TEXAS MATH SOLUTION

Accelerated Grade 7

Module 5 Topic 3

Topic Level Materials

Module Overview
Topic Pacing Guide
Family Guide
Topic Overview
Topic Summary

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Module 5 Overview
Analyzing Populations, Probabilities, and Potential

"Probability is an important part of any mathematical education. It is a part of mathematics that enriches the subject as a whole by its intersection with other uses of mathematics. Probability is an essential tool in applied mathematics and mathematical modeling. It is also an essential tool in statistics." (*GAISE Report*, p. 8)

Why is this Module named Analyzing Populations, Probabilities, and Potential?

This module formally introduces and explores probabilities and uses the numeric and graphical displays students learned in the previous course to compare populations. Students learn to analyze the representativeness of experimental probabilities and statistics drawn from samples of populations, focusing on the validity and usefulness of appropriately generated data. Students also analyze different loan or repayment options to compare which financial decisions are more financially responsible than others.

What is the mathematics of Analyzing Populations, Probabilities, and Potential?

This module contains four topics: *Introduction to Probability*, *Compound Probability*, *Drawing Inferences*, and *Financial Literacy: Your Financial Future*.

In *Introduction to Probability*, students learn the basics of probability and use experimental and theoretical probability to make predictions. They build uniform and non-uniform probability models of simple events and use simulation, including the use of random number tables, to determine probabilities. Students further develop their understanding of probability in *Compound Probability* as they use tools (e.g., arrays, lists, tree diagrams, and simulations) to build models of compound events.

Next, in *Drawing Inferences*, students generate random samples to determine statistics from populations and use those random samples to make conclusions, first about one population and then about two populations. Students are introduced to a new measure of variability, mean absolute deviation. Throughout the topic, students use measures of center and variability and numerical displays of data.

Students begin *Financial Literacy: Your Financial Future* by reviewing prior knowledge about simple and compound interest. They calculate and compare simple and compound interest earnings for different scenarios. They solve real-world

problems comparing how interest rate and loan length affect cost of credit. Students identify and explain the advantages and disadvantages of different payment methods and determine which methods are more financially responsible. Online calculators are used to calculate the total cost of repaying a loan under various interest rates and over different periods of time so they can compare which financial decisions are more financially responsible than others. Finally, students investigate different post-secondary tuition costs to understand that costs vary widely and that there are options for students to find a way to manage the costs of post-secondary education that is affordable to them.

How is Analyzing Populations, Probabilities, and Potential connected to prior learning?

This module builds on students' prior knowledge of proportional reasoning, specifically solving proportions and percent equations, including percent error. These skills are used in this module as students use probabilities to make predictions and as they compare the percent error between experimental and theoretical probabilities and between statistics and parameters.

In the previous course, students learned how to calculate the mean, median, mode, range, and interquartile range of data sets. They also learned to display data sets using dot plots, stem-and-leaf plots, histograms, and box plots. In this module, students are expected to recall this knowledge as they draw comparative inferences between two populations.

Students previous work in calculating simple and compound interest in financial literacy problems applies to the financial literacy problems students encounter in this module. Students must be able to explain how small amounts of money invested regularly, including money saved for college or retirement, will grow over time. This includes calculating and comparing simple and compound interest earnings, solving real-world problems comparing how interest rate and loan length affect cost of credit, and students making financially responsible decisions about different payment methods for credits cards and loans using online calculators.

When will students use knowledge from Analyzing Populations, Probabilities, and Potential in future learning?

This module supports future learning by providing the foundation for probability and random sampling. In future math courses,

students will develop a deeper and possibly more algorithmic approach to probability, including compound and conditional probabilities. Students will also engage in varied types of data collection and need to understand the role of randomization and simulation in making valid inferences. This module provides the groundwork for students to understand these often complex ideas.

