## Five's a Crowd

Grade: 6th to 8th
Periods: 2
Author: Unknown

## Materials

- World map with names of countries or US. map with names of states
- Communities A and B Activity Sheet
- Game Recording Sheet
- Population Densities Activity Sheet
- Dried peas (at least 120 per group)
- Calculators (Optional)


## Instructional Plan

Prior to the lesson, it may be helpful to review the concept of population density: a measure of how crowded a region is. The number of people per square mile, per square km , or other unit area.

Distribute the Communities A and B Activity Sheet.

## Communities A and B Activity Sheet

Ask students to think of each grid as a community. The peas represent people.
Tell students to make a pile of 40 peas and a pile of 80 peas. Have them carefully scatter the pile of 40 peas on Community A and the pile of 80 peas on Community B.


Then ask and discuss these questions:

- Which community has more people? [Community B.]
- Which community appears to be more crowded? [Community A.]

Explain that one way to tell for sure which community is more crowded is by distributing the peas evenly on each grid. Have students do this so they can see how many people would occupy each square.

( 1 pea per square unit)

Next, ask and discuss the following questions:

- How many people are there for each square in Community A? [1 person per square.]
- In Community B? [2 people per square.]
- Would you say that Community B is twice as crowded as Community A? Why? [Yes, because there are twice as many people in each square.]

Explain that the average number of people for each square unit is called population density, as was introduced at the beginning of the lesson.

Record the data for the two communities on a chart:

| Community | Number of <br> People | Area (square <br> units) | Population Density (people <br> per square unit) |
| :---: | :---: | :---: | :---: |
| A | 40 | 20 | 2 |
| B | 80 | 80 | 1 |

Ask the students how they could calculate the population density without using peas or other objects. Guide them to see that if you divide the number of people by the number of square units, you get the population density (the number of people per square unit).

## Activity: Classroom Crowding

Have students imagine that the number of students in the class doubled (but the classroom stayed the same size).

Ask students to discuss the following questions:

- How would the conditions in the classroom seem compared to now? [More crowded, more noise, less space per person.]
- How would this affect teaching and learning? [Answers may vary, but students will probably agree that both would be more difficult. Students would feel less safe, feel less comfortable, and would get less individual attention. Teachers would find it more difficult to meet individual needs of students.]
- What if the number of students stayed the same but the classroom was half the size? [Responses may vary, but help students see that this would also make the room more crowded in the same way as doubling the number of students.]


## Activity: Estimating Population Density

Display the area and population of the United States.

| Country | Population <br> (1997 estimate) | Area <br> (square km) |
| :---: | :---: | :---: |
| U.S. | $271,648,000$ | $9,363,520$ |

Ask students to discuss the following questions:

- On average, about how many people are there in the U.S, for each square kilometer? How did you make your estimate? [One method is to round the population and area, and then divide: $270,000,000 \div 9,000,000=270 \div 9=30$.]

At this point, it may be helpful to ask students what population density is.
Write the area and population data for two more countries:

| Country | Population <br> (1997 estimate) | Area <br> (square km) |
| :---: | :---: | :---: |
| U.S. | $271,648,000$ | $9,363,520$ |
| Denmark | $5,248,000$ | 43,077 |
| Ghana | $18,338,000$ | 238,533 |

Ask the students to answer and discuss the following questions:

- Which of these two countries is more crowded (has a greater population density)? [Denmark]
- How can you tell? [The number of people per square kilometer in Denmark is about $5,000,000 \div 40,000=500 \div 4=125$. The number of people per square kilometer in Ghana is about $18,000,000 \div 200,000=180 \div 2=90$.]

Another way to determine which country is more crowded is to realize that Ghana has about 3.6 times as many people as Denmark, but the area of Ghana is about 6 times the area of Denmark, so Ghana has a lower population density than Denmark. (Note that the ratio of 3.6 to 6 is less than 1; if this result were greater than 1, then Ghana would have a higher population density.]

