

Activity 11

Probably Not!

Objective

- ◆ To find the theoretical probability of different female/male combinations in a family of kittens

Materials

- ◆ TI-73 calculator
- ◆ Student Worksheet

In this activity you will:

- ◆ conduct an experiment to find the probability that all the kittens will be female
- ◆ determine the total number of possible female/male combinations in a five kitten family
- ◆ find the theoretical probability of different female/male combinations

You will need to know this math vocabulary:

- ◆ empirical probability
- ◆ theoretical probability
- ◆ combinations
- ◆ binomial outcome

Introduction

Mikel, a calico cat, is expecting kittens. Hillary, her owner, has five friends who want a calico kitten. However, calico coloring occurs only in female cats. If Mikel has five kittens, what is the probability that she will have exactly five female calico kittens?

Problem

You will work with your partner to *empirically* (experimentally) find the probability of Mikel, the cat, having a litter of five female kittens. You and your partner will flip a coin a total of 50 times where a head will represent a female and a tail will represent a male. Flipping a coin is one way of obtaining a *binomial outcome* (two equally likely outcomes). Then, you will determine all possible outcomes of kitten families and find out the probability of what should happen which is known as the *theoretical probability*.

Activity

- The calculator can very quickly and quietly simulate the flipping of coins. You and your partner will use the coin toss function on the calculator to simulate tossing 5 coins 50 times. Clear the Home screen. (Press **2nd** **[QUIT]** **[CLEAR]**) Press **[MATH]** **[>]** **[>]** and select **6:coin(5)** **[ENTER]**. The number 1 will stand for a head (a female) and the number 0 will stand for a tail (a male). In the first screen at the right, the set of numbers {0 1 0 1 1} represents this order of female/male kitten births. {1st born-male, 2nd born-female, 3rd born-male, 4th born-female, 5th born-female} You will continue to press **[ENTER]** to flip the coins.

```
coin(5)
(0 1 0 1 1)
█
```

```
coin(5)
(0 1 0 1 1)
coin(5)
(1 1 0 0 0)
coin(5)
(1 1 1 0 1)
```

- Use the frequency table on the Student Worksheet to tally your results. You will take 25 trials while your partner tallies the results. Then you will change roles. Record a tally mark for each outcome. You should also record a tally mark in the last row of the table to help you keep track of the number of trials.
- After you and your partner have taken a total of 50 trials, record the totals on the table. Answer questions 1 through 3 on the Student Worksheet.

Your teacher will record each group's results on the Class Data Transparency.

- Copy these results to the class data table and answer questions 4 through 6 on the Student Worksheet.

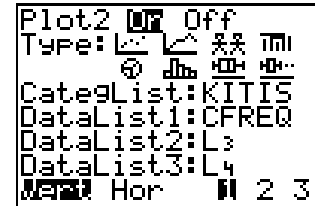
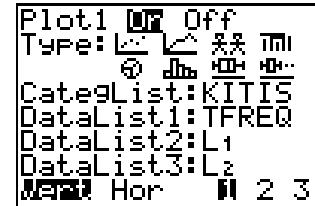
- Next, enter this data into the calculator in the List editor. You will need to name three lists, **KITIS** (for kitties), **TFREQ** (for team frequency totals) and **CFREQ** (for class frequency totals). **KITIS** will be a categorical list that will include the following elements. Make sure you insert quotes around the first element **5F** to specify this list as the categorical list.

KITIS c	CFREQ	TFREQ	B
5F	-----	-----	
4F			
3F			
2F			
1F			
0F			

KITIS(0)=5 F			

- Enter your data in the **TFREQ** list and the class data in the **CFREQ** list. You will now use these lists to create bar graphs.
- Turn off all stat plots (**2nd** **[PLOT]** **4:PlotsOff** **[ENTER]**).
- Display the stat plot menu (**2nd****[PLOT]**).

- d. Define Plot 1 as a Bar graph, as shown at the right. Press **GRAPH** and **TRACE**.
 - e. Turn off Plot 1 and define Plot 2 as shown in the second screen illustration at the right. Press **GRAPH** **TRACE**.
- ✎ Answer question 7 on the Student Worksheet.



