Section 12: Statistics

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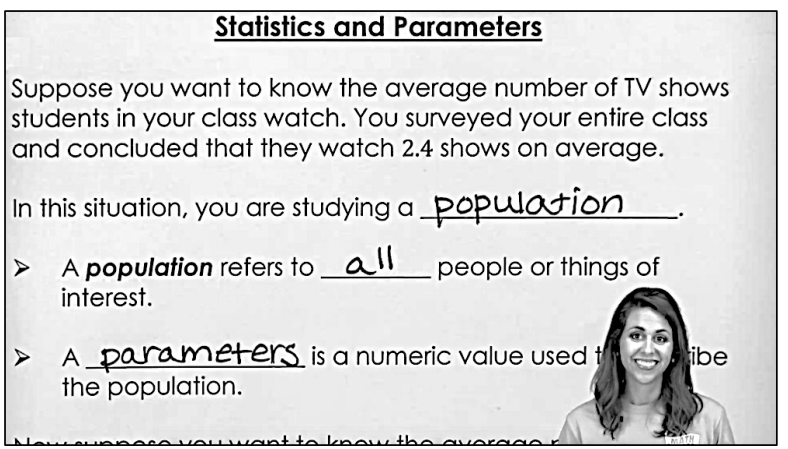


The following Mathematics Florida Standards will be covered in this section:
S-IC.1.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
S-IC.2.3 - Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
S-IC.2.4 - Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
S-IC.2.5 - Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
S-IC.2.6 - Evaluate reports based on data.
S-ID.1.4 - Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Section 12: Statistics
Section 12 – Topic 1
Statistics and Parameters

Suppose you want to know the average number of TV shows students in your class watch daily. You surveyed your entire class and concluded that they watch 2.4 shows on average.

In this situation, you are studying a _____.

- A ***population*** refers to _____ people or things of interest.
- A _____ is a numeric value used to describe the population.

Now suppose you want to know the average number of TV shows students in your school watch daily. You randomly selected and surveyed 100 students from your school. Based on the results, you concluded that they watch 1.9 shows on average.

In this situation, you are studying a _____.

- A ***sample*** is a _____ of the population.
- A _____ is a numeric value used to describe the sample.

There are common statistics and parameters used in statistics.

Sample	Sample ↓ Statistics	Estimate →	Population ↓ Parameters	Population
sample proportion (%)		→		population proportion (%)
sample mean (average)		→		population mean (average)
sample variance		→		population variance
sample standard deviation		→		population standard deviation
Statistics vary from sample-to-sample but parameters are fixed constants that are usually unknown				

What type of data are proportions used for?

What type of data do means describe?

- When we take a sample from a population, we want the sample to be randomly selected and representative of the population.

Let's Practice!

1. The human resource manager at a large corporation with 200 employees wants to estimate the proportion of its employees who have children. The results of a survey are shown below.

Have children	16
Do not have children	24

   a. What is the population?

   b. What is the sample?

   c. What is the parameter and its value?

   d. What is the statistic of interest and its value?

   e. The human resource manager concludes, "Since 40% of the people in my survey have children, exactly 80 of the 200 (or 40%) employees at this company must have children." What is the flaw in her reasoning?

Try It!

2. A light bulb manufacturer claims that the average lifetime of their light bulb is 850 hours. After sampling 100 of their light bulbs, the average lifetime was determined to be 825 hours.

   a. What is the population?

   b. What is the sample?

   c. What is the variable of interest?

   d. What is the parameter?

   e. What is the statistic of interest?

BEAT THE TEST!

1. A school newspaper published a story that included the results of a survey of its juniors and seniors. There are a total of 300 juniors and seniors enrolled at the school.

Going to Prom	20
Not Going to Prom	60

   a. Identify if the data is categorical or quantitative.

   b. What is the population?

   c. What is the sample?

   d. What is the variable of interest?

   e. What is the parameter?

   f. What is the statistic of interest?

Section 12 – Topic 2
Statistical Studies – Part 1

The art and science of collecting and analyzing data is classified as _____.

We can use statistics to make _____ about unknown population parameters based on information obtained from a random sample.

There are many different ways to gather data.

In your own words define a(n):

Sample Survey

Observational Study

Experiment

What is the primary difference between an experiment and an observational study?

There are three principles of experimental design:

Randomization uses chance (instead of personal choice) to assign experimental units to the treatments.

- Minimizes bias
- Evenly distributes the effects of lurking variables across all treatments

Replication assigns multiple subjects / experimental units to each treatment.

