# EXPLORATIONS

## Activity 12

## Will Girls and Boys Be Equal?

## Teacher Notes

### Concept

♦ Modeling a situation to find experimental probability

♦ Constructing a box-and-whisker plot

♦ Probability and statistics

### Skill

♦ Using random numbers to model a problem

♦ Constructing a box-and-whisker plot

### Applicable Calculator Functions

♦ [PRB], RANDI, nCr

### Materials

♦ Student Activity Sheets (page 117)

♦ Rulers

♦ TI-30X IIS/TI-34 II calculator

### Objective

♦ Pairs of students will conduct trials, combine their data with classmates' results, use the combined data to create a box-and-whisker plot, and find the experimental probability model for a given problem

### Prerequisites

No prior calculator use is required: experience with the RANDI function would be helpful. Students need to understand what is happening when they use the random number generator.

### Problem

In *The Giver* by Lois Lowry (Laurel Leaf Books; New York; 1993; ISBN# 0-440-21907-8), each class of fifty children in the community has 25 girls and 25 boys. This means, of course, that each year the birth mothers need to have 25 girl babies and 25 boy babies. How often do you think exactly 25 out of 50 babies will be girls?

### Activity

Briefly discuss *The Giver* by Lois Lowry. In this futuristic book there was much conformity: most parts of people's lives were planned by the Committee of

Elders. Jonas, the twelve-year-old main character of the book, begins to question the way things work in the Community.

Focus on the situation from the book described at the top of the Student Activity Sheet. Have students estimate an answer to the question posed on their papers. Have students share their estimates and reasoning.

Ask students how they might model this situation or carry out an experiment to get a good idea of the probability of exactly 25 out of 50 babies being girls. Students may suggest flipping a coin, rolling a die, etc. If no one suggests using random numbers, provide a short explanation of this technique and show them how to make the calculator generate 1's and 2's randomly to represent girls and boys. Be prepared to answer students who point out that slightly more boys than girls are actually born (considering the chances for girl/boy to be equal is certainly close enough to get a good estimate for the probability).

Have students work in pairs to simulate the births of fifty babies, using the RANDI function on the calculator. Each pair should record their findings on a large class chart.

Have several students comment on the findings. Then have the class combine all the data to find the experimental probability from the enlarged sample. They will probably be surprised at the results. For many seventh or eighth grade classes, it will be appropriate to conduct at least two other experiments before they are prepared to explain their results. It is usually beneficial to have students experiment to find the probability of having exactly 1 girl and 1 boy when there are two children (1/2) and follow that with an experiment to find the probability of having exactly 2 girls and 2 boys when there are four children (6/16 or 3/8). Often they need to list all the possibilities to understand these probabilities. By examining and comparing these situations students usually conclude that the probability for the same number of girls as boys goes down as the total number of children increases because there are more possible outcomes (ways for the children to be arranged). They should then realize that with a group as large as fifty children, there would be many ways to combine girls and boys so that the probability for one particular way, 25 girls and 25 boys, would be rather small.

If your class expresses interest in knowing the theoretical probability of exactly 25 girls and 25 boys (assuming the probabilities for each are the same), it is a perfect time to introduce them to Pascal's Triangle. Such an exploration would conclude with the observation that the theoretical probability for this activity can be found by locating the middle item on the fiftieth row of Pascal's Triangle and dividing by the total of the terms in the fiftieth row or by computing $_{50}C_{25}/2^{50}$(.11227…).

Two appropriate ways to display the results of this activity are in a histogram or in a box-and-whisker plot. If your students are not familiar with this type of graph, it is important to guide them step-by-step through the process.

*Example:*

A class of twenty-four students has the following numbers of girls out of 50 trials:

24, 22, 32, 22, 24, 20, 22, 16, 22, 38, 18, 28, 28, 16, 27, 23, <u>25</u>, 19, 23, 23, 31, 33, <u>25</u>, 19

Using this data, the experimental probability for exactly 25 out of 50 babies being girls is 1/12.

To construct the box-and-whisker plot students can use the following steps.

1.  Write each student's result on a slip of paper and place it at the appropriate place on a large number line on the wall.

2.  Find the first quartile, the median, and the third quartile of the data.

3.  Use the minimum value in the data (16) to mark the left end of the left whisker, the 1st quartile value (21) to find the left end of the box, the median (23) as the vertical line inside the box, the 3rd quartile (27.5) to find the right end of the box, and the maximum value (38) to mark the right end of the right whisker. Complete the plot as shown below:
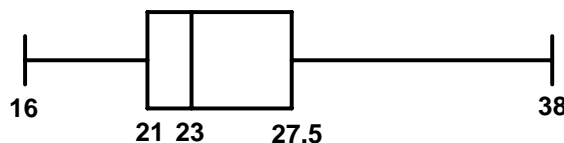


4.  Have each child construct the box-and-whisker plot on the Student Activity Sheet.

## Wrap-Up

Finally, students should write paragraphs about what the class found and what they learned. Allow students to share their responses.

