QuizBus

Dealing with Data

Teacher Guide

http://www.WesternReservePublicMedia.org/quizbus

WESTERN RESERVE
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QuizBus: Dealing with Data
Introduction

We are inundated with information: about our health, about our leisure activities, about sports and so much more. Information is just information. It is our responsibility to process that information and to use it wisely. That is one of the reasons we study data analysis. We need to not only evaluate this information, but also to base personal decisions on evidence (data). We also need to see the dangers of acting on decisions that are not supported by the evidence. The question then becomes, "How do we get that evidence?" Of course the answer is by analyzing the data that we are using to make those decisions.

QuizBus: Dealing with Data will help students in Grades 4-8 have practice with collecting data, presenting it in an understandable fashion, analyzing the data through graphing, identifying ways data can be distorted and looking at both arithmetic and geometric probability (area models). This multimedia package contains five videos, a teacher guide and a Web site, **http://www.WesternReservePublicMedia.org/quizbus**.

Videos

The Treatment

QuizBus: **Dealing with Data** is patterned loosely after the TV program "Cash Cab." The actual quiz show takes place in a school bus. At the start of the program, the bus arrives at a school and agents exit it in search of "contestants" — four math teachers. The contestants are led from the classroom to the QuizBus, which has an on-camera quiz master and an announcer/sidekick, the bus driver. The game begins on the bus, where the quiz show host asks a preliminary question or poses a problem that each of the four contestants tries to answer.

Round 1: In this round, the two teams who answer correctly move on to Round 2.

Round 2: The two remaining teams compete in a head-to-head question-and-answer match. One of these two teams will be eliminated, leaving a final contestant to answer in the program champion round.

Champion Round: The remaining team correctly answers a championship question.

The Content

Video 1

This package includes information on the following:

- The dangers of acting on decisions not supported by evidence
- The basic tenets of teaching data analysis
- Graphs and how to interpret them
- Measures of center and spread (mean, median, mode, range, etc.
- Categorical vs. measurement data
- Continuous vs. discrete data

Video 2

The following types of plots are discussed:

- Line plot
- Bar graph
- Histogram
- Circle plot (pie graph)

Video 3

The following types of plots are discussed:

- Stem-and-leaf
- Box-and-whisker
- Scatter
- Lines of best fit

Video 4

Students use experiments and surveys to determine the following:

- What question they want answered
- What the outcome might be
- What the population and sample are, and how to find them
- What the process is for gathering data
- What plots can be used to show the data
- What conclusions can be drawn from the plots
- What changes could be made if they did this project again
- How to present their data

Video 5

Probability lessons are covered using the following:

- Arithmetic
- Geometry

The Teacher Guide

The teacher guide is divided into four sections:

1. **Teacher pages** give complete instructions on how to conduct the lessons. Each lesson is keyed to Ohio standards in mathematics.

2. **Student handouts** offer easy access to materials that can help the students complete the projects.

3. **Resource pages** can be used by either teachers or students to get more information on a topic.

4. **Data standards** are listed for each grade level and include the corresponding lessons that meet each indicator.

The Basic Tenets of Teaching Data Analysis

The lessons in the teacher guide are built around the basic concepts listed below.

1. Recognize the need to base personal decisions on evidence (data).

2. See dangers of acting on decisions that are not supported by the evidence.

3. Understand that tables of data can be viewed in a more simple or readable format through the use of a graph.

4. Become aware of the fact that graphs can be misleading if data is not accurately portrayed.

5. Know that there is more than one way to solve a problem.

6. It is important to use real (and relevant) data.

7. Emphasis should be on good examples which lead to intuition.

8. Project work is important. Students need to recognize the difficulty in asking the "right question."

9. Variability is ubiquitous (ever present).

10. Always use appropriate vocabulary.

11. Technology can be used, where appropriate.

The QuizBus Web Site

The **QuizBus** Web site, **http://www. WesternReservePublicMedia.org/quizbus**, offers the project videos in a streaming format. The videos can also be downloaded. The complete teacher guide is onthis site, as well as other games and activities that are not included in the teacher guide.

Video 1
Introduction to Data Analysis

Overview

Students look at a graph that has no labels for the axes. They then use the information given to write the labels on the graph.

Objective

Students will be able to correctly label a graph.

Labeling Graphs

Standards Addressed

Mathematics — Data Analysis

Grade 6

Statistical Methods, Benchmark G

06. Make logical inferences from statistical data.

Procedure

1. Have each student work with a partner.

2. Distribute the student handout, What's This Graph Telling Me?

3. Tell the students that the labels were left off these graphs and they need to use the information given to finish the graph.

4. Have the students write a few sentences to tell how they figured out which bar matched the color.

Answers

Problem 1

Favorite Color
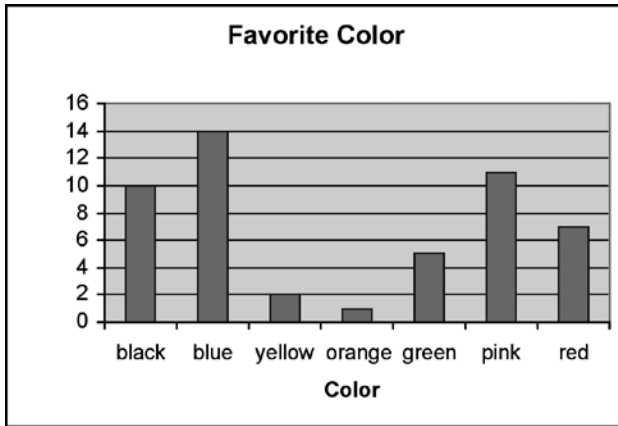
	black	blue	yellow	orange	green	pink	red
	10	14	2	1	5	11	7

Problem 2

Favorite Color
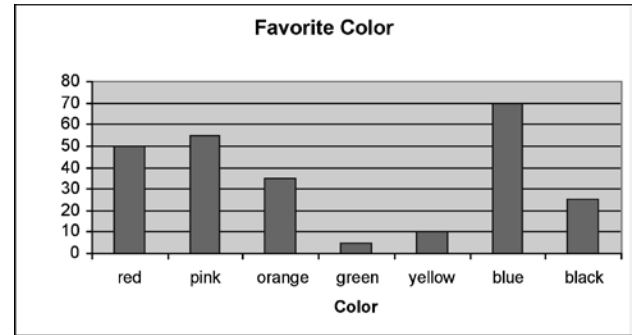
red	pink	orange	green	yellow	blue	black
50	55	35	5	10	70	25

Evaluation

Problem 1

Color labels are correct (2 pts. each).	14 points
Y-axis is labeled correctly.	10 points

Problem 2

Color labels are correct (2 pts. each).	14 points
Y-axis is labeled correctly.	10 points
Written explanation is clear and accurate.	16 points

Name _____

What's This Graph Telling Me?

