

Home Land Security

Pre Calculus:

Glencoe, *Advanced Mathematical Concepts* ©2004, Chapter 13-6: The Binomial Theorem and Probability

Statistics:

Freeman, *The Practice of Statistics (YMS 2nd Ed)*, Chapter 8, The Binomial & Geometric Distributions
Chapter 12, Inference for Proportions

Teacher Guide

Created by: Ray Fox, Overton High School, Nashville, TN

Activity Overview

Students will use simulation to compare the calculated standard deviation to results given by the formula $\sigma = \sqrt{p(1-p)/n}$.

(Level 3 on Webbs Depth of Knowledge)

A Home Land Security Problem

Suppose at Kennedy Airport in New York, one of every seven passenger's luggage is searched. The computer picks who is to be searched at random. If you are traveling in a party of 20, what is the probability your luggage will be searched?

1. What type of procedure will be used? *Binomial*
2. Verify the situation meets the Conditions.
 - a. *independence between trials.*
 - b. *success/failure*
 - c. *fixed probability of success*
 - d. *fixed number of trials,*
3. What is the probability two people in your party will be searched? *0.216; BinomPdf(20,1/7,2)*
From Calculator Page: Menu, 6:Statistics, 5:Distributions, D: Binomial PDF, (n=20, p=1/7,x=2)
4. What is the probability that at least three people in your party will be searched? *0.560*
BinomCdf(20,1/7,3,20); From Calculator Page: Menu, 6:Statistics, 5:Distributions, E: Binomial CDF, (n=20, p=1/7,Lower Bound=3, Upper Bound=20).
5. What is the probability that more than three people in your party will be searched?
BinomCdf(20,1/7,4,20); From Calculator Page: Menu, 6:Statistics, 5:Distributions, E: Binomial CDF, (n=20, p=1/7,Lower Bound=4, Upper Bound=20).
6. What is the probability that no one in your party is searched, but the next person in line is?
0.00065; GeomPdf(1/7,21); From Calculator Page: Menu, 6:Statistics, 5:Distributions, F: Geometric PDF, (p=1/7, X=21) or (1/7)(6/7)²¹*
7. For the party of 20, what is the
 - a. Mean $np = 20/7$ or *2.857*
 - b. Variance $p(1-p)/n$ or *0.006*
 - c. Standard Deviation $\sqrt{p(1-p)/n}$ or *0.078*

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8. Suppose there are 50 passengers in line for your flight. Perform a simulation to estimate how many could be stopped.
 - a. On the TI-Nspire, create a new document, open a calculator page. Type “RandBin(50,1/7)” [enter]. Based on your simulation, how many passengers were stopped?
Answers will vary
 - b. Will your answer be the same as your neighbors? **_No_ Why? Because they are random**
 - c. Cursor UP twice, press [enter] twice, and record your new number **Answers will vary.**
 - d. Is it the same as before? **Most will not** Why or why not? **A new number is found at random. The probability it is the same number is small.**
9. Since we will not always get the same number of searches, we need to simulate a large number of flights. Add a “List & Data” page on your TI-Nspire. In the title cell for column A, type “searches.” In the diamond row of column A (grey) type=RandBin(50,1/7,200). This will simulate 200 flights with 50 passengers each. The cells from 1 to 200 of column A will contain the results.
10. To determine the proportion of passengers stopped for a search, we divide the number searched by the size of the group (50). Change the formula in Column A of the “Diamond Row” to RandBin(50,1/7,200.)/50. To get the answer as a decimal, be sure to include the decimal point after 200.
11. To compute a numerical summary, go back to the “Calculator” page and select
 - a. Menu
 - i. Statistics
 1. Stat Calculation
 - a. One-Variable Statistics
 - i. One list, [OK] [enter]
 - ii. X1 list is “Searches” [OK]
 - b. Record the mean (–)and standard deviation (sx) **Answers will vary, Answers will vary.**
12. To see a graphical representation, add a “Data and Statistics” page. Click at the bottom and select “searches” for the x variable. Describe the dot plot you observe. **You will see a dot plot that approaches a normal distribution curve, with the center around the mean.**
13. What impact will changing the number of people in the group have? To discover the answer, let’s simulate different sizes of groups. NOTE: The number of simulations stays the same. Let’s try a smaller group first, say of 25. To make the changes easier, we are going to enter the group size in “B1”. Then we are going to change the formula in Column A to RandBin(B1,1/7,200.)/B1
Note: In the tns file the standard deviation is in D5

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Fill in the table below:

Party Size	Sx	$\sigma = \sqrt{p(1-p)/n}$
	Have students repeat step 11 (above)	
25	Exact Answers will vary, Should Approx σ	.0700
50	Exact Answers will vary, Should Approx σ	.0495
75	Exact Answers will vary, Should Approx σ	.0404
100	Exact Answers will vary, Should Approx σ	.0350
500	Exact Answers will vary, Should Approx σ	.0156
1000	Exact Answers will vary, Should Approx σ	.0111

13. Make a scatter plot of S_p vs σ . Describe what you see. Points will approximate $S_p = \sigma$.
14. Find the equation of best fit (also called LSRL). Should be approximately a straight line with an equation of $y=x$
15. How many passengers would have to be stopped for you to disbelieve Home Land Security's claim? Answers will vary. Ask for justification.

ADDED VALUE: REPEAT CHART AND ANALYZE FOR THE MEAN.