*1 Day Pacing = 45 min. Session

Module 5: Analyzing Populations, Probabilities and Potential

Topic 3: Drawing Inferences

Lesson #	Lesson Title	Lesson Subtitle	Highlights	TEKS	Pacing*
ELPS: 1.A, 1.C, 1.D, 1.E, 1.G, 2.C, 2.D, 2.G, 2.H, 2.I, 3.A, 3.B, 3.C, 3.D, 3.F, 4.A, 4.B, 4.C, 4.D, 4.G, 4.K, 5.E					
1	March MADness	Mean Absolute Deviation	Students analyze two data sets displayed on a dot plot that have the same mean, but with different amounts of spread. The concept of deviation is introduced, and students calculate the deviations of each data point from the mean. The *mean absolute deviation* is introduced, and students calculate the mean absolute deviation for each data set. Then, they calculate and interpret the mean absolute deviation for two additional data sets. Finally, students convert non-numerical data from two data sets into numerical data to analyze and interpret it using measures of center and variation.	8.11B	2
2	Let's Hear From You!	Collecting Random Samples	Students review the statistical process and deepen their understanding of the second component of the process: data collection. They are introduced to new terms related to data collection. Students then read various problem situations and differentiate between *census* and *sample*, and *parameter* and *statistic*. Students learn that a sample is smaller than the population, and it represents characteristics of the population.	7.6F 7.12B 8.11C	3

Lesson #	Lesson Title	Lesson Subtitle	Highlights	TEKS	Pacing*
			They encounter methods for selecting samples from a population and determine if methods inadvertently misrepresent the population. Students use two tools to generate random numbers: pulling numbers and random number tables. Random number tables are provided.		
3	Tiles, Gumballs, and Pumpkins	Using Random Samples to Draw Inferences	Students use statistical information gathered from a sample to determine a parameter for a population. They complete this process two times with one scenario. The first time students may select the sample using various methods; however, the second time they follow a specific strategy to select a random sample. In each case, students use proportional reasoning to estimate the parameter. They compute percent error and conclude that statistics obtained from samples are more likely to represent the parameter of the population if the sample is randomly chosen. They then analyze data from 100 samples and predict the parameter from the data. Finally, students are provided with a scenario and must design and carry out a sampling plan to estimate the parameter.	7.6F 7.12B 8.11C	2
4	Raising the Bar	Bar Graphs	In this lesson, students analyze categorical data presented in bar graphs. Students analyze three types of bar graphs—single bar graphs (with horizontal or vertical bars), double bar graphs, and stacked bar graphs. Students then answer questions about data provided and create their own graphs from data sets.	7.6G 7.12C	2

Lesson #	Lesson Title	Lesson Subtitle	Highlights	TEKS	Pacing*
5	Dark or Spicy?	Comparing Two Populations	Within the context of a situation, students calculate the measures of center and measures of variability for two different populations. They compare the difference of the measures of center for the two populations to their measures of variation. Students construct dot plots and determine a five-number summary for a data set for comparison purposes. A stem-and-leaf plot is used to display data in one situation.	7.6G 7.12A	2
6	That's So Random	Using Random samples from Two Populations to Draw Conclusions	Students use random samples to draw conclusions about two populations. The characteristics of the two populations are analyzed using graphical displays in the form of stem-and-leaf plots and box plots. In the first situation, students are given a table of values containing data for two populations. In the second situation, students are given two histograms containing data for two distinct populations. Students create graphical displays to answer questions related to each problem situation. Questions focus on means, medians, ranges, mean absolute deviation, and interquartile ranges.	7.6F 7.12A 7.12C	2
End of Topic Assessment					1

Module 5: Analyzing Populations, Probabilities, and Potential

TOPIC 3: DRAWING INFERENCES

In this topic, students continue developing their understanding of the statistical process by focusing on the second component of the process: data collection. Throughout this topic, students create data displays such as bar graphs, circle graphs, dot plots, box plots, stem-and-leaf plots and histograms. They create comparative data displays and compare the difference of the measures of center for two populations to their measures of variability. They calculate and use the mean absolute deviation to describe how data is spread out around the mean of the data set. Then students draw conclusions about two populations using random samples.

Where have we been?

In the previous course, students learned about and used aspects of the statistical problem-solving process: formulating questions, collecting data, analyzing data, and interpreting the results. They also used numerical data displays, including both measures of center (mean, median, mode) and measures of variability (range and interquartile range).

Where are we going?

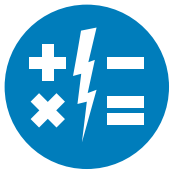
In future math courses, students will learn about specific types of random sampling and the inherent bias in sampling techniques. They will continue analyzing and comparing random samples from populations and comparing their measures of center and variability.