- Reduces chance variation (luck is averaged out)
- Larger samples produce more precise estimates of response differences

Control compares multiple groups, avoid lurking and confounding variables, ensure a realistic setting, use a control group and/or placebo group, blind / double-blind your study.

- Makes groups as similar as possible except for the treatment which minimizes the effects of lurking variables

Let's Practice!

For questions 1 and 3, classify each situation as a sample survey, an observational study, or an experiment. Identify any problems with the method of data collection.

1. A study investigated whether boys are quicker at learning video games than girls. Twenty randomly selected boys played *The Legend of Zelda* and twenty randomly selected girls played *Super Mario*. The time it took them to reach a certain level of expertise was recorded.

2. For your statistics project, you collect data by posting five questions on poster board around your classroom and record how your classmates respond to them.

3. Fifty recent graduates will be randomly selected and their starting salaries and college GPAs will be recorded. The researcher wishes to investigate the relationship between starting salary and college GPA.

Try It!

For questions 4 and 5, classify each situation as a sample survey, an observational study, or an experiment.

4. The local Department of Transportation is responsible for maintaining lane and edge lines on its paved roads. There are two new paint products on the market. Twenty comparable stretches of road are identified. Paint A is randomly assigned to ten of the stretches of road and paint B to the other ten. The department finds that paint B lasts longer.

5. Researchers visiting public high schools found that 75% of the students used computers in their classroom work at least once a week. The researchers visited a total of 50 schools in 15 states.

Section 12 – Topic 3
Statistical Studies – Part 2

For each of the following sample techniques, determine if you think the sampling method is likely to be biased and give your reason.

- ***Simple random sample:*** Every individual in the population has an equal chance of being chosen.

  Biased? O Yes O No

- ***Cluster sample:*** It breaks down the population into smaller groups (clusters) and randomly select clusters to make up your sample.

  Biased? O Yes O No

- ***Stratified sample:*** It breaks down the population into smaller groups that have something in common, and then randomly sample from each group.

  Biased? O Yes O No

- ***Systematic sample:*** Every K^{th} individual is chosen.

  Biased? ○ Yes ○ No

- ***Convenience sample:*** A selection of individuals is based on ease of reaching them.

  Biased? ○ Yes ○ No

- ***Volunteer sample:*** It selects individuals who decide to participate in response to an open invitation.

  Biased? ○ Yes ○ No

Let's Practice!

Use the following information to answer the question below.

Number	Student	House
00	Hannah Abbott	Hufflepuff
01	Susan Bones	Hufflepuff
02	Cho Chang	Ravenclaw
03	Vincent Crabbe	Slytherin
04	Gregory Goyle	Slytherin
05	Hermione Granger	Gryffindor
06	Neville Longbottom	Gryffindor
07	Luna Lovegood	Ravenclaw
08	Draco Malfoy	Slytherin
09	Harry Potter	Gryffindor
10	Fred Weasley	Gryffindor
11	George Weasley	Gryffindor
12	Ron Weasley	Gryffindor

1. Professor Dumbledore is trying to determine the percent of students who know how to perform a cheering charm. To do this, he wants to use a simple random sample of five students. How could he collect this sample?

Try It!

2. Determine the type of sampling technique used in each situation and identify any problems with that technique.

   a. Divide the class into four groups (freshman, sophomore, junior, and senior) and take a random sample of two students from each group.

   b. *Priceline.com* randomly e-mails a Customer Satisfaction Survey for certain transactions done on its site. Customers choose to either respond or not.

3. You are trying to select 25 students to represent your school for an upcoming interview with the local paper about their feelings about the changes to school lunches. Which of the following is the best sampling method in order for the views to be representative of the school?

   Ⓐ Select one of the classes from the school since they are each made up of 25 students.
   Ⓑ Select the last 25 students in line for school lunch.
   Ⓒ Send out a survey to all students and pick the first 25 to respond.
   Ⓓ Randomly select 25 students through a drawing from which all students were entered.

BEAT THE TEST!