3. Make a list of all possible combinations of outcomes.
- ✎ Complete the summary table, keeping in mind that **MFFFF** and **FFFFM** are different outcomes where **MFFFF** means the first kitten born was a male and **FFFFM** means the last kitten born was a male.
 - ✎ Complete Pascal's Triangle following the summary table and answer questions 8 and 9 on the Student Worksheet. Then use the summary table and Pascal's Triangle to complete the Theoretical Probability Table.
4. Name a new list **PROB** and enter the fractional probabilities from the Theoretical Probability Table. Use **□** to enter the fractions into the list.

CFREQ	TFREQ	PROB	11
-----	-----	$\frac{1}{32}$	
		$\frac{5}{32}$	
		$\frac{10}{32}$	
		$\frac{10}{32}$	
		$\frac{5}{32}$	
		$\frac{1}{32}$	
		PROB(3) =	

5. Name another new list **PRED** to predict the expected number of each family combination using the theoretical probabilities in **PROB** list. Use the total number of trials that the entire class collected from the class data table. You can take the number of teams times 50 trials per team or sum the list **CFREQ** by pressing **2nd** **[STAT]** **▶** **▶** **7:sum**(then **2nd** **[STAT]**, scroll down to list named **CFREQ**, and press **ENTER** **ENTER**. Use the sum in the formula shown at the right to make predictions.

sum(LCFREQ)		1000
-------------	--	------

TFREQ	PROB	PRED	12
1	$\frac{1}{32}$	-----	
8	$\frac{5}{32}$		
13	$\frac{10}{32}$		
16	$\frac{10}{32}$		
10	$\frac{5}{32}$		
2	$\frac{1}{32}$		
		PRED = LPROB*1000	

6. Create a double bar graph and compare the empirical and theoretical probabilities. Turn off Plot 1 and 2 and define Plot 3 as shown in the screen at the right. Press **GRAPH** **TRACE**.



- ✎ Answer question 10 on the Student Worksheet.



Name _____
Date _____

Activity 11

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Record your results on the table below. Then answer the questions about the activity.

Coin toss simulation of Mikel's kittens

	Tally of Results	Total
5 Females		
4 Females		
3 Females		
2 Females		
1 Female		
0 Females		
trial tallies		

1. Which outcome(s) seem to be occurring the most often? Why do you think that is happening?

2. Which outcome(s) seem to be occurring the least often? Why do you think that is happening?

3. According to the experiment above, what is the probability that Mikel will have all female kittens?

Class Data Table

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	Total
5 F																
4 F																
3 F																
2 F																
1 F																
0 F																

4. Find the probability of Mikel having all female kittens using the class data.

5. How does this probability compare to the answer in question 3?

6. Which outcome(s) occurred the most using class data?

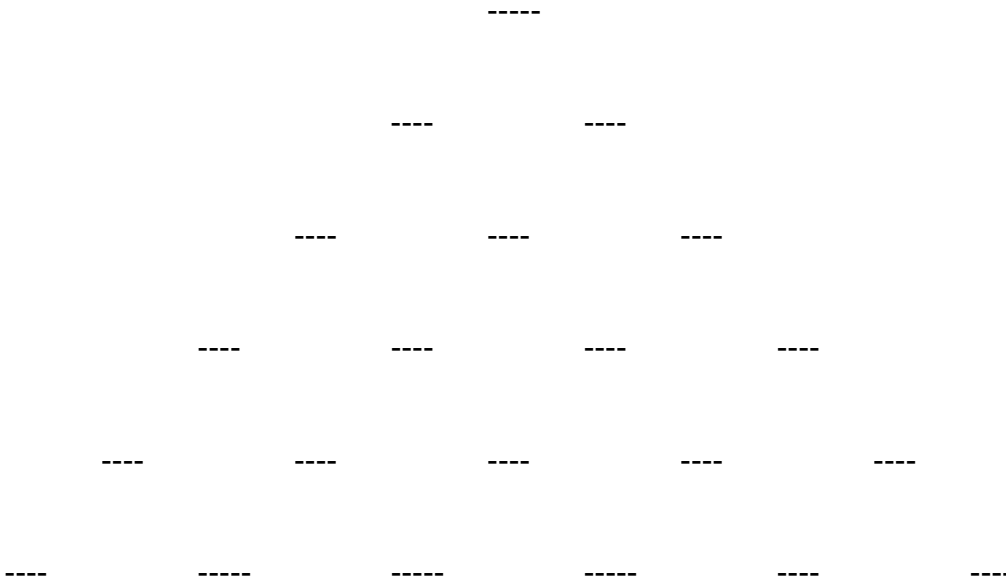
7. What do the bar graphs show? How are they similar? How are they different?