Using a Random Number Table to Select Random Samples

When selecting samples for an experiment, a random number table can be used to assign individuals to groups. The first three lines of a sample random number table are shown.

Random Number Table										
Line 1	65285	97198	12138	53010	94601	15838	16805	61404	43516	17020
Line 2	17264	57327	38224	29301	18164	38109	34976	65692	98566	29550
Line 3	95639	99754	31199	92558	68368	04985	51092	37780	40261	14479

Myth: Cramming for an exam is just as good as spaced practice for long-term retention.



Everyone has been there. You have a big test tomorrow, but you've been so busy that you haven't had time to study. So you had to learn it all in one night. You may have gotten a decent grade on the test. However, did you to remember the material a week, month, or year later?

The honest answer is, "probably not." That's because long-term memory is designed to retain useful information. How does your brain know if a memory is "useful" or not? One way is the frequency in which you encounter a piece of information. If you only see something once (like during cramming), then your brain doesn't deem those memories as important. However, if you sporadically come across the same information over time, then it's probably important. To optimize retention, encourage your student to periodically study the same information over expanding intervals of time.

#mathmythbusted

Talking Points

You can further support your student's learning by asking questions about the work they do in class or at home. Your student is learning to draw inferences from analyzing data.

Questions to Ask

- Does your answer make sense? Why?
- Can you show me the strategy you used to solve this problem? Do you know another way to solve it?
- Does your answer make sense? How do you know?

Key Terms

parameter
When data are gathered from a population, the characteristic used to describe the population is called a parameter.

statistic
When data are gathered from a sample, the characteristic used to describe the sample is called a statistic.

random sample
A random sample is a sample that is selected from the population in such a way that every member of the population has the same chance of being selected.

Drawing Inferences
Topic 3 Overview

How is *Drawing Inferences* organized?

In this topic, students begin by analyzing two data sets displayed as dot plots that have the same mean, but with different amounts of spread. This allows students to review previous work with data displays, and comparing the measures of center and variability of two data sets. Then deviation, specifically mean absolute deviation, is introduced as a new measure of variability. Students compare the two measures of variability, interquartile range and mean absolute deviation.

Next, students continue developing their understanding of the statistical process by exploring the second component of the process: data collection. They learn about samples, populations, censuses, parameters, and statistics. Students then discuss the importance of representative samples, including random samples, for the purpose of making generalizations about the populations represented by the samples. Students collect random and non-random samples, using hands-on tools and simulation strategies, and then use proportional reasoning to estimate the value of the parameter of interest. Students conclude that statistics obtained from samples are more likely to represent the parameter of the population if the sample is randomly chosen.

Finally, students analyze categorical data presented in circle graphs, bar graphs, double bar graphs and stacked bar graphs which allow for part-to-part and part-to-whole comparisons. Students continue to create data displays such as dot plots and stem-and-leaf plots to compare two populations. They calculate the measures of center, measures of variability thus creating the five number summary for data sets for comparison purposes. They compare the calculated measures of center and measures of variability to interpret the differences in the two populations, but also display the data to compare the differences in these measures visually as well. Students then use random samples to make inferences and draw conclusions about two populations. The characteristics of the two populations are analyzed using graphical displays, such as stem-and-leaf plots, box plots, and histograms, and by comparing their shapes, centers and spreads.

What is the entry point for students?

In the previous course, students learned about and used aspects of the statistical problem-solving process: formulating

questions, collecting data, analyzing data, and interpreting the results. They formulated statistical questions, collected survey data, and analyzed data using numerical data displays and measures of center (mean, median, mode) and measures of variability (range and interquartile range). However, the primary focus was on analyzing and summarizing a single set of data at a time. In this course, students are expected to calculate measures for multiple samples or populations and use those measures to compare the data sets.

Students also used random number tables and began working with simulations in the previous two topics. As students move through this topic, they will first engage with the statistical process and simulation tools, eventually combining this knowledge with their prior knowledge of displaying data and calculating measures of center and variability as they draw informal inferences about populations.

How does a student demonstrate understanding?

