Stat Support Activity: Flipping Coins to Create a Sampling Distribution of Sample Proportions

Activity Part 1 Directions:

- Each student will be given a coin to flip.
- Each student will create a sample of coin flips, by flipping the coin 30 times and record the number of times they got tails.
- Each student will then calculate the proportion of tails for their sample by dividing the number of tails by 30. Round the answer to the thousandths place.

  Proportion of Tails = $\frac{\#\ of\ tails}{30}$

- Once each student has their proportion, they will come up to the white board and put a magnet on the number line where their proportion lies. (If magnets are not available, draw a dot with a white-board pen.)
- If there are enough magnets, have each student flip the coin another 30 times and repeat the process.

Activity#1 Questions:

1. What is the chance of getting tails when you flip a coin? (This is the population proportion.)

2. If we flip a fair coin 30 times, how many tails do we expect to get?

3. What were your sample proportions when you flipped the coins?

4. For each sample proportion you calculated, find out how far they are from the population proportion (0.5). *(This is called the margin of error.)*

   Margin of Error = Your sample proportion $(\hat{p})$ *– 0.5*

5. Look at the magnets on the white-board. Draw a picture of the number line and magnets. *(This is called a "sampling distribution", a bunch of sample statistics on the same graph. In this case, a bunch of sample proportions on the same graph.)*

6. Is the shape of the sampling distribution of magnets on the board nearly normal (bell-shaped)?

7. How many total magnets are on the board?

8. Did all of the sample proportions calculated come out to 0.5 (50%)? *(This is called sampling variability.)*

9. Did all the sample proportions calculated come out to be the same? *(Even if they are not all 0.5) (This is also sampling variability.)*

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10. What is the center of the sampling distribution? Is the center close to the population proportion 0.5? *(This is an important discovery. The center of a sampling distribution is close to the population parameter!)*

11. The standard deviation of the sampling distribution is called "Standard Error". Let's see if we can estimate the standard error. Draw a bell curve over the magnets. One standard deviation (standard error) is about half way down the curve where the curve stops being a hill and starts being a valley. This is sometimes called an "inflection point". Estimate the distance from the center to the inflection point. This will be approximate standard error for your sample distribution.

Approximate Standard Error = ???

12. There is a famous formula for computing standard errors for proportions. In this case our population proportion (π) = 0.5 and the sample size was *n = 30,* so see if you can calculate the following. Divide 0.25 by 30 and then take the square root of your answer. Is your standard error estimate in #12 close to your answer with this formula?

$$Standard\ Error\ for\ Proportions = \sqrt{\frac{\pi(1-\pi)}{n}} = \sqrt{\frac{0.5(1-0.5)}{30}} = \sqrt{\frac{0.5(0.5)}{30}} = \sqrt{\frac{0.25}{30}} = ???$$

Activity Part 2 Directions:

- Let's have StatKey flip the coins for us. Go to www.lock5stat.com and click on "StatKey".
- Under "Sampling Distributions" click on "Proportions".
- Click on the box that says "Choose samples of size n = " and change it to 30. *(Remember each sample was created by flipping the coin 30 times.)*
- Go to "Edit Proportion", type in 0.5 and press "OK". *(Remember 0.5 was the population proportion.)*
- Click on "Generate 1 sample". Notice the computer flipped the coin 30 times calculated the proportion for tails and put a magnet on the whiteboard to represent that proportion.
- Click on "Generate 10 samples". Notice the computer created 10 samples each with 30 flips of the coin (a total of 300 flips), and put 10 magnets (10 proportions) on the white board. You should now have a total of 11 proportions on the sampling distribution. Hold your cursor on any of the magnets (proportions) and you will see the 30 flips and number of tails that created it under the "samples" menu.
- Click on "Generate 1000 samples". Notice the computer created 1000 samples each with 30 flips of the coin (a total of 30,000 flips), and put 1000 more magnets (1000 more proportions) on the sampling distribution. You should now have a total of 1011 proportions on the sampling distribution. Hold your cursor on any of the magnets (proportions) and you will see the 30 flips and number of tails that created it under the "samples" menu.

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Activity#2 Questions:

13. Is the shape of the StatKey sampling distribution nearly normal (bell-shaped)?

14. Did all of the sample proportions calculated come out to 0.5 (50%)? *(This is called sampling variability.)*

15. Did all the sample proportions calculated come out to be the same? *(Even if they are not all 0.5) (This is also sampling variability.)*

16. What is the center of the sampling distribution? *(This is located under "mean" on the top right corner of the sampling distribution in StatKey.)* Is the center close to the population proportion 0.5? *(This is an important discovery. The center of a sampling distribution is close to the population parameter we are looking for!)*

17. What is the standard error for the sampling distribution? *(This is located under "mean" on the top right corner of the sampling distribution in StatKey. This is the mean average of all of the sample proportions on the sampling distribution.)* Is the standard error close to the formula answer we calculated in #12?