Oh no! You forgot to put the labels on the graph you made of your class's favorite colors. You remember some of the details, but you forget which bar matches which color and what the interval is for the vertical axis. Here's what you remember:

- Blue was the most popular color
- Twice as many said blue than red
- Black got four fewer votes than blue
- Pink was the second most popular color
- Green got four more votes than orange
- Some people voted for yellow
- Five voted for green

Please label the axes with the colors along the horizontal axis (x-axis) and the frequency on the vertical axis (y-axis).
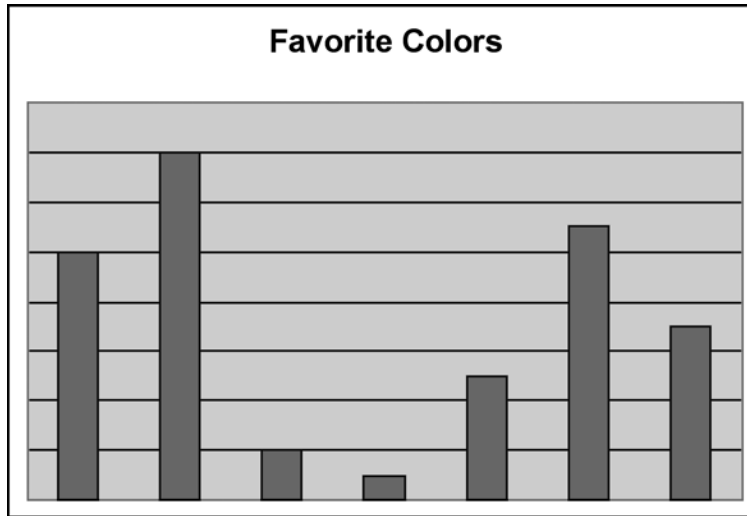
Now that you've figured out the axes, please fill in the frequency table below.

Color	Number of votes

Problem 2

Now try this one. It's more difficult.

This is what you know:

- Red got 50 votes

- Orange got 10 more votes than black

- More said blue than any other color

- Blue got seven times more votes than yellow

- Pink got 11 times more votes than green

- Fewer said green than yellow

Please label the axes with the colors along the horizontal axis (x-axis) and the frequency on the vertical axis (y-axis). Write a few sentences telling how you figured out the missing labels.
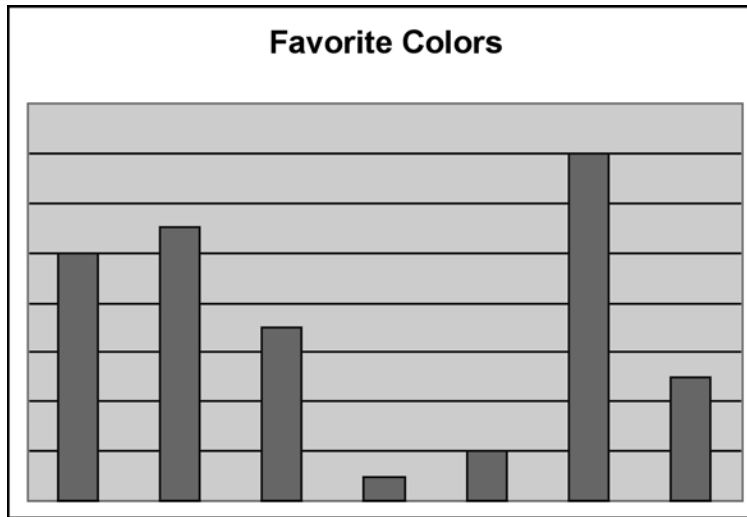
Now that you've figured out the axes, please fill in the frequency table below.

Color	Number of votes

This activity is adapted from Census at School, **www.censusatschool.ntu.ac.uk**.

Overview

Using graphing calculator technology, students learn about creating and interpreting graphs. This lesson is to be used as an introduction to interpretation of graphs.

Objective

Students will be able to describe an appropriate scenario given a graph or choose an appropriate graph given a scenario.

Interpreting Graphs Using CBR and Graphing Calculator

Standards Addressed

Mathematics — Data Analysis

Grade 4

Data Collection, Benchmark B

> 02. Represent and interpret data using tables, bar graphs, line plots and line graphs.

> 05. Propose and explain interpretations and predictions based on data displayed in tables, charts and graphs.

Grade 5

Data Collection, Benchmark C

> 05. Modify initial conclusions, propose and justify new interpretations and predictions as additional data are collected.

Grade 8

Statistical Methods, Benchmark F

> 06. Make conjectures about possible relationship in a scatter plot and approximate line of best fit.

> 09. Construct convincing arguments based on analysis of data and interpretation of graphs.

Materials

- Overhead projector
- TI-83 or TI-84 view screen
- TI- 83 or TI-84 calculator
- CBR with cords, screen or blank wall to project on

Vocabulary

- Coordinate plane (quadrant one)
- X-coordinate, y-coordinate
- X-axis (time)
- Y-axis (distance)
- Origin
- Independent variable
- Dependent variable

Procedure

1. Control the calculator for younger groups. Have older students do the projects themselves. (Directions for the calculator are included as a separate sheet)

2. Group students in teams of four or five.

3. Introduce students to the CBR (students are told that they will be working with a device with a magic eye).

4. Ask for a volunteer to walk down a hallway. Let students look at the graph created. Allow for another volunteer.

5. Students should discuss in their groups what they think is being measured.

   a. What two variables are involved in the graph? **Answer:** Distance in feet and time in seconds.

   b. What is happening at the origin? **Answer:** No time has elapsed and no distance was traveled.

6. Discuss answers. Decide appropriate labels to figure out speed — ft./sec. or mi./hr. or in./min.? (An extension of the lesson could address an additional variable discussion of conversion between units.)

7. Describe situations and ask students to model them by walking and checking their path on the calculator, if possible, i.e. line straight across (zero slope), downhill (negative slope), uphill positive slope, vertical line (undefined).

8. Show a match graph and ask groups to discuss how they think they should walk to re-create the graph. Have groups write down their plan. Call on students to walk and attempt to match it. Discuss the graph created, revise the plan and try again. Do several times with students from various groups.

9. Discuss distance from origin at start of graph, speed (rate of change of the graph), slope of the line and what is occurring when slope is positive or negative. (For younger groups you may want to omit discussion of slope.)

10. Show a match graph and devise a possible scenario to go with it (e. g., Bob left his house to walk to his friend's house. Halfway there he stopped to talk with the postman, looked and saw that he was late and ran the rest of the way there.) Have a student act out your scenario and see if it matches the graph.

11. Give students another graph and ask them to come up with a possible scenario in their groups. Have various groups give their scenarios and then act them out to see if they match the graph correctly.

12. Give students several scenarios and ask them to draw an appropriate graph in their groups. The correctness can be checked by acting it out and having the graph drawn.