Students will demonstrate understanding of the standards in this topic if they can:

- Calculate the mean absolute deviation for a data set.
- Use the mean absolute deviation as a measure of variability to describe how data is spread out around the mean of the data set.
- Explain how inferences about a population can be made by examining a random sample.
- Explain why generalizations made about a population from a sample are only valid if the sample represents that population.
- Use data from a random sampling to make inferences and draw conclusions about a population.
- Use tools to generate random samples.
- Generate multiple samples (or simulated samples) of the same size to draw inferences about a population.
- Create and interpret data displays, such as bar graphs, dot plots and circle graphs, including part-to-part and part-to-whole comparisons.
- Identify similarities and differences in two different data sets.
- Compare and draw informal inferences about two populations based on their measures of center and variability (mean, median, range, interquartile range).
- Compare two numerical data distributions on a graph, such as a comparative dot plot, stem-and-leaf plot, histogram or box plot, by visually comparing the shapes, centers, and spreads of the data displays.

Why is *Drawing Inferences* important?

This topic develops students' statistical literacy as they increase their knowledge of, and the level of complexity of their engagement with, the steps of the statistical problem-solving process. In future math courses, students will continue developing strategies that will allow them to engage in higher levels of statistical sophistication in terms of data collection, analysis, and interpretation. They will learn about specific types of random sampling and the inherent bias in sampling techniques. Students continue analyzing random samples from populations, comparing their measures of center and variability, until they realize the need for a standard method for comparing variability. This realization will lead to use of the standard normal distribution for calculating the likelihood of a specific outcome, which leads students to significance testing, margin of error, and confidence intervals.

How do the activities in *Drawing Inferences* promote student expertise in the mathematical process standards?

All Carnegie Learning topics are written with the goal of creating mathematical thinkers who are active participants in class discourse, so elements of the habits of mind should be evident in all lessons. Students are expected to make sense of problems and work towards solutions and to reason using concrete and abstract ideas. They should communicate their thinking while providing a critical ear to the thinking of others.

This topic is designed to help students reason statistically and to use appropriate tools to generate random samples and compare populations. Students are expected to describe data displays, compute measures of center and variability to compare data sets, and reason about representative and random samples. Throughout the topic, students use real-world data as they engage in the statistical process.

Materials Needed

- Paper bags
- Scissors
- Blank paper

Learning Together

ELPS: 1.A, 1.D, 1.E, 1.G, 2.C, 2.D, 2.G, 2.H, 2.I, 3.A, 3.B, 3.C, 3.D, 3.F, 4.A, 4.B, 4.C, 4.G, 4.K, 5.E

Lesson	Lesson Name	TEKS	Days	Highlights
1	March MADness: Mean Absolute Deviation	8.11B	2	Students analyze two data sets displayed on a dot plot that have the same mean, but with different amounts of spread. The concept of deviation is introduced, and students calculate the deviations of each data point from the mean. The *mean absolute deviation* is introduced, and students calculate the mean absolute deviation for each data set. Then, they calculate and interpret the mean absolute deviation for two additional data sets. Finally, students convert non-numerical data from two data sets into numerical data to analyze and interpret it using measures of center and variation.
2	Let's Hear From You!: Collecting Random Samples	7.6F 7.12B 8.11C	3	Students review the statistical process and deepen their understandings of the second component of the process: data collection. They are introduced to new terms related to data collection. Students then read various problem situations and differentiate between census, sample, parameter, and statistic. Students learn that a sample is smaller than the population, and it represents characteristics of the population. They encounter methods for selecting samples from a population and determine if methods inadvertently misrepresent the population. Students use two tools to generate random numbers: pulling numbers and random number tables. Random number tables are provided.