Be sure these questions are answered:

♦ *What were the results of the experiment? How do they relate to your estimate? Were you surprised? Why/why not?*

♦ *As the number of possible outcomes for an event increases, what happens to the probability of a particular outcome?*

♦ *How did this activity add to your understanding of probability?*

## Assessment

Students' paragraphs can serve as an assessment tool to check their understanding. Also, a similar activity in which students create a model and interpret the results is appropriate.

*Example:*

In a family with four children, what is the probability that there are three boys and one girl?

## Extensions

Pose the following problem to students:

> *Suppose the Committee of Elders decided the Community should expand so that each family has five children. If the babies are randomly assigned to each family, how often will a family have no girls, one girl, and so forth? Model this situation using random numbers and find the experimental probabilities.*

Note: Students will likely need discussion to establish that each trial will need five random numbers, one for each child in the family. Also, at some point, you will want to relate this problem to Row 5 of Pascal's Triangle.

## Activity 12

## Will Girls and Boys Be Equal?

*Objective:* *You will work with a partner to conduct trials, combine your data with classmates' results, and use the combined data to create a box and whisker plot. You will then find the experimental probability for the given situation.*

*Problem:* *Each class of 50 children in the Community has 25 girls and 25 boys. This means, of course, that each year the birth mothers need to have 25 girl babies and 25 boy babies. How often do you think exactly 25 out of 50 babies will be girls?*

*- from The Giver by Lois Lowry*

1. Estimate the answer to the above question with a fraction.

2. Model the problem, using the RANDI function on your calculator. Do fifty trials and record the results below.

Girls                                                      Boys

_____        _____

3. Combine your data with that of your classmates to represent a large number of years. (You may not need all the rows in the table.)

| Number of Girls | Number of Times Result Obtained |
|---|---|
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**4.** Use the data to create a box-and-whisker plot.

**5.** Analyze your results.

    **a.** What does the box-and-whisker plot tell you?

    **b.** Based on your class's experiment, what is the probability that a group of 50 babies would include exactly 25 girls?

**6.** After your class or group discussion, write the two paragraphs below about this activity.

    **a.** What we found:

    **b.** What I learned:

# Will Girls and Boys Be Equal?
# Keystrokes for the TI-34 II

**Example:** *Randomly generate 1's for girls and 2's for boys as a model for births.*

| PRESS | DISPLAY |
|---|---|
| [PRB] | <u>nPr</u>  nCr  ! → |
| ◁ or ▷ to RANDI | RAND  <u>RANDI</u> |
| [ENTER] | RANDI ( |
| 1 [2nd] [,] 2 | RANDI(1,2 |
| [ENTER] | RANDI(1,2<br>               1  (you may see 2) |
| [ENTER] | The calculator will continue to generate 1's and 2's. |

**Example:** *Find ₅₀C₂₅ to display the number of possible combinations of boys and girls for 50 children.*

| | |
|---|---|
| 50 [ENTER] | 50<br>               50 |
| [PRB] | <u>nPr</u>  nCr  ! → |
| ◁ or ▷ to nCr | nPr  <u>nCr</u>  ! → |
| [ENTER] | Ans nCr |
| 25 [ENTER] | Ans nCr 25<br>**1.264106064** x 10¹⁴ |

Note: To find the theoretical probability for exactly 25 girls out of 50 births, add the following keystrokes to the sequence for $_{50}C_{25}$:

| PRESS | DISPLAY |
|---|---|
| ÷ | Ans ÷ |
| 2 ∧ 50 ENTER | Ans ÷ 2^50<br>0.112275173 |

## Will Girls and Boys Be Equal?
## Keystrokes for the TI-30X IIS

***Example:*** *Randomly generate 1's for girls and 2's for boys as a model for births.*

| PRESS | DISPLAY |
|---|---|
| [PRB] | nPr  nCr  ! → |
| ◁ or ▷ to RANDI | RAND  RANDI |
| [ENTER] | RANDI ( |
| 1 [2nd] [,] 2 | RANDI(1,2 |
| [ENTER] | RANDI(1,2<br>        1  (you may see 2) |
| [ENTER] | The calculator will continue to generate 1's and 2's. |

***Example:*** *Find $_{50}C_{25}$ to display the number of possible combinations of boys and girls for 50 children.*

| | |
|---|---|
| 50 | 50<br>        50 |
| [PRB] | nPr  nCr  ! → |
| ▷ or ◁ to nCr | nPr  nCr  ! → |
| [ENTER] | Ans nCr |
| 25 [ENTER] | Ans nCr 25<br>1.264106064 $\times 10^{14}$ |

Note: To find the theoretical probability for exactly 25 girls out of 50 births, add the following keystrokes to the sequence for $_{50}C_{25}$:

| PRESS | DISPLAY |
|---|---|
| ÷ | Ans ÷ |
| 2 ^ 50 ENTER | Ans ÷ 2^50<br>          0.112275173 |