10.1 Comparing Two Proportions

Learning Objectives:

1. Describe the shape, center, and spread of the sampling distributions of $\hat{p}_1 - \hat{p}_2$.
2. Determine whether the conditions are met for doing inference about $\hat{p}_1 - \hat{p}_2$.
3. Construct and interpret a confidence interval to compare two proportions.
4. Perform a significance test to compare two proportions.

Vocabulary: two sample z interval for $p_1 - p_2$, pooled (combined) sample proportion, randomization distribution.

*Read 612–615 **Read Case Study on p. 609****
What is meant by "the sampling distribution of the difference between two proportions"?

What are the shape, center, and spread of the sampling distribution of $\hat{p}_1 - \hat{p}_2$? (see box on p. 614)

Alternate Example: Nathan and Kyle both work for the Department of Motor Vehicles, but they live in different states. In Nathan's state, 80% of the registered cars are made by American manufacturers. In Kyle's state, only 60% of the registered cars are made by American manufacturers. Nathan selects a random sample of 100 cars in his state and Kyle selects a random sample of 70 cars in his state. Let $\hat{p}_N - \hat{p}_K$ be the difference in the sample proportion of cars made by American manufacturers.

(a) What is the shape of the sampling distribution of $\hat{p}_N - \hat{p}_K$? Why?

(b) Find the mean of the sampling distribution. Show your work.

(c) Find the standard deviation of the sampling distribution. Show your work.

Read 616–619

What are the conditions for calculating a two-sample *z* interval for $p_1 - p_2$?

What is the standard error of $\hat{p}_1 - \hat{p}_2$? How is this different than the standard deviation of $\hat{p}_1 - \hat{p}_2$? What does this measure?

What is the formula for a two-sample *z* interval for $p_1 - p_2$? Is this on the formula sheet?

Alternate Example: *Gun Control*

Have opinions changed about gun control? Gallup regularly asks random samples of U.S. adults their opinion on a variety of issues. In a poll of 1011 U.S. adults in January 2013, 38% responded that they "were dissatisfied with the nation's gun laws and policies, and want them to be stricter." In a similar poll of 1011 adults in January 2012, only 25% agreed with this statement.

(a) Explain why we should use a confidence interval to estimate the change in opinion rather than just saying that the percentage increased by 13 percentage points.

(b) Use the results of these polls to construct and interpret a 90% confidence interval for the change in the proportion of U.S. adults who would agree with the statement about gun laws.

(c) Based on the interval, is there convincing evidence that opinions about gun control have changed?

Can you use your calculator for the Do step? Are there any drawbacks?

HW page 629 (1–11 odd)

Significance Tests for a Difference in Proportions

Example: *Hungry Children*
Researchers designed a survey to compare the proportions of children who come to school without eating breakfast in two low-income elementary schools. An SRS of 80 students from School 1 found that 19 had not eaten breakfast. At School 2, an SRS of 150 students included 26 who had not had breakfast. More than 1500 students attend each school.

What are the two explanations for why the SRS from each school do not have the same result?

Read 619-624
What are the conditions for conducting a two-sample *z* test for a difference in proportions?

We can get a more precise estimate of the standard deviation of a sample statistic by combining, called the _____ or _____ sample proportion of the estimates given by two independent samples.

Hungry Children Two-way table

	School		**Total**
Breakfast?	1	2	
No	19	26	**45**
Yes	61	124	**185**
Total	**80**	**150**	**230**

What standard error do we use for a two sample *z* test for a difference in proportions?

What is the test statistic for a two-sample *z* test for a difference in proportions? Is this on the formula sheet?

Alternate Example: *Hearing loss*
Are teenagers going deaf? In a study of 3000 randomly selected teenagers in 1988–1994, 15% showed some hearing loss. In a similar study of 1800 teenagers in 2005–2006, 19.5% showed some hearing loss. (These data are reported in *Arizona Daily Star*, August 18, 2010)

(a) Do these data give convincing evidence that the proportion of all teens with hearing loss has increased?

(b) Between the two studies, Apple introduced the iPod. If the results of the test are statistically significant, can we blame iPods for the increased hearing loss in teenagers?

Is it OK to use your calculator for the Do step? Are there any drawbacks?

HW page 631 (13–19 odd)

Inference for Experiments

Read 625–627

What mistake do students often make when defining parameters in experiments? How can you avoid it?

Example: *Yawning Seed*

The Mythbusters team conducted an experiment involving 50 subjects. Each subject was placed in a booth for an extended period of time and monitored by hidden camera. Thirty four subjects were randomly assigned to be given a "yawn seed" by one of the experimenters; that is, the experimenter yawned in the subject's presence before leaving the room. The remaining 16 subjects were given no yawn seed. Define the parameters the researchers are comparing.

Alternate Example: *Cash for quitters*

In an effort to reduce health care costs, General Motors sponsored a study to help employees stop smoking. In the study, half of the subjects were randomly assigned to receive up to $750 for quitting smoking for a year while the other half were simply encouraged to use traditional methods to stop smoking. None of the 878 volunteers knew that there was a financial incentive when they signed up. At the end of one year, 15% of those in the financial rewards group had quit smoking while only 5% in the traditional group had quit smoking. Do the results of this study give convincing evidence that a financial incentive helps people quit smoking compared to traditional methods? (These data are reported in *Arizona Daily Star,* February 11, 2009)

HW page 630 (21, 23, 25–30)