Five's a Crowd: A Game of Population Density

I. **Overview**
II. **Conducting the Lesson**
III. **Teacher to Teacher**
IV. **Handouts**

I. OVERVIEW

Lesson Summary

Students play a game in which they try to list 5 countries or states in order from most crowded to least crowded. Using area and population data from a web site, they estimate quotients to make their list. They determine whose list is closest to the actual order by applying a mathematical model (scoring system), which they later evaluate.

As extensions, students try to develop a better scoring system for the game and explore mathematical and social issues related to population density.

Grade Level	6 – 8

Estimated Time	• Pre-activity- 1 period (of about 45 minutes) • Activity - 2 periods • Extensions - about 1 period each
Objectives	• To understand how area and population affect population density • To estimate quotients of large numbers • To decide whether a game is fair • To create, use, and compare mathematical models (specifically, models for describing the closeness of two lists)
Materials	• World map with names of countries or US. map with names of states. • State Data Handout (If researching state data) • Recording Sheet. • Access to web sites used in this lesson

• (Optional) Calculator.

NCTM Standards   Number and Operation, Data Analysis and Probability, Problem Solving

Web sites   www.un.org/pubs/CyberSchoolBus/infonation/e_infonation tm
On this site you can choose up to 7 countries and obtain a wealth of information about each country: life expectancy, average temperature, population, area, etc. In this lesson, students obtain area and population data. Students can request the site compute the population density, or students can compute the data on their own.

www2.crcmich.org/ALMANAC/SOCNECON/popstate.ht m
This site shows a chart of the 50 states and lists the population, area and population density of each state.   In this lesson students use the site to check their population density calculations against those given on the site.

http://putwest.boces.org/Standards.html
Correlation To State Standards
Visit this web site to verify or modify the teaching of this lesson so that it is in alignment with your local/state standards requirements.

-

II. CONDUCTING THE LESSON

Outline
A. Pre-Activity
B. Introducing the Activity
  1. Classroom Crowding
  2. Estimating Population Density
  3. Demonstrate the Game *Five's a Crowd*
C.   Doing the Activity
D.   Students Reflecting on the Activity
E. Extensions

Vocabulary

Population density -- A measure of how crowded a region is. The number of people per square mile, per square km, or other unit area.

> *[**Teaching Notes:** Teaching notes, answers, and sample responses are shown indented and in italics.]*

A. PRE-ACTIVITY

Objective

To understand population density and see how division is used to calculate it

Materials

• Handouts A

• Handout B

• Dried peas (at least 120 for each group).

Activity

Let students think of each grid as a community. The peas represent people.

1. 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.

(40 peas)

(80 peas)

Guiding Questions

Then ask and discuss these questions:

- Which community has more people?

    [B]

- Which community appears more crowded?

    [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 there are for each square.

xx	xx	xx	xx
xx	xx	xx	xx
xx	xx	xx	xx
xx	xx	xx	xx
xx	xx	xx	xx

(2 peas per square unit)

x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x

(1 pea per square unit)

Guiding Questions
- How many people are there for each square in Community A?

   [1]
- In Community B?

   [2]
- Would you say that Community B is twice as crowded as Community A?

   [yes]
- Why?

   [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*.

Record the data for the two communities on a chart:

Community	Number of People	Area (number of (square units)	Population Density (people 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).

B. Introducing The Activity

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

Guiding Questions
• How would the conditions in the classroom seem compared to now ? *[more crowded, more noisy, etc.]*
- 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.]

2. Estimating Population Density
Display the area and population of the United States.

Country	Population (1997 estimate)	Area (square km)
U.S.	271,648,000	9,363,520

Guiding Questions
- On average, about how many people are there in the U.S, for each square kilometer?
- How did you make your estimate?

   [Sample response: rounded the population and area and then divided. 270,000,000 _ 9,000,000 _ 270 _ 9 = 30]

Review the term **population density**, which is a way of describing how crowded a place is by stating the average number of people in each square kilometer or square mile (or other unit of area).

Write the area and population data for two more countries:

Country	Population (1197 estimate)	Area (square km)
U.S.	271,648,000	9,363,520
Denmark	**5,248,000**	**43,077**
Ghana	**18,338,000**	**238,533**

Guiding Questions

- Which of these two countries is more crowded (has a greater population density)?