13. Give students "exit tickets" to be completed individually to check comprehension.

Evaluation

Use Interpreting Graphs Direction Sheet and Exit Ticket student handouts.

Name _____

Exit Ticket
Interpreting Graphs

1. Explain what is happening in this picture if a person is walking outside starting in front of a store.

Distance in ft.

store   Time in Seconds
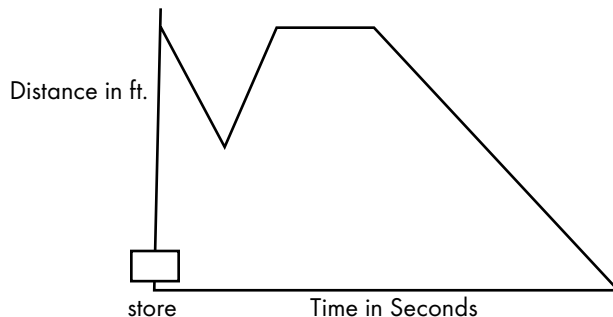
2. Draw your own graph and explain what is happening to create the graph. Label the graph.
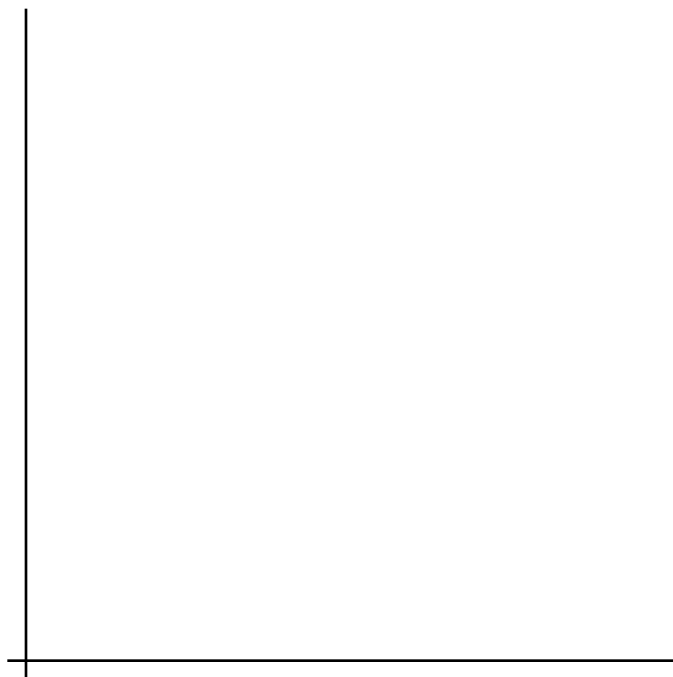
Interpreting Graphs Direction Sheet

- Connect the calculator (TI-83 plus TI-84) to the viewscreen

- Connect the calculator to the CBR

- Turn on calculator and press APPS key

- Choose CBL/CBR option

- Follow directions on the screen press any key to continue

- Choose the RANGER option – that is the R in CBR

- Press any key to continue

- Choose SET UP/SAMPLE
    - For this lesson, you need the following settings:
        - Real time: yes
        - Time (sec): 15
        - Display: Dist
        - Begin on: Enter
        - Smoothing: None
        - Units: Feet

- Once the settings are correct, move cursor to START NOW when you are ready to begin, press ENTER. The CBR will begin ticking off the time and if there is motion in front of it you will see the graph on the screen.

- To do another graph, press ENTER. Choose REPEAT SAMPLE.

- To have students try to match the graph, choose DIST MATCH and press ENTER.

- Press ENTER when you are ready for the graph to appear. When students are ready to try and walk to match the graph, press enter again and the student's graph will appear along with the original graph. To try the same graph, again press ENTER when finished and select SAME MATCH. To try a new graph, select NEW MATCH.

Misleading Graphs

Overview

Students look at real-life graphs to determine why they are misleading.

Objective

Students will be able to correct a graph that is drawn incorrectly and describe why it is incorrect.

Standards Addressed

Mathematics — Data Analysis

Grade 7

Statistical Methods, Benchmark G

> 06. Identify misuses of statistical data in articles, advertisementsand other media.

Procedure

1. Talk about how a graph helps to make data easy to understand.

2. Distribute the student handouts.

3. Review the handout CNN and the Schiavo Case with the students. Have them study the graph and discuss why it is misleading.

   Answer: The vertical axis does not begin with zero, so the difference shown leads you into thinking that the difference is great.

4. Ask students to draw the graph correctly. They will see the difference when they make the graph with zero as the origin of both the x and the Y axes.

5. Have students look at the following graphs and write a sentence or two as to why they are misleading.

   Answers: Graph #1 — The x-axis is fine, but the y-axis has inconsistent intervals.

   Graph #2 — The pictures in the graph are not of equal size. It looks as if there are more people who have horses as pets.

Evaluation

Evaluation could be done as a class where students share their reasons why the graphs are misleading, or points could be given if answers are correct.

Name _____

CNN and the Schiavo Case

In 2005, all eyes were on the fate of Terry Schiavo. She had been in a car accident and was in a vegetative state in a hospital. There was great controversy between Terry's husband, who wanted to remove the feeding tube, and her parents, who wanted the tube to remain. The case went to court and the Florida state court decided that the tube could be removed.

A poll of Democrats, Republicans and Independents was held and CNN reported the information gathered by using a graph similar to the one below. The question was whether they agreed with the court's decision to remove the feeding tube. Sixty-two percent of Democrats agreed compared to 54 percent of Republicans and 54 percent of Independents.

Percent Who Agreed With Court

What do you think of this graph? Because of the title of this page, you probably figured out that the graph is misleading. Why is this so? Using the space below, make a graph that shows the data more accurately.

Don't forget to label the axes and to include a title.

Information from **http://mediamatters.org/items/200503220005**

More Misleading Graphs

Graph #1

Number Missed by Four Students
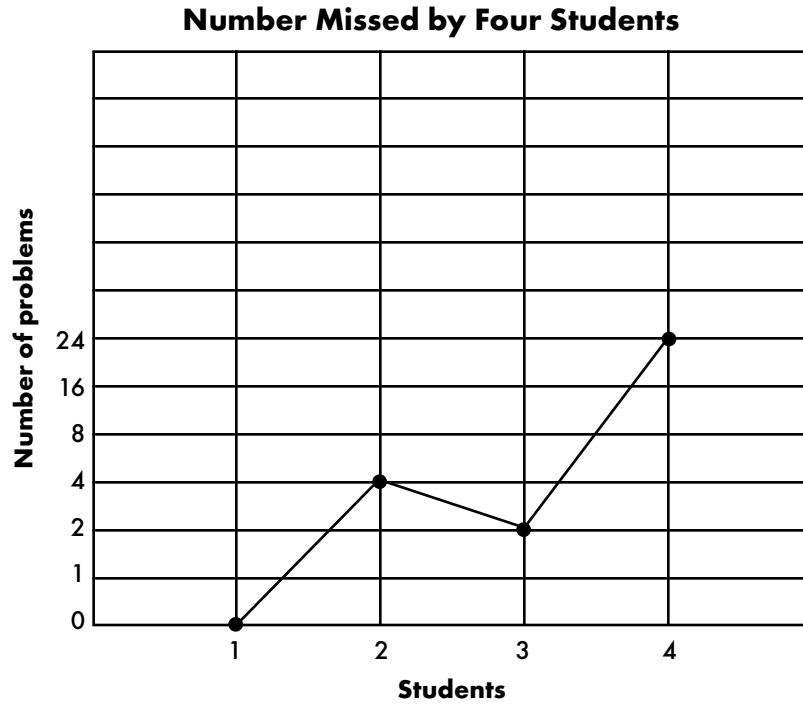
What's wrong with Graph #1?