1. Researchers are interested in the best way to prepare for an AP exam. Two hundred students will be randomly assigned to use one of the following four treatments:

   Treatment 1: Review class notes
   Treatment 2: Review class notes and attend a review course
   Treatment 3: Review class notes and study from a prep book
   Treatment 4: Review notes, attend a review and study from a prep book

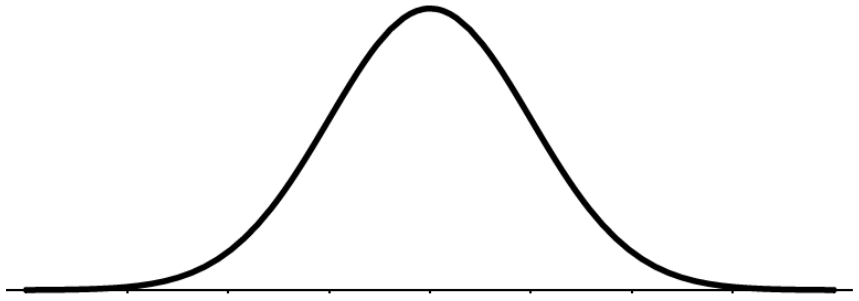
   Part A: Design an experiment and discuss the proper use of randomization.

   Part B: What are potential lurking or confounding variables?

   Part C: How could the experiment be modified to control for gender?

Section 12 – Topic 4
The Normal Distribution – Part 1

Consider the following distribution of data.

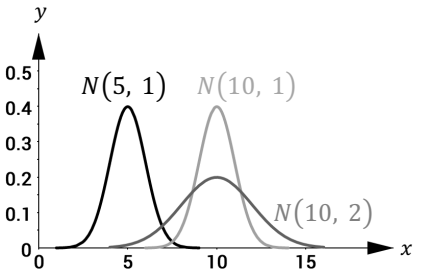


The curve above represents a _____. Recall that a normal distribution is centered at the mean,_____, and has a standard deviation,_____.

What properties do you notice about the normal distribution?

The properties of the normal distribution are:

- Smooth 'family' of curves. Each distribution / curve has a different mean and standard deviation.



- Notation: $N(\mu, \sigma)$, where μ = population mean and σ = population standard deviation.
- The normal distribution is bell (mound) shaped, symmetric, and unimodal.
- The area under curve is equal to the probability.
- The total area under the curve is 1, or 100%.
- The normal distribution follows the Empirical Rule, which is also known as the $68\% - 95\% - 99.7\%$ rule.
- Probabilities associated with the normal distribution are found using z-table.

The normal distribution curve follows the ***Empirical Rule***.

$\uparrow \mu \uparrow$

$\mu \pm 1\sigma \rightarrow \cong 68\%$

$\uparrow \quad \mu \quad \uparrow$

$\mu \pm 2\sigma \rightarrow \cong 95\%$

$\uparrow \quad \mu \quad \uparrow$

$\mu \pm 1\sigma \rightarrow \cong 99.7\%$

The empirical rule follows:

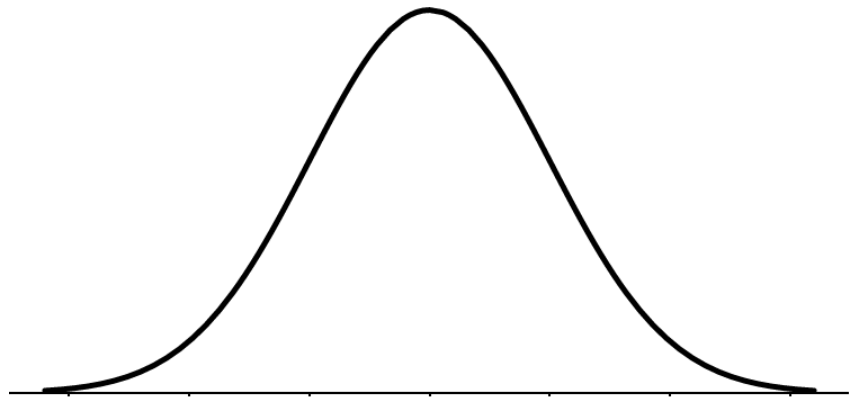
- _____ of the data falls in between one standard deviation of the mean or _____.

- _____ of the data falls in between two standard deviations of the mean or _____.

- _____ of the data falls in between three standard deviations of the mean or _____.

Let's Practice!

1. The amount of soda in a 12 ounce can has a normal distribution with a mean of 12.25 ounces. and a standard deviation of 0.15 ounces. Correctly draw the distribution weights and describe them using the Empirical Rule. The middle 95% of weights fall between what two values?



Try It!

2. Intelligence Quotient (IQ) scores have a normal distribution with a mean of 100 and a standard deviation of 15. What percent of people have IQ scores between 85 and 130?