Lesson	Lesson Name	TEKS	Days	Highlights
3	Tiles, Gumballs, and Pumpkins: Using Random Samples to Draw Inferences	7.6B 7.12B 8.11C	2	Students use statistical information gathered from a sample to determine a parameter for a population. They complete this process two times with one scenario. The first time students may select the sample using various methods; however, the second time, they follow a specific strategy to select a random sample. In each case, students use proportional reasoning to estimate the parameter. They compute percent error and conclude that statistics obtained from samples are more likely to represent the parameter of the population if the sample is randomly chosen. They then analyze data from 100 samples and predict parameter from the data. Finally, students are provided with a scenario and must design and carry out a sampling plan to estimate the parameter.
4	Raising the Bar: Bar Graphs	7.6G 7.12C	2	In this lesson, students analyze categorical data presented in bar graphs. Students analyze three types of bar graphs: single bar graphs (with horizontal or vertical bars), double bar graphs, and stacked bar graphs. Students then answer questions about data provided and create their own graphs from data sets.
5	Dark or Spicy?: Comparing Two Populations	7.6G 7.12A	2	Within the context of a situation, students calculate the measures of center and measures of variability for two different populations. They compare the difference of the measures of center for the two populations to their measures of variation. Students construct dot plots and determine a five-number summary for a data set for comparison purposes. A stem-and-leaf plot is used to display data in one situation.
6	That's So Random: Using Random Samples from Two Populations to Draw Conclusions	7.6F 7.12A 7.12C	2	Students use random samples to draw conclusions about two populations. The characteristics of the two populations are analyzed using graphical displays in the form of stem-and-leaf plots and box plots. In the first situation, students are given a table of values containing data for two populations, and in the second situation, students are given two histograms containing data for two distinct populations. Students create graphic displays to answer questions related to each problem situation. Questions focus on means, medians, ranges, mean absolute deviation, and interquartile ranges.

Suggested Topic Plan

*1 Day Pacing = 45 min. Session

Day 1	Day 2	Day 3	Day 4	Day 5
TEKS: 8.11B **LESSON 1** **March MADness** GETTING STARTED ACTIVITY 1	**LESSON 1** continued ACTIVITY 2 TALK THE TALK	TEKS: 7.6F, 7.12B, 8.11C **LESSON 2** **Let's Hear From You!** GETTING STARTED ACTIVITY 1	**LESSON 2** continued ACTIVITY 2 ACTIVITY 3	**LESSON 2** continued ACTIVITY 4 TALK THE TALK
Day 6	**Day 7**	**Day 8**	**Day 9**	**Day 10**
TEKS: 7.6F, 7.12B, 8.11C **LESSON 3** **Tiles, Gumballs, and Pumpkins** GETTING STARTED ACTIVITY 1 ACTIVITY 2	**LESSON 3** continued ACTIVITY 3 TALK THE TALK	TEKS: 7.6G, 7.12C **LESSON 4** **Raising the Bar** GETTING STARTED ACTIVITY 1	**LESSON 4** continued ACTIVITY 2 ACTIVITY 3 TALK THE TALK	TEKS; 7.6G, 7.12A **LESSON 5** **Dark or Spicy?** GETTING STARTED ACTIVITY 1
Day 11	**Day 12**	**Day 13**	**Day 14**	
LESSON 5 continued ACTIVITY 2 TALK THE TALK	TEKS: 7.6F, 7.12A, 7.12C **LESSON 6** **That's So Random** GETTING STARTED ACTIVITY 1 ACTIVITY 2	**LESSON 6** continued ACTIVITY 3 TALK THE TALK	**END OF TOPIC ASSESSMENT**	

Assessment

There is one assessment aligned to this topic: End of Topic Assessment.

Drawing Inferences Summary

KEY TERMS

- deviation
- absolute deviation
- mean absolute deviation (MAD)
- survey
- data
- population
- census
- sample
- parameter
- statistic
- random sample

LESSON 1

March MADness

One measure of variation that describes the spread of data values is **deviation**. The deviation of a data value indicates how far that data value is from the mean. To calculate the deviation, subtract the mean from the data value:

$$\text{Deviation} = \text{data value} - \text{mean}$$

For example, the mean of the data set 15, 12, 13, 10, 9, and 13 is 12.

The table describes each data point's deviation from the mean.

Data Point	15	12	13	10	9	13
Deviation from the Mean	3	0	1	−2	−3	1

In order to get an idea of the spread of the data values, take the absolute value of each deviation and then determine the mean of those absolute values. The absolute value of each deviation is called the **absolute deviation**. The **mean absolute deviation (MAD)** is the mean of the absolute deviations.

For example, the mean absolute deviation of the data shown in the table is $\frac{|3| + |0| + |1| + |-2| + |-3| + |1|}{6} = \frac{10}{6}$.

So, the MAD is about 1.67.

LESSON 2

Let's Hear From You!