Graph #2

Each picture represents 50 people's preferences.

Favorite Pets
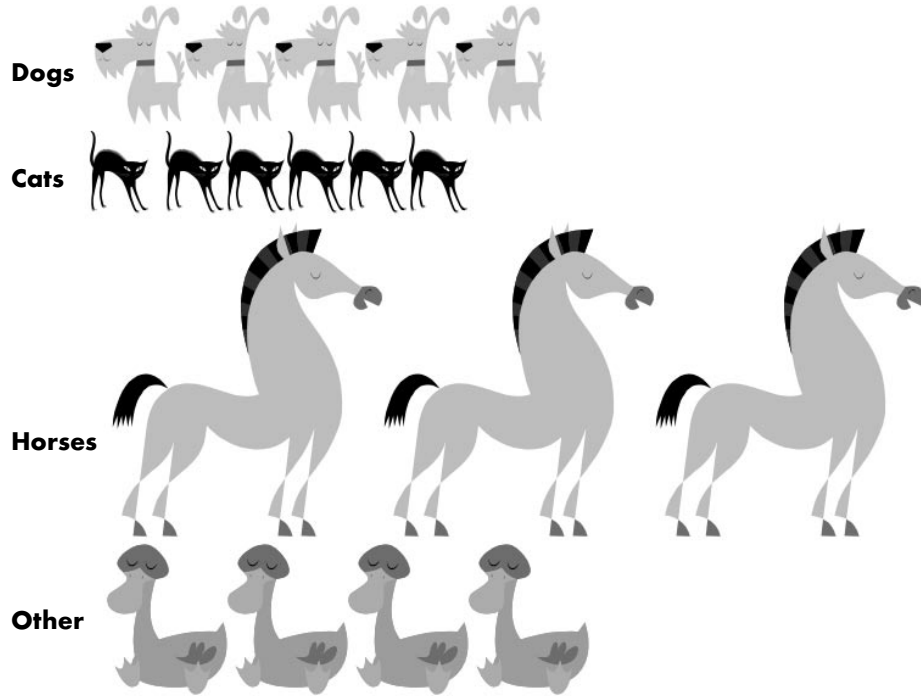
What's wrong with Graph #2?

Mean, Median, Mode and Range

Overview

Students play a card game to determine whether mean, median, mode or range will give them the highest result.

Objective

Students will be able to estimate and compute mean, median, mode and range.

Standards Addressed

Mathematics — Data Analysis and Probability

Grade 4

Statistical Methods. Benchmark E

07. Identify the median of a set of data and describe what it indicates about the data.

08. Use range, median and mode to make comparisons among related sets of data.

Grade 5

Statistical Methods, Benchmark F

06. Determine and use the range, mean, median and mode, and explain what each does and does not indicate about the set of data.

Grade 6

Statistical Methods, Benchmark F

04. Understand the different information provided by measures of center (mean, mode and median) and measures of spread (range).

Grade 7 (Enrichment Activity)

Data Collection, Benchmark A

01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots and other types of graphs, when appropriate.

Statistical Methods, Benchmark F

03. Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion or exclusion of outliers affects those measures.

Grade 8

Statistical Methods, Benchmark D

04. Compare two sets of data using measures of center (mean, mode, median) and measures of spread (range, quartiles, interquartile range, percentiles).

Materials

• One deck of cards per pair students

Procedure

1. Give each pair of students a deck of cards. Ask them to take out all of the face cards so that they will only keep the cards ace through 10.

2. Distribute to each pair of students the handout What's the Deal: Mean, Median, Mode and Range.

3. The goal of the game is to get the highest score at the end of the time period.

4. Review mean, median, mode and range and how to calculate each.

5. Before the students play, ask each to player specify which measure they would expect to have the highest total after five or 10 sets of numbers have been drawn.

6. Have each pair of students deal out seven cards and list the numbers that are dealt. Then instruct them to compute the mean, median, mode and range, and record the data on the handout.

7. Students could repeat the exercise as man as 10 times, depending on how much class time you have. The students need to shuffle the cards each time before redealing them.

8. Have the students exchange papers between groups to check the accuracy of their answers.

9. Any student who selected the correct column as being the highest can enter his/her score to see who the classroom winner is (the person with the highest score).

10. **Enrichment:** Depending upon the amount of time available, you could gather classroom data from each group for each item and make box-and-whisker plots with the composite data. Students can then write the results of the experiment using the information from the box-and-whisker plot.

11. Students can write about why range will often give them the highest score.

12. **Extension**: Have students complete the handout Measures of Center and Spread.

Answers

Mean Health Care Salaries

1. Mean – $56,531.67

2. Median – $34,855

3. Mode – No Mode

4. Range – $163,190

5. The median is a good measure because the very large salary of surgeons skews the data and makes it much higher. The best measure often depends on the purpose of its use.

Income Problem

1. Mean – $33,250

2. Median – $24,500

3. Mode – $21,000

4. Range – $84,000

5. The owner would use the mean because the average salary would be higher.

6. The union leader would use either the median or the mode. The median would show that half of the people make less than $24,000. The mode would show that half of the people earn only $21,000.

7. The statistician would use the median. It shows that half receive more than the median and half earn more.

Evaluation

For 10 groups of data

There are 10 groups with four answers for each group and four totals. Students could receive a point for each correct answer plus six bonus points if either partner selected range as their guess of what would give them the highest score for a total of 50 points.

For five groups of data

There are five groups with four answers for each group plus four totals. Students could receive two points for each correct answer plus six bonus points if either partner selected range as their guess of what would give them the highest score.

Name _____

What's the Deal?
Mean, Median, Mode and Range

Which will give you highest total?

1. Take out all of the face cards so that you only have left ace through 10.

2. Shuffle those cards and deal seven of them. Before you calculate the mean, median, mode and range, make a prediction as to which one will give you the highest total if this is repeated five or 10 times.

3. Calculate the mean (rounded to the nearest tenth), median, mode and range for this set of numbers. Shuffle the cards and repeat this five or 10 times as directed by your teacher.