  [Denmark]

- How can you tell?

  [Sample response: The number of people per square kilometer in Denmark is about 5,000,000 / 40,000 = 500/4 =125. The number of people per square kilometer in Ghana is about 18,000,000 / 200,000 = 1800 / 20=90)

  Show students another way they could have determined which country is more crowded:

  Ghana has over 18,000,000 people and Denmark has over 5,000,000 people. So, Ghana is about 3 or 4 times more populated than Denmark.

  The area of Ghana is close to 240,000 sq. km and Denmark's is close to 40,000 sq. km. So the area of Ghana is about 6 times the area of Denmark.

  Since the area is 6 times greater and the population is only 3 or 4 times greater, Ghana must have a lower population density than Denmark.]

3. Describe or demonstrate the game *Five's a Crowd*.

GAME RULES

Note: To play this game with countries, follow steps 1 - 7 as stated below.

Note: To play this game with states, use the State Data Handout with Steps 1 and 2. Then follow steps 3 - 7 as stated below.

1. Student teams visit a web site and together they choose 5 countries. For example: Romania, Ghana, Denmark, Indonesia, Libya. The web site is:www.un.org/pubs/CyberSchoolBus/infonation/e_infonation.htm

2. On the site, students request the area and population for each country. For the 5 countries in the example above, the data would look like this:

Country	Population	Area (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

3. Teams have 3 minutes to try and order the 5 countries or states from most crowded(greatest population density) to least crowded, and list them on their Recording Sheet

For example:

TEAM'S LIST	ACTUAL ORDER	POINTS AWARDED
1. Indonesia		
2. Romania		
3. Libya		
4. Ghana		
5. Denmark		
	TOTAL	

You can adjust the time limit for this step, depending on students ability to estimate quotients of large numbers,

4. Students either calculate the population densities or request that data from the web site and then record or print their data. For example:

Country	Population	Area (square km)	Population Density (people per sq. km)
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

For states, the web site is:

www2.crcmich.org/ALMANAC/SOCNECON/popstate.htm

5. The teams write the actual order of the countries or states. For example:

TEAM'S LIST	ACTUAL ORDER	POINTS AWARDED
1. Indonesia	**1. Denmark**	
2. Romania	**2. Indonesia**	
3. Libya	**3. Romania**	
4. Ghana	**4. Ghana**	
5. Denmark	**5. Libya**	
	TOTAL	

6. Teams 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.

Example:

TEAM'S LIST	ACTUAL ORDER	POINTS AWARDED
1. Indonesia	1. Denmark	**3**
2. Romania	2. Indonesia	**3**
3. Libya	3. Romania	**1**
4. Ghana	4. Ghana	**5**
5. Denmark	5. Libya	**0**
	TOTAL	**12**

7. Teams discuss how they determined their scores. The team with more points wins the round.

C. Doing the Activity

Organize the class into teams of 2-3 students. Have each team play against another team. Teams play 2 or more rounds of the game.

As teams try to put the countries or states in order, use the opportunity to provide 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 questions.

Guiding Questions

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.]*

Guiding Questions

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.

    [Sample response: 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.

    [Sample response 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 ÷ 2,000,000 is the same as 6 ÷ 2 which is 3]

- Was the actual order about what you expected? Why or why not?

Guiding Questions

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 3 points for that country?

    [Sample response: Romania is third in population density. Since we put it second, we're just one off from the correct placement. A ranking that is off by 1 place gives us 3 points.]

- How did you figure out the rest of your score?

    [Answers will vary but may include: We looked at the country we ranked first, found its actual ranking, then checked the scoring system to see if we got any points. Then we looked at the country we ranked second, and found its actual ranking, etc.]

D. Students Reflecting on the Activity

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,

	Area	Population	Population Density Site's Figure	Density Actual 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

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.)

Guiding Questions

Pose these problems about the scoring system.

- What is the highest score you can get in a round?

  > *[25]*

- How?

  > *[Get all 5 in correct order.]*

- Suppose a team scored 14 points with the 5 countries (or states) you chose.
Show what their list might have been.

  > [Sample response for countries shown in example:

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	14

- Why is a score of 20 impossible for a team in one round?