## Demonstrate the game "Five's a Crowd."

Note: To play this game with countries, follow the first two steps as listed below. To play this game with states, use the State Data Handout with the first two steps, and then the remaining steps as indicated below.

Student teams visit a website and together they choose 5 countries. For example, a team might choose Romania, Ghana, Denmark, Indonesia, and Libya.

On the site(s), students request the area and population for each country. For the five countries in the example above, the data would look like this:

| Country | Population | Area <br> (square km) |
| :--- | :--- | :--- |
| Denmark | $5,248,000$ | 43,077 |
| Ghana | $18,338,000$ | 238,533 |
| Indonesia | $203,479,000$ | $1,904,569$ |
| Libya | $5,784,000$ | 1759,540 |
| Romania | $22,606,000$ | 238,391 |

Teams have three minutes to order the five countries or states from most crowded (greatest population density) to least crowded, and list them on their Game Recording Sheet. You can adjust the time limit, depending on student's ability to estimate quotients of large numbers.

Game Recording Sheet
For example,

| Team's List | Actual order | Points Awarded |
| :---: | :---: | :---: |
| Indonesia |  |  |
| Romania |  |  |
| Libya |  |  |
| Ghana |  |  |
| Denmark |  |  |
|  | TOTAL |  |

Students should then calculate the population densities or request that data from a web site. For computation purposes, they should record or print their data in a table as follows:

| Country | Population | Area $\left(\mathrm{km}^{2}\right)$ | Population Density <br> (people per $\mathrm{km}^{2}$ ) |
| :---: | :---: | :---: | :---: |
| Denmark | $5,248,000$ | 43,077 | 122 |
| Ghana | $18,338,000$ | 238,533 | 77 |


| Indonesia | $203,479,000$ | $1,904,569$ | 106 |
| :---: | :---: | :---: | :---: |
| Libya | $5,784,000$ | $1,759,540$ | 3 |
| Romania | $22,606,000$ | 238,391 | 95 |

State information (as of 2004) is available in the activity sheet below.

Population Densities Activity Sheet
The teams write the actual order of the countries or states and calculate their score as follows:

5 Points for each country listed in the correct place
3 Points for each country off by 1 place
1 Point for countries off by 2 places
0 Points for countries off by 3 or more places
For example,

| Team's List | Actual Order | Points Awarded |
| :---: | :---: | :---: |
| Indonesia | Denmark | $\mathbf{3}$ |
| Romania | Indonesia | $\mathbf{3}$ |
| Libya | Romania | $\mathbf{1}$ |
| Ghana | Ghana | $\mathbf{5}$ |
| Denmark | Libya | $\mathbf{0}$ |
|  | TOTAL | $\mathbf{1 2}$ |

Allow teams to discuss how they determined their scores. The team with the most points wins the round.

After demonstrating the game, organize the class into teams of 2-3 students. Have each team play against another team. Teams can play two or more rounds of the game. As teams try to put the countries or states in order, use the opportunity to give help as needed with estimation and to assess students' ability to estimate. While students determine the actual order and calculate their score, assess student progress by observing and asking the questions listed below.

## Assessments and Extensions

## Extensions

12. Students consider and write about what it might be like to live in a small country with a lot of people or a large country with few people.
13. Students play a variation of Five's a Crowd, in which teams try to list the countries or states in order before seeing the area and population figures. They use what they know about the countries or states to get a sense of how crowded they are.
14. Students create their own game that uses data from the same Web site.
15. Students critique the scoring system for Five's a Crowd. Then they create a method of scoring that they think would be fairer, one that would better indicate which team's list was closer to the actual order. Students try out their system by applying it to the rounds of the game they've already played and to additional rounds as well.
16. Students present their scoring systems and explain why they think theirs are better than the original.

## Questions and Reflections

## Questions for Students

1. Ask these questions about the on-line data:

* Were you surprised by any of the data?
* What did you learn from the data?
[Students may not have had a good sense of the size or population of some of the countries they chose.]