4. If you have no mode, use the highest card in your hand. If you have two or more modes, select the highest number.

Which calculation do you think will give you the highest total?

_____   _____

Player 1   Player 2

Numbers	Mean	Median	Mode	Range
Sample: 4 4 5 7 6 2 5	4.7	5	5	5
TOTALS				

Name _____

Measures of Center and Spread

Measures of Center

Mean — A number that represents the middle point, or average. It is the quotient obtained by dividing the sum total of a set of figures by the number of figures.

Median — The value in an ordered set of values that represents the point of which there are as many instances higher as there are lower.

Mode — The most frequent value of a set of data.

Measure of Dispersion (Spread)

Range — The difference between the highest and the lowest numbers in a set of data.

Try These

Mean Health Care Salaries (2006) **http://www.bls.gov/oes/current/oes_nat.htm#b00-0000**

Surgeon	$184,150
Home Health Aides	20,960
Nurses Aides	22,960
Dental Assistants	30,850
Physical Therapists	41,410
Athletic Trainers	38,860

Mean _____   Mode_____

Median_____   Range _____

Which measure best describes this set of data and why?

You work for a company and you want a raise in your pay. You find out the following information:

Annual Income	Number of Employees
$105,000	1
60,000	3
30, 000	1
28,000	5
21,000	10

Find the information below:

Mean _____   Mode_____

Median_____   Range _____

In negotiations:

The owner of the company will probably use the _____to describe the company. Why?

The union leader (person negotiating for the workers) will probably use the _____to describe the company. Why?

A statistician would probably use the _____to describe the company. Why?

Overview

Students work together to determine if various types of data gathered are categorical (qualitative) or measurement (quantitative) data. The enrichment activity allows students to determine if the measurement data is discrete or continuous.

Objective

Students will be able to distinguish between categorical and measurement data.

Types of Data
Categorical vs. Measurement and Discrete vs. Continuous

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark E

    02. Select and use a graph that is appropriate for the type of data to be displayed; e.g., numerical vs. categorical data, discrete vs. continuous data.

Grade 8

Data Collection, Benchmark B

    03. Differentiate between discrete and continuous data and appropriate ways to represent each.

Procedure

1. Photocopy and cut out the labels on the Measurement vs. Continuous Data page. Divide the students into pairs or groups and give each group an envelope that contains the labels.

2. Have a class discussion of the difference between categorical and measurement data.

3. Have each group place the items under the Measurement Data headings or Categorical Data. Remind them that measurement data or amounts of categorical data can be put on a number line.

4. Discuss answers. You can go around the room and have the each group tell you where they put the data and then get some class consensus to each item.

Measurement Data	Categorical Data
Age	Pizza toppings
Time it takes to get to school	Color of a car
Temperature	Dominant hand
Weight	Letter grades
Height	Gender
Grade-point average	Type of candy
Unpopped kernels of popcorn in a bag	Citizenship
Class size	NFL team
Calories in a hamburger	
Family size	

5. Review the meaning of discrete and continuous data. Show these number lines:

Discrete data is data that can be counted. (You can't have a half a person).
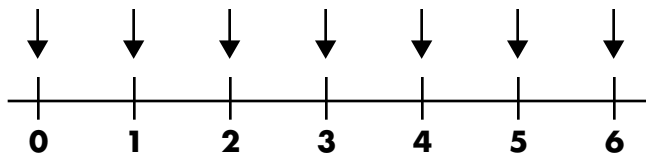
If your data shows that you have six red cars, seven blue cars and three white cars, you can put 6, 7 and 3 on a number line. However, if you are graphing it, the data is car color; therefore, it is categorical data. The axis would show blue, red and white, not the numbers. The numbers would be shown on the vertical axis of a graph.

Continuous data can be assigned an infinite number of values between whole numbers.
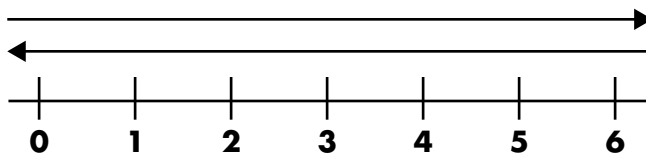
6. Photocopy the Discrete vs. Continuous Data page and cut out one page of labels per group. Put each set of labels in an envelope and give one envelope to each group. Have the students place the labels under either the Discrete Data or Continuous Data headings.

Discrete Data	Continuous Data
Unpopped kernels of popcorn in a bag	Age
Class size	Weight
Family size	Height
Calories in a hamburger	Time it takes to get to school
Number of people who prefer Guido's pizza	Temperature
Number of people who got an A on the test	Grade-point average
Number of Cleveland Browns fans	Calories in a hamburger
Baskets completed in a minute	Arm length

7. Talk about the fact that sometimes numbers can be categorical data. For example, the numbers on a football jersey or ZIP codes. Would you want to find the mean, median, mode or range for either of these sets of numbers? This is a tough concept for the kids because you could put them on a number line, but it would be meaningless.

Evaluation

There are 15 items on the student evaluation sheet (giving two points each for the two definitions). Percents could be used if a grade needs to be given.

Answers for the Evaluation

1. Measures that have a numerical value and could be placed on a number line

2. Identifies a class or category

3. Quantitative

4. Qualitative

5. a. Categorical
   b. Measurement
   c. Measurement
   d. Categorical
   e. Categorical

6. a. Discrete
   b. Continuous
   c. Discrete
   d. Dontinuous

Measurement vs. Continuous Data

Pizza toppings	Gender	Height
Age	Time it takes to get to school	Grade-point average
Color of car	Unpopped kernels of popcorn in a bag	Family size
Dominant hand	Weight	Citizenship
Letter grades	Type of candy	NFL teams
Class size	Temperature	Calories in a burger

Measurement Data | **Categorical Data**

Discrete vs. Continuous Data

Weight	Age	Unpopped kernels of popcorn in a bag
Height	Family size	Class size
Temperature	Calories in a burger	Time it takes to get to school
No. of people who prefer Guido's pizza	Arm length	Grade point average
No. of Cleveland Brown's fans	Baskets completed in a minute	No. of people who got an A on the test

Continuous Data

Discrete Data

Name _____

Types of Data
Evaluation

1. Define measurement data.

2. Define categorical data.

3. What other word can be used for measurement data? _____

4. What other word can be used for categorical data? _____

5. Label these items as measurement or categorical data.

    a. The color of your eyes is brown _____

    b. Speed of your car _____

    c. Your height _____

    d. Number of boys in your class _____

    e. People named Smith in your class _____

6. Label these measurement data as discrete or continuous.

    a. People in the band _____

    b. Time to get to school _____

    c. People in your family _____

    d. Temperature _____

Video 2

Line Plots, Bar Graphs, Histograms and Circle Graphs

http://www.WesternReservePublicMedia.org/quizbus

Wheel of Fortune
Line Plots

Overview

Students make a line plot of letter usage using 50 words from any book. They then play an online Wheel of Fortune game using what they have learned.