  [Hint: If you get 4 of the countries or states correct, what must be true about the other one?

  If 4 are placed 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 one point.]

- What is the lowest possible score in one round?

  [Encourage students to experiment. You can get a score of 3, but not 2 or 1. For example, for the countries shown above, the following order yields a score of 3: Ghana, Libya, Denmark, Indonesia, Romania.]

This site allows you to choose up to 7 countries and obtain data about those countries: population, area, etc. . In a matter of seconds, the data chosen are communicated to you.

E. Extensions
- 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.
- 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 .
- Students create their own game that uses data from the same web site.
- 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.

Students present their scoring systems and explain why they think theirs are better than the original.

III. TEACHER TO TEACHER

A. TEACHER REFLECTIONS

Here are a few quesitons to ask yourself or discuss with a colleague during and after the lesson.

• Did students achieve the objectives for this lesson?

• What additional experiences do students need to be successful with this lesson?

• What additional experiences do students need before moving to the next lesson?

• Are students able to give and explain their reasoning? Are their reasons logical?

• What are the indicators that students are able to work together?

• How do students decide upon shared responsibilities?

• Are students able to quantify, organize and/or record information?

• Were directions clear and usable by students? If not what adjustments would be appropriate for me to make?

• What new vocabulary did students use that might need to be reinforced in the next lesson?

• What additional extensions would be appropriate?

B. RELATED RESOURCES

http://putwest.boces.org/Standards.html
Correlation To State Standards

Visit this website to verify or modify the teaching of this lesson so that it is in alignment with your local/state standards requirements.

IV. HANDOUTS

There are four reproducible handouts for this lesson:

> Recording Sheet
> Population Density Handout A
> Population Density Handout B
> State Data Handout

These four handouts can be copied from the following pages.

Name_____   Date _____

Recording Sheet

*Five's a Crowd***: A Game of Population Density**

Data Chart

Country	Population	Area (square km)	Population Density (people per sq. km)

Scoring Chart

OUR LIST	ACTUAL ORDER	POINTS
1.	1.	
2.	2.	
3.	3.	
4.	4.	
5.	5.	
	SCORE FOR THIS ROUND	

For Pre-Activity - Population Density (handout A)

For Pre-Activity - Population Density (Handout B)

STATE DATA HANDOUT

STATE	1990 POPULATION	LAND AREA	STATE	1990 POPULATION	LAND AREA
Alabama	4,040,587	50,750	Montana	799,065	145,556
Alaska	550,043	570,374	Nebraska	1,578,385	76,878
Arizona	3,665,228	113,642	Nevada	1,201,833	109,806
Arkansas	2,350,725	52,075	New Hampshire	1,109,252	8,969
California	29,760,021	155,973	New Jersey	7,730,188	7,419
Colorado	3,294,394	103,729	New Mexico	1,515,069	121,364
Connecticut	3,287,116	4,845	New York	17,990,455	47,224
Delaware	666,168	1,955	North Carolina	6,628,637	48,718
Florida	12,937,926	53,997	North Dakota	638,800	68,994
Georgia	6,478,216	57,919	Ohio	10,847,115	40,953
Hawaii	1,108,229	6,423	Oklahoma	3,145,585	68,679
Idaho	1,006,749	82,751	Oregon	2,842,321	96,002
Illinois	11,430,602	55,593	Pennsylvania	11,881,643	44,820
Indiana	5,544,159	35,870	Rhode Island	1,003,464	1,045
Iowa	2,776,755	55,875	South Carolina	3,486,703	30,111
Kansas	2,477,574	81,823	South Dakota	696,004	75,896
Kentucky	3,685,296	39,732	Tennessee	4,877,185	41,219
Louisiana	4,219,973	43,566	Texas	16,986,510	261,914
Maine	1,227,928	30,865	Utah	1,722,850	82,168
Maryland	4,781,468	9,775	Vermont	562,758	9,249
Massachusett	6,016,425	7,838	Virginia	6,187,358	39,598
Michigan	9,295,297	56,809	Washington	4,866,692	66,581
Minnesota	4,375,099	79,617	West Virginia	1,793,477	24,087
Mississippi	2,573,216	46,914	Wisconsin	4,891,769	54,314
Missouri	5,117,073	68,898	Wyoming	453,588	97,105