

AP Statistics – 6.3N Activity <i>(Revised 2020 to use Z scores)</i>	Name:
Goal: Understand Normal Model as an Approximation to the Binomial Model	Date:

I. Example: Teens and Debit Cards

In a survey of 506 teenagers ages 14-18, subjects were asked a variety of questions about personal finance. One question asked teens if they had a debit card. Suppose that exactly 10% of teens ages 14-18 have debit cards.

(a) Show that the distribution of X is approximately binomial.

Let X = the number of teens in a random sample of size 506 that have a debit card.

- B DEBIT OR NO DEBIT CARD
- I Sampling without replacement. SINCE THERE ARE MILLIONS OF TEENS AND WE HAVE A SAMPLE OF 506, THE 10% CONDITION HAS BEEN MET.
- N FIXED TRIALS $n = 506$
- S FIXED PROBABILITY $p = 10\%$

This is a binomial distribution $\rightarrow B(506, .1)$

(b) Check the conditions for using a Normal approximation in this setting.

To use the Normal distribution you must check BOTH np and $n(1-p)$ must be Greater or Equal to 10.

Check:

$$np \geq 10$$

$$506(.1) \geq 10$$

$$50.6 \geq 10 \checkmark$$

$$n(1-p) \geq 10$$

$$506(.9) \geq 10$$

$$455.4 \geq 10 \checkmark$$

(c) Use a Normal distribution to estimate the probability that 40 or fewer teens in the sample have debit cards.

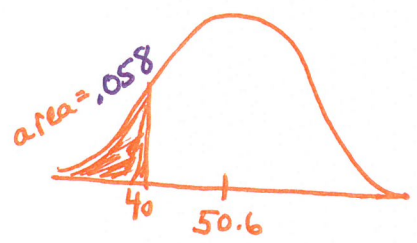
USING A NORMAL APPROXIMATION:

(a+b) Conditions met $n = 506$ $p = .1$

ON Green Sheet

$$\begin{cases} \mu_x = np = 506(.1) = 50.6 \\ \sigma_x = \sqrt{np(1-p)} = \sqrt{506(.1)(.9)} = 6.75 \end{cases}$$

STATE DISTRIBUTION $\rightarrow N(50.6, 6.75)$



$$P(X \leq 40) =$$

$$P\left(Z \leq \frac{40 - 50.6}{6.75}\right) =$$

$$P(Z \leq -1.57) =$$

.058

NORMAL CDF

THERE IS APPROXIMATELY, A 6 % Chance that 40 OR FEWER TEENS will have a debit card.

EXACT PROBABILITY WITH BINOMIAL DISTRIBUTION:

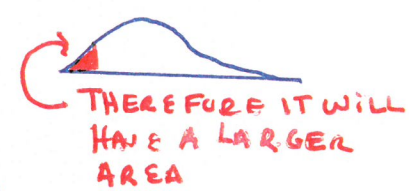
$$B(506, .1)$$

$$P(X \leq 40) = .063$$

Binomial DF

Remember

① BINOMIAL DISTRIBUTION GRAPH WITH $p = .1$ IS SKewed RIGHT



② As $n \uparrow$, the distrib. approaches a Normal distrib.

II. Notes –see definitions on page 395

The Normal Distribution can be used as an approximation for the binomial distribution

- If... the number of successes and failures are at least 10. ($np \geq 10$ and $n(1-p) \geq 10$)
- In English that means – when the number of trials is large, this method can be used.

$$\mu = np$$

$$\sigma = \sqrt{np(1-p)}$$

$$P(x \geq 4000) = P\left(z \geq \frac{x - \mu}{\sigma}\right)$$

MUST
~~Optional to calculate z-score,~~

but you **MUST CLEARLY** sketch normal graph.

***In the above model,** replace the inequality with less than, etc., whatever is appropriate for the problem you are solving. Additionally, replace the 4000 for your problem.*

Steps:

Step 1: Define the Random Variable and check binomial conditions

Step 2: Check the normal conditions $np \geq 10$ and $n(1-p) \geq 10$

**** You must show BOTH calculations to indicate you verified the normal condition.**

Step 3: Calculate the mean and standard deviation with the formulas above (green sheet); and state the normal model $N(\mu, \sigma)$

Step 4: Sketch the normal graph (identify area for probability, mean and x-value); and calculate the probability of interest

Step 5: State your conclusion, in the context of the problem.