Objective

Students will understand how to gather and interpret data and then construct a line plot.

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark E

    02. Select and use a graph that is appropriate for the type of data to be displayed.

    04. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.

Statistical Methods, Benchmark F

    06. Determine and use range, mean, median and mode, and explain what each does and does not indicate about the set of data.

Grade 6

Data Collection, Benchmark A

    01. Read, construct and interpret line graphs, circle graphs and histograms.

Statistical Methods, Benchmark B

    05. Describe the frequency distribution of a set of data, as shown in a histogram or frequency table, by general appearance of shape: e.g. number of modes, middle of data, level of symmetry, outliers.

Data Collection, Benchmark E

    02. Select, create and use graphical representations that are appropriate for the type of data collected.

Statistical Methods, Benchmark F

    04. Understand the different information provided by measures of center (mean, mode and media) and measures of spread (range).

Statistical Methods, Benchmark G

    06. Make logical inferences from statistical data.

Materials

- Any book or textbook
- Computer with Internet Access

Procedure

1. Students should bring a book to class or use their textbooks and randomly select a 50-word passage.

2. Using the Wheel of Fortune Data Sheet, have the students make a line plot of the letters used.

3. Instruct the students to go to **www.station.sony.com/casualproduct.vm?Id=041** and play Wheel of Fortune. They should use only the most-common letters that appear on their data sheets. (If the Sony link is dead, go to **google.com** and type in "Wheel of Fortune." There are many sites that have this game.)

4. Collate the data as a class. There are a variety of ways this can be done. The way we found worked the best was to have a series of papers, each labeled with one of the letters. Put the papers on the board and have each student go to each of the sheets and record their count for that letter. Then break the students into groups and give them the sheets to find the mean of that letter. Write the mean in large letters and put them back on the board. Students can then go around and fill in the mean on their data sheet.

5. Allow the students to play the game again using the classroom data.

6. As a class, students can then compare the results of the game when their personal data was used with the results when classroom data was used.

7. Have the students write a few sentences explaining the result of using their own data and the class data.

8. **Extensions:**
    a. A second class can perform the same activity and the results can be compared.

    b. Textbooks in various subjects can be used to see if the same distribution is true for math, science, social studies or other texts.

Evaluation

This is an introductory activity. Areas to note are the correctness of the plot and the presence of a title. The sentences should tell how close the personal data was to the class data and if it made a difference when they played the game.

This lesson was adapted from SEQual Facilitator's Guide.

Wheel of Fortune Data Sheet

Name _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A																									
B																									
C																									
D																									
E																									
F																									
G																									
H																									
I																									
J																									
K																									
L																									
M																									
N																									
O																									
P																									
Q																									
R																									
S																									
T																									
U																									
V																									
W																									
X																									
Y																									
Z																									

This lesson was adapted from SEQual Facilitator's Guide.

Overview

A line plot is a way to organize data on a horizontal number line to show frequency. In this activity, students collect data to create a line plot representing the number of keys carried on keychains.

Objective

Students will be able to gather and organize data and then construct a line plot.

Line Plots

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark E

02. Select and use a graph that is appropriate for the type of data to be displayed.

04. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.

Statistical Methods, Benchmark F

06. Determine and use range, mean, median and mode, and explain what each does and does not indicate about the set of data.

Grade 6

Statistical Methods, Benchmark B

05. Describe the frequency distribution of a set of data, as shown in a histogram or frequency table, by general appearance of shape: e.g. number of modes, middle of data, level of symmetry, outliers.

Data Collection, Benchmark E

02. Select, create and use graphical representations that are appropriate for the type of data collected.

Statistical Methods, Benchmark F

04. Understand the different information provided by measures of center (mean, mode and media) and measures of spread (range).

Statistical Methods, Benchmark G

06. Make logical inferences from statistical data.

Procedure

1. Have the students complete the How Many Keys? handout as homework.

2. Instruct them to construct a line plot showing key survey data on the horizontal axis. Display a segment of line, starting with the lowest or minimum value and ending with the highest or maximum value. They may want to go one below the minimum and one above the maximum on their number line.

3. For each person surveyed, students should place an "x" above the corresponding key value on the horizontal axis.

4. Have them continue until there is an x for each value in the data collected.

5. When the line plot is complete, the number of x's above each value indicates the frequency that this key count appears in the data.

6. Students should then add a title to the graph.

7. Encourage the class to find and discuss patterns in the data. Students can find **variability, clusters, gaps** and **outliers** on their line plots, and can compare their plots with those around them.

8. Ask the students to find the mean, median, mode and range of the data.

9. Class discussion should include students' summaries of their findings. They can refer to the mean, median, mode and range of the data to support their findings. Questions might include the following:

    a. Who had the highest mean? Median? The lowest?

    b. Did anyone not have a mode? More than one mode?

    c. What was the largest range? The smallest?

    d. Did anyone have big gaps in their data? Large clusters of data?

(This could also be done with students working in groups instead of as a whole class.)

Evaluation

Evaluate line plots using criteria checklist

_____ Title

_____ Correct spelling

_____ Neatness (used a ruler)

_____ Accurate data placement

_____ Correct calculation of mean, median, mode and range

Name _____

How Many Keys?

Line Plots

Your school wants to design a school mascot key chain, but doesn't know how big to make it. You need to determine how many keys it should hold. How many keys do you think most adults carry on their key chains? You will need to conduct a survey of 10 or more adults to find this information. Use the tally chart to record your findings. Then find the **mean** (average), the **median** (the number in the middle), the **mode** (the most frequent) and the **range** (the difference between the highest and lowest). Write a few sentences about your findings.

Number of Keys	Adults Surveyed	Total
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Mean _____   Median _____

Mode _____   Range_____

What I found: _____

_____

Bar Graphs

Overview

The students use M&M candies to make a variety of graphs using the same data. The lesson focuses on the need and value of graphing techniques.

Objective

Students will be able to make a variety of graphs using the same data. They will gain an understanding of how organizing the data makes it easier to analyze.

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark E

02. Select and use a graph that is appropriate for the type of data to be displayed.

04. Determine appropriate data to be collected to answer questions posed by students or teachers, collect and display data, and clearly communicate findings.

Grade 6

Data Collection, Benchmark D

03. Compare representations of the same data in different types of graphs such as bar graph and circle graph.

Data Collection, Benchmark E

02. Select, create and use graphical representations that are appropriate for the type of data collected.

Statistical Methods, Benchmark G

06. Make logical inferences from statistical data.

Materials

- Six 3-¼ oz bags of M&Ms
- Each bag should be emptied into six clear containers, i.e. 8-oz plastic cups, sandwich bags, snack bags, plastic bowls, etc.
- Poster-size paper
- Rulers
- Colored markers

Procedure

1. Fill six containers with one bag of M&Ms each.

2. Have the students divide into six groups, and distribute one container of M&Ms to each group. Students should not empty or touch the M&Ms in their container.