Section 12 – Topic 5
The Normal Distribution – Part 2

Suppose we want to know the percent of people with Intelligence Quotient scores within 1.5 standard deviations of the mean.

We use _____ to measures the number of standard deviations an observation is away from the mean.

- The z-score can be calculated using the formula $z = \frac{x-\mu}{\sigma}$.
- We use z-scores to help us find probabilities for the normal distribution using the z –table.

Let's Practice!

1. IQ scores have a normal distribution with a mean of 100 and a standard deviation of 15.

   a. Calculate and interpret the z-score for the observation of 70.

   b. Calculate and interpret the z-score for the observation of 106.

Try It!

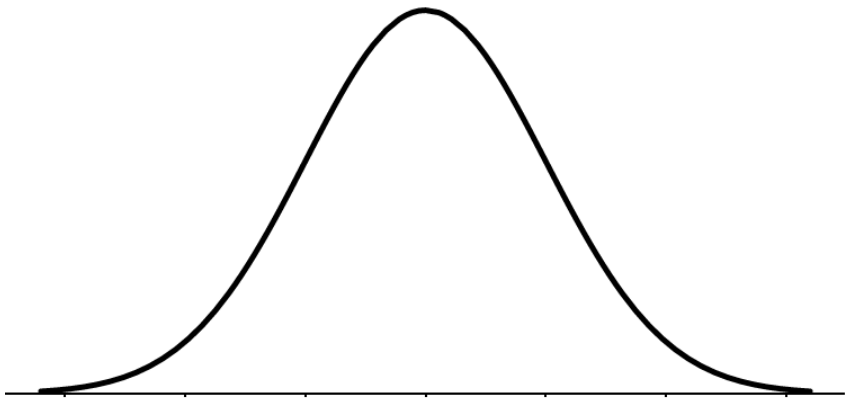
2. The amount of soda in a 12 ounces can of soda has a normal distribution with a mean of 12.25 ounces and a standard deviation of 0.15 ounces.

   a. Calculate and interpret the z-score for 12.40 ounces.

   b. Calculate and interpret the z-score for 12 ounces.

Every normal distribution can be transformed into a ***standard normal distribution*** where the mean is _____ and has a standard deviation of_____.

A standard normal distribution table, or z –table, can be used to determine _____. The z –table gives us the area / probability to the left of z.



The probability of an event occurring is notated as $P(x < X)$, where X is the observed event.

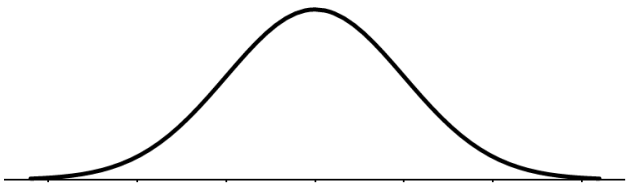
We can use the standard normal distribution curve by converting the value from a normal distribution to the corresponding z-score.

The probability of an event occurring $P(x \leq X) = P\left(z < \frac{X-\mu}{\sigma}\right)$.

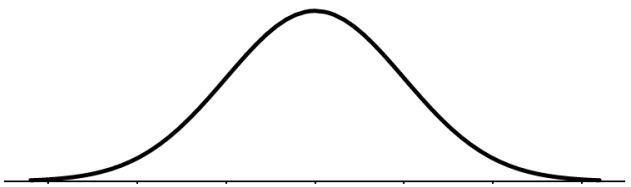
Let's Practice!

3. The amount of soda in a 12 oz. can of soda has a normal distribution with a mean of 12.25 oz. and a standard deviation of 0.15 oz.

   a. Label the curve with the values of X, number of ounces in a can, as well as the corresponding z –scores.



   b. What percent of soda cans contain less than 12 ounces? Shade the normal distribution curve.

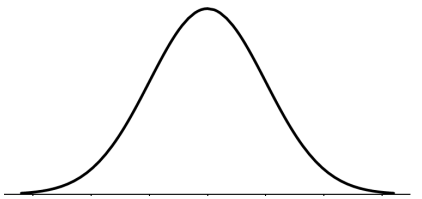


Section 12 – Topic 6
The Normal Distribution – Part 3

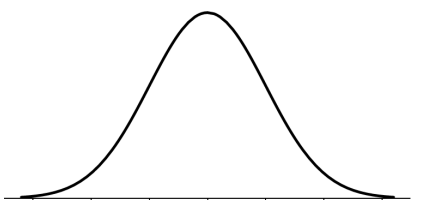
Try It!

