Name: Key Hour: _____ Date: _____

**Learning Targets**

- State and check the Random, 10%, and Large Counts conditions for performing a significance test about a population proportion.
- Calculate the standardized test statistic and P-value for a test about a population proportion.

## Lesson 9.2: Day 1: Are you sure Mrs. Cowells isn't a good free throw shooter?

VS

In Lesson 9.1 we used simulation to estimate a P-value to decide whether or not Mrs. Cowells was exaggerating about her free throw percentage. Today, we will use a formula to find a P-value.

1. We're going to carry out the significance test from lesson 9.1 again. Begin by writing the hypotheses. $H_0: p = 0.8$ $H_a: p < 0.8$ p: true proportion of free throws Mrs. C makes

2. a. Each class found a different P-value because each dotplot was different. Would it be appropriate to use a Normal distribution to model the sampling distribution of $\hat{p}$? Justify your answer. Since we believe $H_0$ to be true, we will use p from $H_0$ when checking Normal condition (large counts)
$np \geq 10$ so $50(.80) \geq 10$ ✓ 40 $n(1-p) \geq 10$ so $50(.20) = 10 \geq 10$ ✓

   b. Are there any other conditions we should check?
   Random and 10% (Independent)

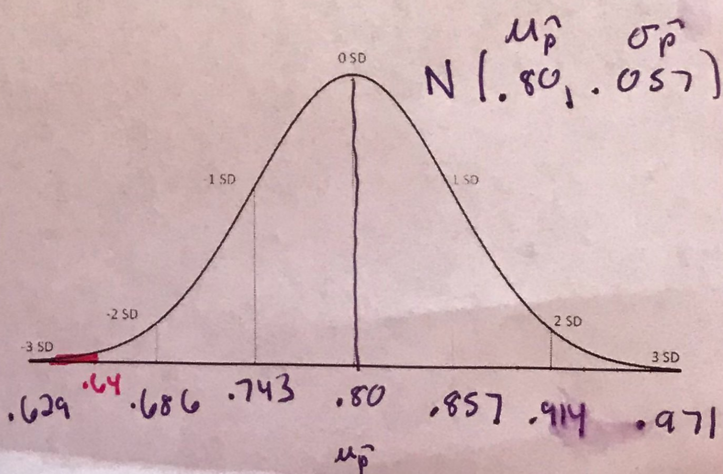
3. Now that conditions have been met, find the mean and standard deviation of the sampling distribution of $\hat{p}$.

$\mu_{\hat{p}} = p = 0.8$ $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{.8(.20)}{50}} = .057$

4. Use the mean and standard deviation you found to label the Normal curve.

5. How many standard deviations below the mean (z-score) is $\hat{p} = 0.64$? Label it on the normal curve.

$z = \frac{.64 - .80}{.057} = -2.81$




6. Find the probability of an 80% shooter making 32/50 ( $\hat{p} = 0.64$) or less.

Using table A and z-score P = .0025

Using Calculator: P = normcdf(-1000, .64, .80, .057) = .0025

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7. What conclusion can we make?

Since .0025 < .05, we have convincing evidence against the null hypothesis and reject it. Therefore it appears the true proportion of free throws made by Mrs. C is less than 80%.

# Lesson 9.2 Day 1– Significance Test for *p*

**…portant ideas:**

**T. #1 Significance tests for population proportions Conditions must be met:**

1. Random: Data should come from a well-designed random sample or random assignment in an experiment. Otherwise we can't infer to the population or establish cause and effect.

2. Independent: sampling with replacement for the population allows us to use standard deviation formulas, or if sampling without replacement, we meet the 10% condition for independence $10n > N$

3. Normal: sampling distribution of the statistic is approximately normal

** For Hypothesis Tests, we start by assuming the Null $H_0$ is True, so we will use p, the population proportion we are assuming to be true from $H_0$. ***

(Your textbook will label p from $H_0$ as $p_0$. The AP Formula Sheet just uses p.)

FOR LARGE COUNTS CONDITION (NORMAL CONDITION) so $p_0 = p$ from $H_0$

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

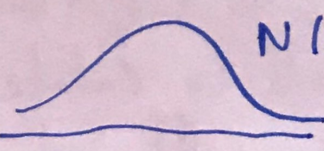
**T. #2 Calculations: Test Statistic & P-Value**

…est Statistic: Measures how far the sample result ($\hat{p}$) from the null parameter (p) and in what direction (+/−) …a standardized scale. (ex - z-scores)

…e use the Test Statistic to find the P-Value

…est Statistic (z- score) = $\dfrac{\text{statistic} - \text{parameter}}{\text{stand. error of the statistic}}$ ← ON AP Formula Sheet

Test statistic (z) $= \dfrac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}}$



$N(\mu_{\hat{p}}, \sigma_{\hat{p}})$

$\mu_{\hat{p}} = p$

$\sigma_{\hat{p}} = \sqrt{\dfrac{p(1-p)}{n}}$

used to calculate P-value → can use table A for z score or normalcdf

Always draw picture + label curve $N(\mu_{\hat{p}}, \sigma_{\hat{p}})$

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# Check Your Understanding

According to the U.S. Census Bureau, the proportion of students in high school who have a part-time job is 0.25. An administrator at a local high school suspects that the proportion of students at her school who have a part-time job is less than the national figure. She would like to carry out a test at the $\alpha = 0.05$ significance level. The administrator selects a random sample of 200 students from the school and finds that 39 of them have a part-time job.

(a) State appropriate hypotheses for performing a significance test. Be sure to define the parameter of interest.

$H_0: p = .25$ p = proportion of high school students who have a part time job.

$H_a: p < .25$

(b) Explain why the sample result gives some evidence for the alternative hypothesis.

$39/200 = .195$ which is less than .25

(c) Check if the conditions for performing the significance test are met.

① Random: random sample of 200 students ✓

② 10% (Independent) $10(200) <$ pop of all students at school; 2000. Reasonable to assume ✓

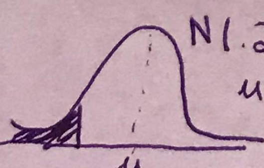
③ Normal: Large counts use p (aka $p_0$) $200(.25) \geq 10$, $50 \geq 10$; $200(.75) \geq 10$, $150 \geq 10$ ✓

(d) Calculate the standardized test statistic and P-value.

Test statistic: z-score = $\frac{\text{stat} - \text{parameter}}{\text{st dev of statistic}} = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}} = \frac{.195 - .25}{\sqrt{\frac{.25(.75)}{200}}} = \frac{-.055}{.0306} \approx -1.80$

$\mu_{\hat{p}} = 0.25$

$\sigma_{\hat{p}} = .0306$




Pvalue = Normcdf(−100, .195, .25, .0306) = .036

(e) What conclusion would you make?

Since $.036 < .05$ ($p < \alpha$), we have convincing evidence against the null hypothesis and reject it. It appears that the proportion of h.s. students at this school who have part time jobs is less than .25.