3. Students should be given one minute to examine the contents.

4. Ask the following questions in a rapid-fire format:

   a. What color appears most often?

   b. How many M&Ms are in your container?

   c. How many of each color do you have?

   d. Is there an equal number of each color?

5. Discuss why these questions were hard to answer and what is needed to make the information easier to interpret. **Answer:** Organize data using a graph.

6. The following graphing advantages should be included in this discussion and listed on the board: organization of data, ease of readability, speed of response, ability for quick comparisons, ability to rank responses.

7. Review vocabulary associated with graphs, such as x-axis or horizontal axis, y-axis or vertical axis and consistent intervals.

8. Assign each group one of these graph types to make on large poster paper: bar graph, line graph, picture graph and circle graph.

9. Display the graphs on the board. Discuss their correctness. Are the axes labeled? Are consistent intervals used? Is there a title? Ask the students to write one paragraph explaining why it was important to make a graph to find the answer to the questions, and which graph was easiest to read and understand.

Evaluation

Rubric for Paragraph Evaluation

Category	4	3	2	1
Use of Terms/ Examples	Every major point was well-supported with several relevant facts and/or examples.	Most major point were well-supported with relevant facts and/or examples.	Some major points were well-supported with facts and/or examples, but some of the relevance was questionable.	None of the major points were supported.
Understanding of Graphs	Information was clearly presented using appropriate vocabulary.	Most information was well-presented using appropriate vocabulary.	Some information was well-presented but with flaws in vocabulary usage.	Information was not adequately presented.

Grades: Making a Histogram

Overview

Students make a histogram using data from a class test.

Objective

Students will be able to create and interpret a histogram.

Standards Addressed

Mathematics — Data Analysis

Grade 6

Data Collection, Benchmark A

01. Read, construct and interpret line graphs, circle graphs and histograms.

Statistical Methods, Benchmark B

05. Describe the frequency distribution of a set of data, as shown in a histogram or frequency table, by general appearance or shape; e.g., number of modes, middle of data, level of symmetry, outliers.

Data Collection, Benchmark E

02. Select, create and use graphical representations that are appropriate for the type of data collected.

Grade 7

Data Collection, Benchmark E

02. Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.

Data Collection, Benchmark G

02. Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.

Materials

- Graph paper
- Protractor
- Compass

Procedure

1. Review different types of graphs: line plot, circle or pie graphs, bar graphs and histograms.

2. Remind the students that a histogram shows an interval of values while a bar graph shows a single value or item.

3. Have the scores of a test that was given to the class written on the board for the students to copy or have them written horizontally on a handout to distribute to the class.

4. Tell the students that they are to organize this data using a circle graph and a histogram. Do not tell them what the intervals for the data should be. (Most students will use tens, e.g., 100-90, 89-80, etc. Some will use fives.)

5. Remind the students to label the histogram's axes, create a title and label the parts of the pie chart or make a legend.

6. After these charts have been created, put some on the board or use an overhead to show the graphs. Compare the graphs that have different intervals and ask the class to determine which is easiest to read, which represents the data in the clearest manner, etc.

7. If the students need more practice, histograms can be created using student heights, time it takes to get to school, hours spent playing video games or watching television.

Evaluation

Histogram

X-axis is titled.	5 points
Y-axis is titled.	5 points
Intervals are consistent.	5 points
Graph is titled.	5 points
Graph is accurate.	10 points
Graph is neat (easily readable).	5 points

Circle (or Pie) Graph

Sections of the graph are accurate.	10 points
Labels (or a legend) are visible.	10 points
Graph is titled.	5 points
Graph is neat (easily readable).	5 points

Zodiac Circle Graphs

Overview

Students manually create a frequency chart and circle graph using the zodiac signs of their classmates.

Objective

Students will be able to accurately calculate fractions, percentages and central angles; measure and construct angles using a protractor; and construct a circle graph by hand.

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark A

01. Read, construct and interpret frequency tables, circle graphs and line graphs.

Grade 6

Data Collection, Benchmark A

01. Read, construct and interpret line graphs, circle graphs and histograms.

Statistical Methods, Benchmark B

05. Describe the frequency distribution of a set of data, as shown in a histogram or frequency table, by general appearance or shape; e.g., number of modes, middle of data, level of symmetry, outliers.

Data Collection, Benchmark E

02. Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.

Grade 7

Data Collection, Benchmark E

02. Analyze how decisions about graphing affect the graphical representation; e.g. scale, size of classes in a histogram, number of categories in a circle graph.

Materials

- Protractors
- Calculators
- Compasses
- Overheads or pictures of circle graphs from magazines, newspapers, etc.
- Zodiac table

Procedure

1. Bring in different magazines or newspapers and allow some time for students to view the different ways companies and individuals present their information to the public.

2. Use an overhead projector or Web images to present examples of circle graphs and to briefly discuss these items:

    a. What is represented in each graph.

    b. The message that the creator of the graph is trying to convey to the audience.

    c. The details such as labels, legends, choice of color, etc.

    Explain to the students that the examples were probably created using computer software. Creating graphs by hand, however, gives a deeper understanding of the concepts underlying circle graphs.

3. Tally the students' zodiac signs of the classroom. Have a zodiac chart handy for reference in case students don't know their zodiac sign.

4. Use this information to make a frequency chart. Calculate the fraction of the class in each category. If, for example, 12 students out of 24 are Capricorns, then the fraction of the class that is a Capricorn is one-half (½). Write this number in a separate column in your table.

5. Next calculate the percentage of the class in each category (for the above example, 50 percent of the students are Capricorns) and write this number on yet another column.

6. Use the percentage in each category to calculate the measurement of the central angle for each sector of your circle graph by multiplying the percentage by 360. Make this another column in the frequency table.

7. Use a compass to construct a circle on the blackboard and a protractor to measure the opening of the desired angle.

$\angle ABC = 180°$
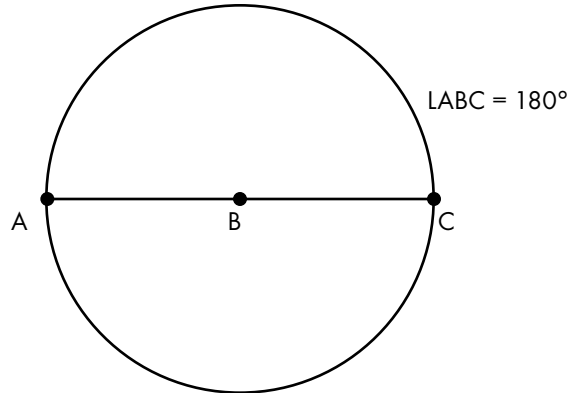
8. Repeat this procedure until all the categories from your survey have been represented on your graph. Make sure to use conventional symbols and labels.