1. Intelligence Quotient (IQ) scores have a normal distribution with a mean of 100 and a standard deviation of 15.

   a. What is the probability of a person having an IQ of 112 or more?



   b. What is the probability of a person having an IQ between 95 and 105? Shade the normal distribution curve.



BEAT THE TEST!

1. Consider two Algebra 2 students Raj and Mike who are in different classes. Raj scored a 92 on his final exam when the section average was an 88 with a standard deviation of 6.2. Mike scored an 85 on his final exam when the section average was a 69 with a standard deviation of 8.6. Who did better relative to their class?

2. The lifetime on a certain brand of tires has a normal distribution with a mean of 60,000 miles and a standard deviation of 3,000 miles.

   Part A: Approximately what percentage of tires of this brand last longer than 58,000 miles?

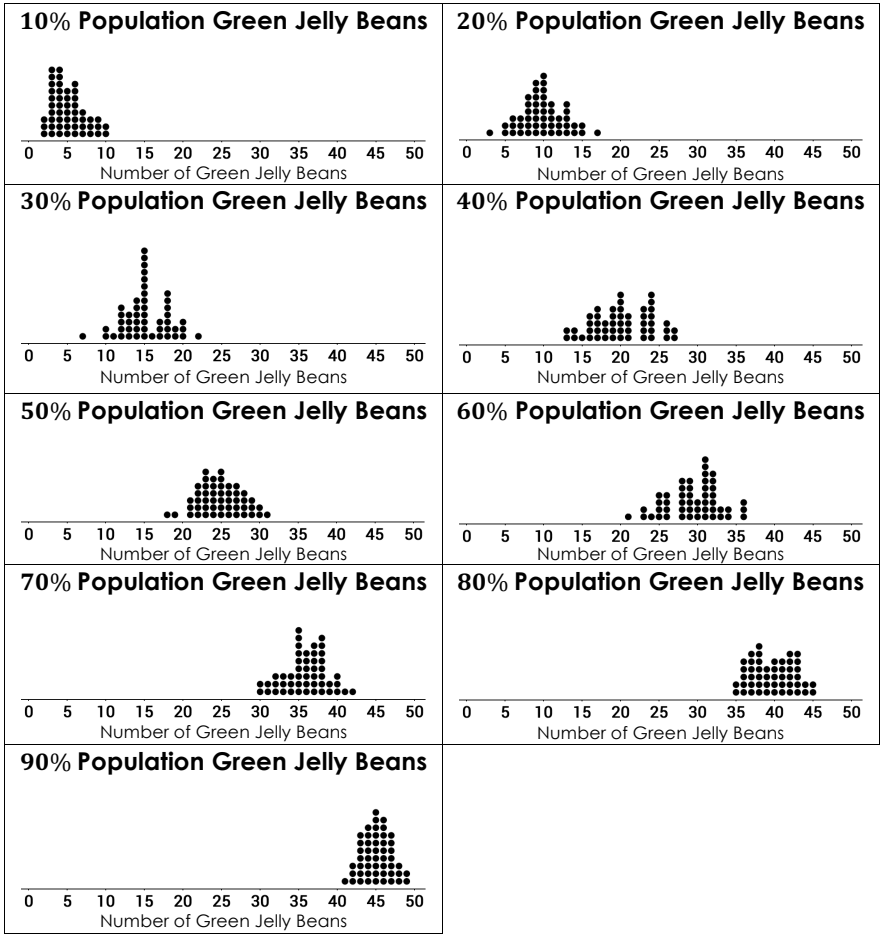
Part B: Approximately what percent of tires of this brand last between 55,000 and 65,000 miles?

Part C: What percent of tires of this brand last exactly 60,000 miles?

Section 12 – Topic 7
Estimating Means and Proportions

Mr. Howe has 18 students in his Algebra 2 class. Each student chose a partner and each pair was given a bag with 50 jelly beans. Each bag had a different population of green jellybeans.

The students simulated drawing 50 different random samples of size 50, replacing the jelly bean after each draw, and created a graph of their simulated sampling distributions, shown below.



Let's Practice!

1. After the class simulation, Mr. Howe gave a surprise bag to Myra and Hassam with the percent marked on the bottom. They drew 31 green jelly beans in a random sample of 50 from the surprise bag.

    a. Consider the class-simulated sampling distributions. Which of the following percentages might reasonably be the percentage of green jelly beans in the surprise bag?

