NUMB3RS Activity: The Crowded Ballroom
Episode: "Brutus"

Topic: area, perimeter, percentages   **Grade level:** 9 - 10
Objective: To estimate the size of a crowd
Time: about 45 minutes
Materials: tape measures, yard sticks, or meter sticks

Introduction

At one point in "Brutus," Charlie and Amita help the FBI model real-time crowd dynamics in a crowded ballroom. In this activity students will develop a method for determining the size of a crowd in a ballroom (or any other setting).

Discuss with Students

At the start of this activity students are asked to invent a method for estimating the size of a crowd. Four possible methods are given in the answers section and it will be interesting to see what your students propose.

Have your students set up rectangular areas where a group of them will stand. The idea is to simulate what it is like in a crowded space. These rectangles can be set up in or out of your classroom. You will need tape measures, yard sticks or meter sticks to form the rectangles.

Student Page Answers:
1. *Answers will vary. Possible answers include observing how long it takes people to file out afterwards, or how "densely packed" the crowd appears to be* **2. Method 1**: *You could first estimate how much space a person occupies in a crowded area by simply having a group of people stand in a space with a set area. Then you could measure the area where the event took place (this might be hard to measure, so an estimate might be the best you can do). Then you can divide the area by the average amount of space that each person occupies to find the number of people who were there.* **Method 2**: *You could estimate how much garbage is in the area after the event. Sometimes, there is a relationship between how much garbage remains in an area after an event and the number of attendees. You can read more about this unusual method at **http://gaspee.com/CrowdEstimates.htm** Method 3*: *You could make use of photographs taken from a plane or a satellite. The estimates can and do vary depending on who does them and the techniques used. The organizers of an event may use a technique that gives a large number of attendees to show that many people support their cause. Or, one political party may choose a method that underestimates the crowd at another party's event. Consult the Web sites listed in the Extensions section for more information about counting crowds.* **3.** *Students will find that a person occupies around 1.5 to 2.0 square feet of space in a crowded environment. This figure will vary, of course, depending on the mix of people (children, adults, etc.). Students' estimates will vary.* **4.** *No; there are many possible different rectangles for a given perimeter, and areas of these rectangles will vary (as will the number of people who can stand in the space).* **5.** *It is not true; the area does not increase by 25%, it increases by 56.25%.*

Name: _____ Date: _____

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1. A journalist is asked to cover a major event in a large ballroom. She wants to include a note about how many people attended the event. How could she estimate the number of people without actually counting everyone?

2. Describe several different methods that could be used to estimate the size of a crowd at an outdoor political event. How might the estimate of the crowd size supplied by organizers of the event differ from estimates made by other groups? Why?

3. Find a location where you can make a rectangle that measures 5 feet by 5 feet. Have your classmates stand close to each other inside this rectangle (as if you are in a small area watching a music concert). Count the number of people you can fit in this rectangle and find the ratio of this number to the area of the rectangle. Then use a proportion to estimate the number of people who could fit into a rectangle that measures 6 feet by 9 feet.

4. Can the perimeter of a rectangle be used to provide an accurate estimate of the number of people standing inside of it? Why?

5. Suppose that a crowd has gathered in a rectangular ballroom with an area of 5,000 square feet and that the room is filled to capacity. If each side of the ballroom were enlarged by 25%, determine if it is true that 25% more people could stand inside this larger ballroom.

The goal of this activity is to give your students a short and simple snapshot into a very extensive math topic. TI and NCTM encourage you and your students to learn more about this topic using the extensions provided below and through your own independent research.

Extensions

Would it be possible to fit everyone in the world into a cube that measures one mile by one mile by one mile?

This is an example of a Fermi Question—an estimation problem designed to teach dimensional analysis, approximation, and the importance of clearly identifying one's assumptions. Numerous examples of these questions can be found at the Web sites below.

- Sheila Talamo - Fermi Questions
  http://mathforum.org/workshops/sum96/interdisc/sheila1.html

- Fermi Questions
  http://www.physics.uwo.ca/science_olympics/events/puzzles/fermi_questions.html

- Old Dominion University Fermi Problems Site
  http://www.physics.odu.edu/~weinstei/wag.html

Additional Resources

Counting crowds is very tricky, and there is a great deal of variation in estimates that are reported to the media. Information can be found at the following Web sites:

- The Hong Kong 7/1 March: Crowd Size Estimates
  http://www.zonaeuropa.com/20040702_1.htm

- Counting crowds: Using Aerial Photography to Estimate the Size of Sunday's Peace March in San Francisco
  http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2003/02/21/MN20213.DTL

- Crowd Estimates
  http://gaspee.com/CrowdEstimates.htm

- Protests and Mobilizations: How Do We Know How Big They Are?
  http://electionupdates.caltech.edu/2006/04/
  protests-and-mobilizations-how-do-we.html