There are four components of the statistical process:

- Formulating a statistical question.
- Collecting appropriate data.
- Analyzing the data graphically and numerically.
- Interpreting the results of the analysis.

One data collection strategy you can use is a survey. A **survey** is a method of collecting information about a certain group of people. It involves asking a question or a set of questions to those people. When information is collected, the facts or numbers gathered are called **data**.

The **population** is the entire set of items from which data can be selected. When you decide what you want to study, the population is the set of all elements in which you are interested. The elements of that population can be people or objects. A **census** is the data collected from every member of a population.

In most cases, it is not possible or logical to collect data from the entire population. When data are collected from a part of the population, the data are called a **sample**.

When data are gathered from a population, the characteristic used to describe the population is called a **parameter**. When data are gathered from a sample, the characteristic used to describe the sample is called a **statistic**. A statistic is used to make an estimate about the parameter.

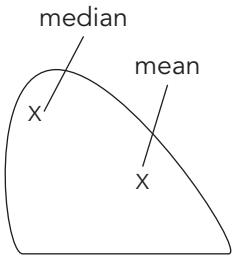
When information is collected from a sample in order to describe a characteristic about the population, it is important that such a sample be as representative of the population as possible. A **random sample** is a sample that is selected from the population in such a way that every member of the population has the same chance of being selected.

LESSON
3

Tiles, Gumballs, and Pumpkins

If you are estimating a parameter that is a count, rather than a percentage, you can use proportional reasoning to scale up from the ratio of the number of observations in your sample to the statistic.

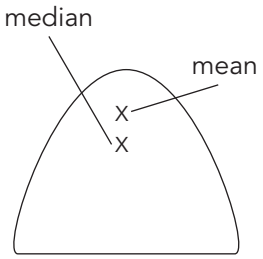
There are three common distributions of data: skewed left, skewed right, and symmetric. The distribution of data can help you determine whether the mean or median is a better measure of center.



skewed right

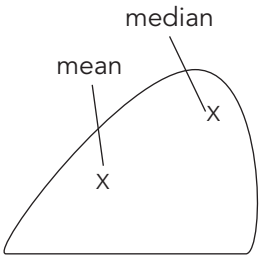
The mean of a data set is greater than the median when the data are skewed to the right.

The median is the best measure of center because the median is not affected by very large data values. The mean is affected by large values.



symmetric

The mean and median are equal when the data are symmetric.



skewed left

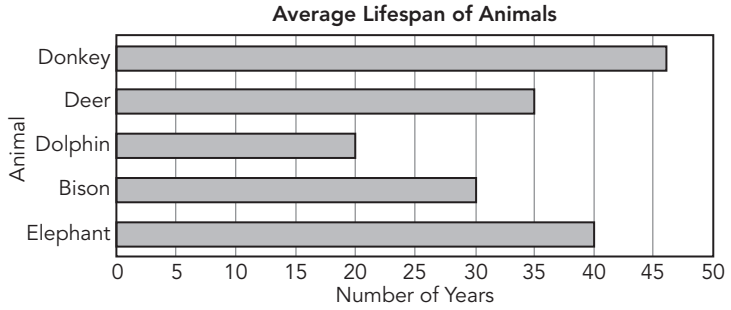
The mean of a data set is less than the median when the data are skewed to the left.

The median is the best measure of center because the median is not affected by very small data values. The mean is affected by small values.