    Ⓐ 40% to 60%
    Ⓑ 50% to 70%
    Ⓒ 60% to 80%
    Ⓓ 70% to 90%

    b. Let p represent the proportion of green jellybeans in the surprise bag. Use your answer from part a to write an inequality that describes possible values for p.

Consider a random sample that reasonably comes from the population of 0.20 to 0.50. This is sometimes rewritten as 0.35 ± 0.15. The value 0.15 is called a ***margin of error.***

    c. Write the inequality from question 1b using this notation.

    d. What is the margin of error?

Try It!

2. Mr. Howe introduced a second surprise bag. Students drew 22 green jelly beans in a random sample of 50 from the surprise bag.

    a. Consider the class simulated sampling distributions. What percentages might reasonably be the percentage of green jelly beans in the surprise bag?

    b. Let p represent the proportion of green jellybeans in the surprise bag. Use your answer from question 2a to write an inequality that describes possible values for p.

    c. Determine the margin of error.

We can also use another method to determine the margin of error.

The formula for the approximate standard deviation of the distribution of sample proportions is given by

$$\sqrt{\frac{\hat{p}(1-\hat{p})}{n}},$$

where $\hat{p}$ is the sample proportion and n is the number of samples.

In normal distributions, 95% of sample proportions lie within _____ standard deviations of the population proportion (p).

Let's Practice!

3. The student government association at Crestview High School surveyed to determine if they would rather have a coffee stand or frozen yogurt stand during lunch. 130 out of 200 randomly selected students said that they preferred a coffee stand.

   a. Determine the interval that represents the margin of error.

   b. Interpret the margin of error in the context.

   c. How would the margin of error be affected if 400 people were surveyed?

Try It!

4. In Miami, 800 people were interviewed and asked if they purchase gluten free food. Of those interviewed, 220 said "yes." Determine and interpret the interval that represents the margin of error in the survey.

BEAT THE TEST!

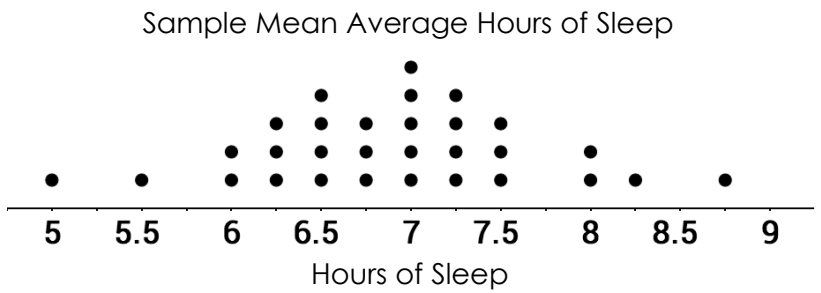
1. A new drug was given to a random sample of 400 people with acne. The results showed that 210 of the people improved. Based on these results, can it be said that more than half the people with acne will improve if they are given the drug?

Section 12 – Topic 8
Margin of Error When Estimating Population Means

Most studies report that an average teenager needs at least 7 hours of sleep each night. This is especially important before major exams.

Ms. Worrall's class wanted to determine the average number of hours of sleep that students at the Christa McAuliffe Middle School in Palm Beach got on the Sunday before exam week.

Since they could not poll all 1,087 students, the 30 students in the class each had to poll 20 students for a sample and find the average number of hours they slept, rounded to the nearest quarter hour. The distribution of their random sample means is shown below.



Let's Practice!

1. Consider the distribution of the sample means.

   a. Complete the table on the next page, and use the results to find the standard deviation of the distribution of the sample means.

Average Hours of Sleep	Difference in Sample Means and the Average of the Sample Means $x - \overline{x}$	Square of the Difference $(x - \overline{x})^2$
5		
5.5	-1.379	1.902
6		
6		
6.25	-0.629	0.396
6.25	-0.629	0.396
6.25	-0.629	0.396
6.25	-0.629	0.396
6.5	-0.379	0.144
6.5	-0.379	0.144
6.5	-0.379	0.144
6.5	-0.379	0.144
6.75	-0.129	0.017
6.75	-0.129	0.017
6.75	-0.129	0.017
7		
7		
7		
7		
7		
7.25		
7.25		
7.25		
7.25		
7.5	0.621	0.386
7.5	0.621	0.386
7.5	0.621	0.386
8		
8		
8.25	1.371	1.880
8.75		
$\overline{x} = 6.879$		$\sum (x - \overline{x})^2 =$

b. Using the formula $s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$, find the standard deviation for the sample.

c. Use the standard deviation to find the margin of error.

d. Determine and interpret the interval that represents the possible values for the population mean.