Summary of Possible Kitten Family Combinations

5 Females ___outcome	4 Females ___outcomes	3 Females ___outcomes	2 Females ___outcomes	1 Female ___outcomes	0 Females ___outcome
FFFFF	MFFFF FMFFF FFMFF				

8. How many different outcomes are shown in the table above?

Pascal's Triangle



9. What can you observe about any similarities between the last row in Pascal's Triangle and the summary of outcomes in the Summary table?

Theoretical Probability Table

Kitten families	Probability as a fraction
5 females	
4 females	
3 females	
2 females	
1 female	
0 females	

10. Report on your observations of the two bar graphs. How are they similar?

Teacher Notes



Activity 11

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Math Strand

- ◆ Probability
- ◆ Statistics

Materials

- ◆ TI-73 calculator
- ◆ Student Worksheets (page 102)
- ◆ Teacher transparency (page 110)

Students will investigate empirical and theoretical probabilities and make a connection to Pascal's triangle and binomial outcomes.

Vocabulary

empirical probability	the experimental probability of an event
theoretical probability	in theory, what should happen
combinations	an arrangement or listing where order is not important
binomial outcome	two events that are equally likely

Classroom Management:

Students should work in pairs. The class should be familiar with simple probability and should have been exposed to Pascal's Triangle. If they have not, you should introduce it as a special triangular arrangement of numbers with many interesting patterns. Complete the triangle with the students.

You may want to model tossing 5 different coins all together with each coin representing the sex of each kitten. Make sure they understand that a 5 female family means 0 male family.

Activity

1. In the eighth row on the Coin toss simulation of the table, the students can keep a trial tally record to keep track of how many trials they have taken. An optional method is using another calculator as an electronic tally. To do this, one student would use a calculator to toss the coin while the other student would use a different calculator to tally the results for the coin toss simulation. Have the students name a list on one of their calculators **Femal** for Females. The person operating this calculator will enter the number of females on each trial as an element of the list as the other student executes the coin toss command.

The screen shot at the right shows an example of the last three trials while the last three elements in the **FEMAL** list show the trials.

```
coin(5)
(1 1 0 1 0)
coin(5)
(1 1 1 0 1)
coin(5)
(0 1 1 1 0)
```

L5	L6	FEMAL ?
		1 1 1 0 1 1 1 0 1 0
FEMAL(50) =		

Students should sort the list by pressing $\text{2nd}[\text{QUIT}]$ to go to the Home screen and $\text{2nd}[\text{STAT}] \rightarrow \text{2:SortD(}$ followed by $\text{2nd}[\text{STAT}]$, selecting the list named **FEMAL**, and pressing $\square[\text{ENTER}]$.

```
SortD(LFEMAL)
Done
```

They should then scroll down the list and count the number of 5's, 4's, 3's, 2's, 1's and 0's and record the total on their frequency tables. They may switch calculators after the first 25 trials.

L5	L6	FEMAL ?
-----	-----	5 4 3 2 1 0
FEMAL(1)=5		

- For more information about accessing lists, naming lists, and setting up stat plots, see Appendix A, B, or D.