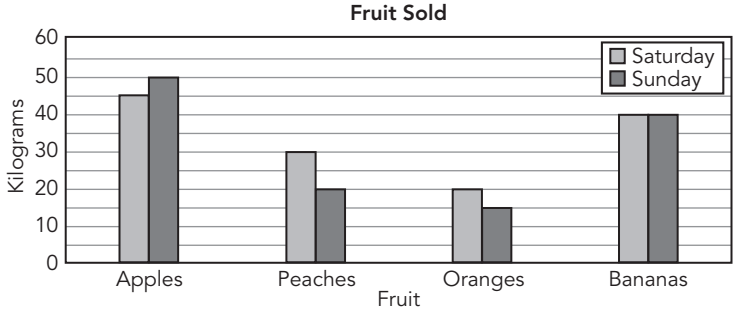
LESSON
4

Raising the Bar

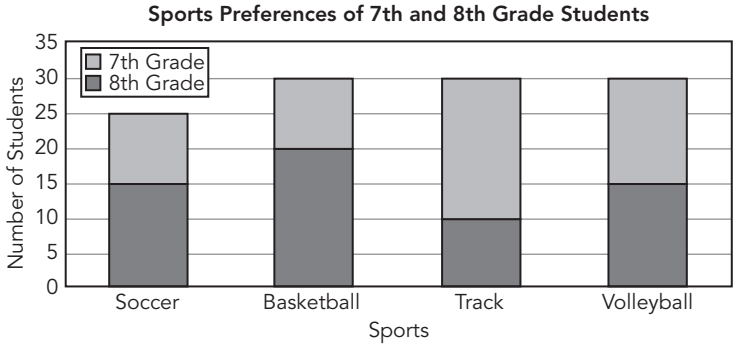
Some graphs are used to display data that consists of different categories. Bar graphs display data using horizontal or vertical bars so that the height or length of the bars indicates its value for a specific category.



A double bar graph can be used when each category contains two different groups of data. The bars may be vertical or horizontal, and a key explains the colors or patterns for each group. The two bars representing the same category are side by side, and space is used to separate the categories.

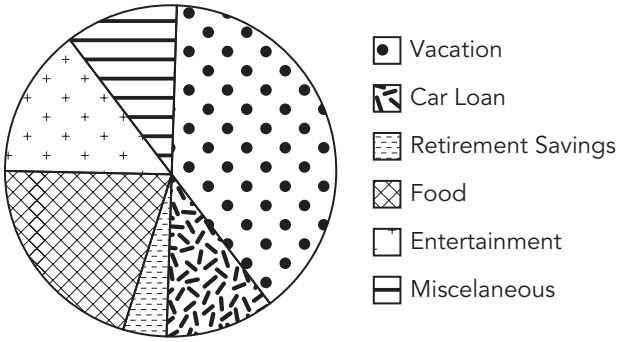


A stacked bar graph is a graph that stacks the frequencies of two different groups for a given category on top of one another so that you can compare the parts to the whole. Each bar represents a total for the whole category, but still shows how many data pieces make up each group within the entire category.



You can also use circle graphs to represent the relationship between each part and the whole. For example, this circle graph shows the expenses for families in random cities across the state. As shown in the graph, families tend to spend the greatest amount of money on vacation and the least amount of money on retirement savings.

Average Family Expenses



LESSON 5

Dark or Spicy?

Data for two populations may overlap. Comparing the measures of center and variation for the two populations can help you interpret the differences between the two populations.

Comparing the difference of means with the variation in each data set can be an important way of determining just how different two data sets are.

For example, consider these data sets.

5, 3, 4, 5, 10	5, 3, 100, 5, 10
Mean = 5.4	Mean = 24.6

The difference in their means is 19.2. Depending on what you are measuring, that can be a big difference. You can create a comparative dot plot to visually represent and observe the difference in the data sets. Upon investigating the values in each data set, it is apparent that the data sets overlap. The right data set is the same as the left one except for one The data value 100 in the right data set is skewing the data to the right and causing the difference of 19.2 between the means of the two data sets.

LESSON
6

That's So Random

You can use the means to compare two populations with approximately symmetric data sets. You can use the medians and the interquartile range to compare two populations with skewed data sets.

For example, suppose Forrest wanted to compare the number of text messages sent each day by 7th grade students to the number of text messages sent each day by 8th grade students. He randomly selected and surveyed 10 students from each grade. The data sets provided represent the number of text messages each student said they sent each day.

Grade 7: 44, 40, 43, 73, 74, 76, 56, 59, 66, 54

Grade 8: 77, 86, 69, 52, 76, 79, 60, 61, 57, 85

Forrest created a back-to-back stem-and-leaf plot to display the data.

Grade 7		Grade 8
Leaf	Stem	Leaf
4 3 0	4	
9 6 4	5	2 7
6	6	0 1 9
6 4 3	7	6 7 9
	8	5 6

For grade 7, the mean number of texts sent per day is 58.5, the median is 57.5 and the interquartile range is 29. For grade 8, the mean number of texts sent per day is 70.2, the median is 69 and the interquartile range is 22.