Try It!

2. Assume that Mr. Miller had two classes poll students to find the average sleep time. Now, there are 60 sample means.

   a. How would the additional sample means affect the standard deviation?

   b. DeMar says that the margin of error will be greater since there are more sample means. Do you agree? Justify your answer.

Sometimes we only have one random sample. In such cases, we can find the approximate standard deviation of the distribution of the sample means using the formula $\frac{s}{\sqrt{n}}$, where s is the standard deviation of the sample and n is the size of the sample.

Let's Practice!

3. There are 450 male athletes at a school. The athletic director wants to determine the average weight (in pounds) that an athlete can bench press. She took a sample from 15 athletes.

$110, 130, 140, 150, 160, 160, 180, 210, 220, 240, 260, 270, 280, 280, 320$

   a. Calculate the standard deviation for the sample.

   b. Calculate the standard deviation for distribution of the sample means.

   c. Determine the margin of error for the sample mean.

   d. Determine the interval that represents the possible values for the population mean.

Try It!

4. Consider the approximate standard deviation of the distribution of the sample means using the formula $\frac{s}{\sqrt{n}}$, where s is the standard deviation of the sample and n is the size of the sample.

   a. How can we decrease the variability in the sample means?

   b. How does decreasing the variability in the sample means affect the interval that represents the possible values for the population mean?

BEAT THE TEST!

1. A generic low-sugar brand of bread asserts that they have less sugar than the leading low sugar name brand. A random sample of ten slices of the generic brand result in the following sugar measurements (in grams).

   $$0.79, 0.69, 0.73, 0.65, 0.78, 0.74, 0.69, 0.68, 0.78, 0.69$$

   The approximate standard deviation for the sample is 0.0466.

   Part A: Determine the interval that represents the possible values for the population mean sugar content.

   Part B: The leading low-sugar name brand is known to have a mean sugar content of 0.67 grams per slice. Based on your data from the sample, can the generic brand assert that they have lower sugar content?

Section 12 – Topic 9
Comparing Treatments – Part 1

A candle company introduced a new type of wax into their candles. They claim their candles burn longer than the leading brand. The burn times of ten candles (five from each brand), rounded to the nearest hundredth of an hour, are shown below. The candles are the same height and width. They were burned in the same conditions.

$$12.25, 11.89, 12.14, 11.96, 12.02, 11.56, 12.21, 11.69, 12.15, 11.92$$

For now, we will randomly divide the candles into two groups using a random number generator and not pay attention to the brand.

Group A	12.15	12.21	12.02	11.69	12.14
Group B	11.56	12.25	11.92	11.89	11.96

Let's Practice!

1. Consider Group A and Group B.

   a. Calculate the mean for Group A and Group B.

   b. Calculate the difference between the means: $(\bar{x}_A - \bar{x}_B)$.

   c. Interpret the difference value in the context.

Try It!

2. The burn times were randomized three more times. The means and difference values (Diff) were calculated. Interpret the following difference values.

   a. 0.35

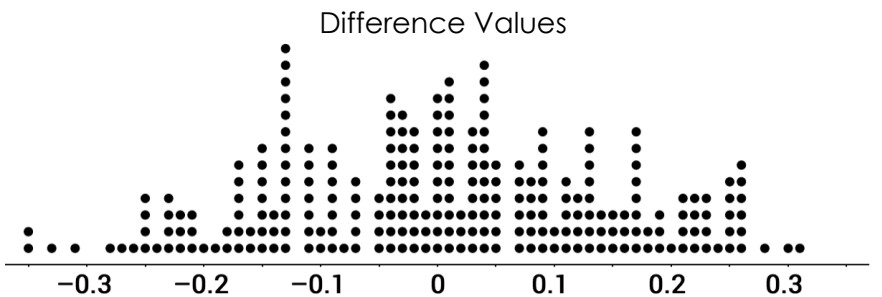
   b. -0.21

3. What would a difference value of 0 or very near 0 mean?

We must consider that the observed differences in the means could be from chance or they could be statistically _____.

We only looked at one randomization. Imagine that we randomized them and completed 249 more simulations.

The dot plot below represents the distribution of the difference values from the 250 simulations.



Let's Practice!

4. Determine if the following differences values are statistically significant.

   a. 0.13

   b. -0.24

Try It!

