks and marshmallows!



Instructions:

1. Split kids into groups of 2-3. (For 50 kids, we would have 16-25 groups altogether, but we'll teach only 5-8 groups at a time)
2. Give each group 50 marshmallows and 100 colored toothpicks. Be sure to remind them not to prick themselves (or each other) with the toothpicks…the ends are sharp.
3. Let them build! Set a time limit: 20 minutes, for example.
4. Help them along the way with hints: 1) triangles are stronger than squares, 2) a strong foundation goes a long way, etc…
5. Measure the heights of each structure to determine the winning group!

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Post-activity discussion:

1. What did everyone learn? What were some of the problems that everyone encountered in their construction?
2. Did everyone come to realize that triangles are stronger than squares? So here's a problem: human beings love to live in square shaped things (for example, the room we're in). So, how do we make things strong?" [We use trusses, or framing, see Visual Aid 5-7]

For the more advanced kids…

- Calculate the forces on a free-standing triangle or square, and prove that shapes other than triangles are statically indeterminate.
- For a static system, all the forces must balance out.

  $\sum \vec{F} = 0$: The sum of all forces acting on the system must be zero. Which also means that:
  1) the sum of the horizontal components of the forces equals zero
  2) the sum of the vertical components of the forces equals zero