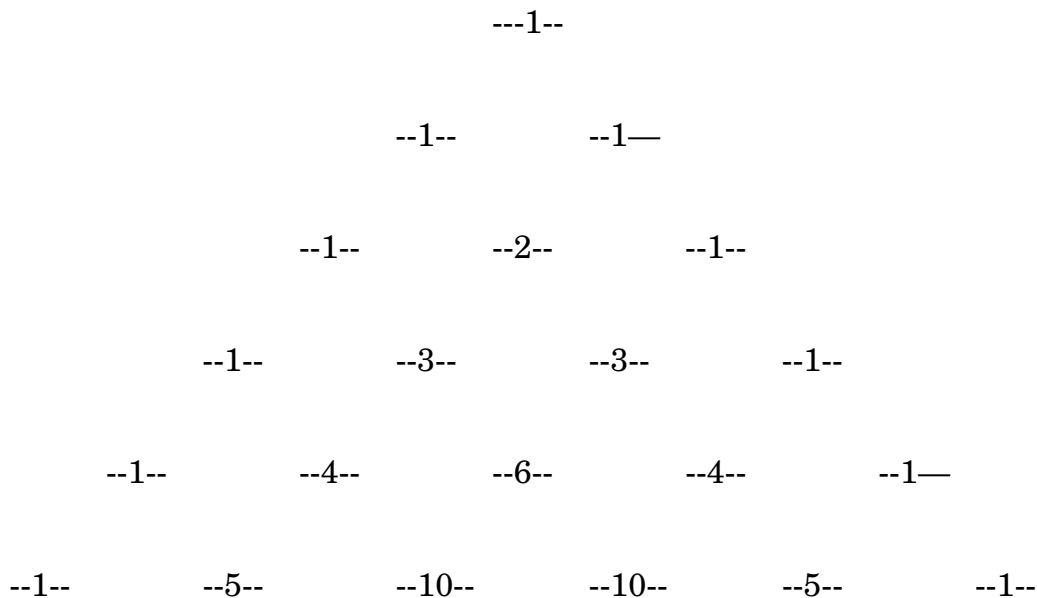
Answers to Student Worksheet

- 3 females and 2 females should be most likely but may not.
- 5 females and 0 females should be the least likely but again they may not.
- Answers will vary.
- Answers will vary.
- Answers will vary. However, the larger the sample space the closer the probability will be to the theoretical probability of $1/32$.
- Answers will vary. 2 or 3 females should occur the most.
- Answers will vary. The middle bars representing 2 or 3 females should be the tallest and most likely to occur. The outer bars representing 0 or 5 females should be the shortest and the least likely to occur.

5 Females <u>1</u> outcome	4 Females <u>5</u> outcomes	3 Females <u>10</u> outcomes	2 Females <u>10</u> outcomes	1 Female <u>5</u> outcomes	0 Females <u>1</u> outcome
FFFFF	MFFFF FMFFF FFMFF FFFMF FFFFM	MMFFF MFMFF MFFMF MFFFM FMMFF FMFMF FMFFM FFMMF FFMFM FFFMM	MMMFF MMFMF MMFFM MFMMF MFMFM MFFMM FMMMFM FMMFM FMFMM FFMMM	FMMMM MFMMM MMFMM MMMFM MMMMF	MMMMM

8. 32 outcomes

Pascal's Triangle



9. They are the same.

10. The two bar graphs should be similar with the theoretical representation as perfectly symmetrical stairs up and back down.

Going Further

- ◆ Circle Graphs could be created using the empirical or theoretical data. The different combinations are presented in Pascal's triangle in an organized manner. The triangle could be extended with more investigations of probabilities of events with two equally likely outcomes.
- ◆ *Problem:* On a recent talk show a couple with 10 sons were the guests. Students could experimentally and theoretically explore this situation. They could also make predictions given certain criteria.
- ◆ *Connection to Science:* Investigate the genetic combinations of calico coloring. Calico coloring is a sex-linked color trait. Therefore, all calico cats that can reproduce are female.

Class Data Transparency

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	Total
5F																
4F																
3F																
2F																
1F																
0F																