5. Determine if the following differences values are statistically significant.

   a. 0.22

   b. -0.18

Let's recap: There are three things to help us determine if the difference value is statistically significant.

- The difference value is relatively far from _____.
- For positive differences, the percentage of observed values that fall at or above the difference value is very _____.
- For negative differences, the percentage of observed values that fall at or _____ the difference value is very small.

Section 12 – Topic 10
Comparing Treatments – Part 2

A candle company introduced a new type of wax into their candles. They claim their candles burn longer than the leading brand. The burn times of ten candles (five from each brand), rounded to the nearest hundredth of an hour, is shown below. The candles are the same height and width. They were burned in the same conditions.

The candles with the new wax had the following burn times.

$$12.25, 11.89, 11.96, 12.15, 12.21$$

The candles from the leading brand had the following burn times.

$$12.14, 12.02, 11.56, 11.69, 11.92$$

Let's look at how we would carry out an actual randomized experiment with the data.

Step 1: Define the treatment group and the control group:

Step 2: Develop competing claims.

A ***null hypothesis*** claims that there is no difference between the two groups in the experiment.

- The new wax _____ _____ increase burn time.

An ***alternative hypothesis*** claims that this is a difference between the two groups.

- The new wax _____ _____ burn time.

Write a difference value inequality that supports the alternative hypothesis.

Step 3: Find the mean for each group and the difference value.

Step 4: Take all ten values and randomly assign them into two groups and find the difference values.

You can do this manually by writing the ten burn times on slips of paper, placing them in a bag, and drawing out five slips for the first group and the remaining five will be the second group. Find the difference value and repeat the process. Create a distribution of the difference values.

What are drawbacks of using the manual method?

We can also use technology to create the randomization distribution.

Step 5: Use the randomized distribution and the difference value inequality to determine the probability of getting a difference value greater than or equal to than the one you found for the control and treatment group.

Step 6: Make a conclusion.

BEAT THE TEST!

1. Consider the data from the candle burning experiment. It was discovered that two of the values were interchanged. The correct values are displayed below.

   The candles with the new wax had the following burn times.

   $$12.25, 11.89, 12.14, 12.15, 12.21$$

   The candles from the leading brand had the following burn times.

   $$11.96, 12.02, 11.56, 11.69, 11.92$$

   Part A: Calculate the difference value for the treatment group and the control group.

   Part B: Does this change your conclusion from the experiment?

Section 12 – Topic 11
Interpreting Data

Here we will take everything we have learned about statistics and use it to interpret data in each given scenario.

Let's Practice!

1. Is gas mileage affected by the brand of gas used? 90 cars were randomly assigned to brands A, B, and C gasoline. The resulting gas mileage was recorded in mpg (miles per gallon).

   Gas brand A: 18 mpg
   Gas brand B: 25 mpg
   Gas brand C: 16 mpg

   a. How many treatment groups were there?

   b. How many subjects were in each treatment?

   c. Do you think there were enough subjects in each treatment? Explain.

   d. How were the subjects assigned to the treatments groups? Why is this important?

   e. Do you see any issues with the design of this experiment? Explain.

   f. Newspaper reporters came up with some titles for this experiment. Which one is most appropriate?

      - "A certain brand of gas results in better gas mileage."
      - "Cars help improve gas mileage."
      - "People can get better gas mileage for their car."

Try It!

2. If you flip a coin enough times, it should land on heads 50% of the time and on tails 50% of the time. Take a coin and flip it 40 times.

   a. What is the proportion of times that the coin landed on heads?

   b. How close is your proportion to the theoretical result of 0.50 for the proportion of heads?

   c. Calculate the margin of error in your experiment.

   d. How reasonable do you think these results are?

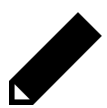
BEAT THE TEST!

1. In the last election, one of the states reported a close race. In a recent poll of 100 people from the state, the Democratic candidate had 47% support in a recent poll, while the Republican candidate had 45%. The margin of error for this poll is 5%.

   Part A: What is meant by a margin of error of 5%?

   Part B: What could be some reasons why the percentages of the two candidates do not add up to 100%?

   Part C: Upon further reading, the results of this poll can be said to be 'a toss-up'. Why would these results be interpreted in such a way?



Test Yourself! Practice Tool

Great job! You have reached the end of this section. Now it's time to try the "Test Yourself! Practice Tool," where you can practice all the skills and concepts you learned in this section. Log in to Math Nation and try out the "Test Yourself! Practice Tool" so you can see how well you know these topics!

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