2. Ask these questions about ranking the countries (or states):

* How did you decide which country (or state) was most crowded? Least crowded?
* Did you estimate? How? Did you round the numbers? Give an example.
[Yes, for Denmark, we rounded 5,248,000 to 5,000,000 and we rounded 43,077 to 40,000. so that we had numbers that we could divide mentally. 5,000,000 / 40,000 is the same as $500 / 4$, which is 125.]
* Did you use numbers that work well together? Give an example.
[Yes, for Libya, we changed 5,784,000 to 6,000,000, and we changed 1,759,540 to $2,000,000$ so that we had numbers, which were easy to compute. Then we could divide mentally. $6,000,000 \div 2,000,000$ is the same as $6 \div 2$, which is 3 .]
* Was the actual order about what you expected? Why or why not?

3. Ask these questions about scoring:

* Is this an easy game to score? Why or why not?
* What are the rules for scoring in this game?
* Why did you award yourselves _ points for that country?
[Student responses may be of the form: "Romania is third in population density. Since we put it second, we were one off from the correct placement. A ranking that is off by one place earn 3 points."]
* How did you figure out the rest of your score?
[Answers will vary, but students should say that they compared their rankings with the actual rankings and checked the scoring system to see if they got any points.]

4. Pose questions like the ones below to encourage students to evaluate the game and to assess student progress.

* Did your ability to rank countries improve as you played more rounds of the game?

Why or why not?

* What have you learned from the data you collected?
* Did you think the game was fair? Why or why not?
* Did you think the scoring system was fair? Did the score always show whose list was closer to the actual order? Why or why not?
* Did you check to see if the Web site always calculates population density correctly?

Note that in January 2000, the population densities given by the site were not always consistent with the area and population data.
For example,

| Country |  | Population |  |  | Density |
| :--- | :--- | :--- | :--- | :--- | :--- |
|  | Area |  | Population Site's | Actual |  |
|  |  |  | Figure | Quotient |  |
| Denmark | $5,248,000$ | 43,077 | 121 | 122 |  |
| Ghana | $18,338,000$ | 238,533 | 73 | 77 |  |
| Indonesia | $203,479,000$ | $1,904,569$ | 102 | 106 |  |

5. Ask students, "Why is it important to determine whether data is reliable?" Help students see that you can make the wrong decisions if you base them on calculations made from incorrect data. For example, if you calculate unit price to decide which package of batteries to buy, you may not choose the best buy if you start with incorrect prices.
6. Pose these problems about the scoring system.

* What is the highest score you can get in a round? How?
[The maximum points for one round is 25 , which can be earned by getting all five in the correct order.]
* Suppose a team scored 14 points with the five countries (or states) you chose. Show what their list might have been.

| Team's List | Actual Order Points Awarded |  |
| :--- | :--- | :--- |
| 1. Indonesia 1. Denmark | 3 |  |
| 2. Romania | 2. Indonesia | 3 |
| 3. Ghana | 3. Romania | 3 |
| 4. Denmark | 4. Ghana | 0 |
| 5. Libya | 5. Libya | 5 |
|  | Total |  |

* Why is a score of 20 impossible for a team in one round? (Hint: If four of the countries or states are ranked correctly, what must be true about the other one?)
[If four were ranked correctly, the other one must be correct as well, so you would get 25 points, not 20.]
* Is a score of 0 possible? (Hint: think about the country or state that's third place in the actual order.)
[It's not possible, because no matter where you place the one that's actually third, you will get at least 1 point.]
* What is the lowest possible score for one round?
[It is possible to get a score of 3, but not less. For example, for the countries shown above, the following order yields a score of 3: Ghana, Libya, Denmark, Indonesia, Romania. Students should convince themselves that it is not possible to get less than 3 points.]


## Objectives and Standards

## Learning Objectives

Students will:

- Understand how area and population affect population density.
- Estimate quotients of large numbers.
- Create, use, and compare mathematical models.