9. Model how to check your calculations by making sure that the sum of all your categories is 100 percent and the sum of all your angles is 360 degrees.

10. **Technology Extension:** Students can use their data to create circle graphs using the child-friendly Web site **http://nces.ed.gov/nceskids/ createagraph**. Compare the two and draw conclusions about which method of creating graphs is more efficient.

11. **Extension:** To develop their understanding further, students should independently create their own circle graph using the percentages from the nutrition facts label from their favorite foods. Or they can bring in their favorite recipe, work out the percentages from each ingredient and create a circle graph manually. They can check their work on the computer.

Evaluation

Category	4	3	2	1
Fractions	Understand, solve and explain problems involving simple fractions. Calculations are done correctly. Works independently.	Student is able to add fractions with simple denominators. Calculations are made with few errors. Student works independently but sometimes needs assistance.	Student is able to identify the numerator and denominator, and calculations are attempted. Student requires assistance.	Student is unable to understand fractions and is unable to identify numerator and denominator. No calculations are made. Student requires assistance.
Percentages	Student understands, calculates and describes percent using appropriate terminology. Student works independently.	Student is able to calculate simple percentages. The mathematical concepts of finding percentages are understood. Calculations are made with few errors. Student works independently but sometimes needs assistance.	Student is able to identify the concepts involved in calculating percentages. Calculations are attempted, but many errors are made. Student requires assistance.	Student is unable to understand percentages and to make calculations. Student requires assistance.
Angles	Student understands and demonstrates congruence of figures by measuring angles and sides, matching corresponding parts. Student is able to use mathematical terms and calculate the central angle with no errors, and works independently.	Able to estimate the size of angles within a reasonable range. Use mathematical language to describe geometric ideas. Calculations of the central angle are made with little error. Works independently; needs little assistance.	Student is able to use a protractor and understands concepts concerning angles. Calculations of central angles are attempted, but many errors are made. Student requires assistance.	Student is unable to understand the concepts concerning angles (i.e. measurements and calculations of central angle etc.). Calculations aren't attempted. Student requires assistance.
Constructed Circle Graphs	All circle graphs are correctly labeled and well-presented. Student works independently.	Most circle graphs are complete. Works independently; needs little assistance.	Some circle graphs are incomplete or inaccurate drawn. Assistance is necessary.	Circle graphs are incorrect (missing titles, legends, labels or angles incorrectly drawn). Student requires assistance.

Name _____

Zodiac Table

Sign	Dates	Tally	Number	Fraction	Percent
Capricorn	Dec. 22 – Jan. 20				
Aquarius	Jan. 21 – Feb. 19				
Pisces	Feb. 20 – March 20				
Aries	March 21 – April 20				
Taurus	April 21 – May 21				
Gemini	May 22 – June 23				
Cancer	June 24 – July 23				
Leo	July 24 – Aug. 23				
Virgo	Aug. 24 – Sept. 22				
Libra	Sept. 23 – Oct. 23				
Scorpio	Oct. 24 – Nov. 22				
Sagittarius	Nov. 23 – Dec. 21				

A Variety of Graphs

Overview

The students use a computer to make a variety of graphs using the same data. They then make some comparisons and answer questions about the graphs.

Objective

Students will be able to interpret data using line, circle and bar graphs.

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark D

    03. Read and interpret increasingly complex displays of data, such as double bar graphs.

Data Collection, Benchmark E

    02. Select and use a graph that is appropriate for the type of data to be displayed; e.g., numerical vs. categorical data, discrete vs. continuous data.

    04. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.

Grade 6

Data Collection, Benchmark A

    01. Read, construct and interpret line graphs, circle graphs and histograms.

Data Collection, Benchmark D

    03. Compare representations of the same data in different types of graphs, such as a bar graph and circle graph.

Data Collection, Benchmark E

    02. Select, create and use graphical representations that are appropriate for the type of data collected.

Grade 7

Data Collection, Benchmark A

    01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate.

Procedure

1. Discussion with the class whether they know what is meant by the sentence, "We are living in the Information Age." (This refers to the current historical time period. It is called the Information Age because technology, especially computer technology, has enabled us to transcend barriers of communication that used to exist.)

2. Review the types of graphs that the students have already created:

   a. **Circle Graph:** How many degrees are in a circle and how many degrees would be equal to 1 percent? How many degrees on the circle would represent 21 percent? (A circle has 360 degrees in it. If 360 degrees represents 100 percent, then 360/100 represents 1 percent or 3.6 degrees on the circle graph. Twenty-one percent would be represented by 360 times .21 or 75.6 degrees on the circle graph.)

   b. **Bar graph:** What do the bars represent? What do the axes tell you? (One axis displays the categories that are being compared and the other compares the frequency of occurrence.)

   c. **Line graph:** What is the most important concept when making a line graph? (There should be consistent intervals on the number line.)

   d. **Histogram:** What is the difference between a bar graph and a histogram? (On a histogram the bar shows an interval of data — not just one number.)

3. Distribute the student handout A Variety of Graphs: Sample Data. Have students work with a partner to discuss the questions and then have a brief class discussion about their responses.

4. Students will now begin to create line, circle and bar graphs using the Web site Create a Graph (**http://nces.ed.gov/nceskids/createagraph/default.aspx**). For each set of data, ask students to brainstorm an appropriate title for a graph so that people know what type of information is being presented.

5. To use Create a Graph, students must select the Start Making Graphs icon. They then select the design layout that is most appropriate for the data set they want to represent. Inform students that each page can be accessed by selecting the corresponding tab that appears on the right side of the page. On the Data Page, students can enter the titles that they discussed in step 4. They will need to write the labels for the axes. They will then enter data for each type of graph in the dialog box. On the Labels Page student can select what information they want shown on their graph and how they want it to be displayed. Note: Students can show actual numbers, percentages or both in a variety of fonts and colors.

6. Students can preview their graph by selecting the Preview tab. Finally after completing the graph, they can print out, save or e-mail their results for evaluation. To check for additional comprehension, students can answer the Check for Understanding questions on the handout.

7. **Extensions:**

   a. As a class, collect data on select corporations or favorite sports team over a specific amount of time. Post the class data and begin charting once the class has compiled at least two data points.

   b. Gather samples of graphs that appear in a variety of different, everyday contexts. Build a bulletin board to reinforce the skill and emphasize the importance of graphical analysis and interpretation.

Evaluation

- **Excellent:** The student has enthusiastically participated in all activities and added constructive ideas and suggestions to the discussions. The student also visited appropriate Web sites and has participated in the activities located on the Web site. He or she constructed very neat and well-organized graphs.

- **Good:** The student participated in all activities. He or she has added ideas and/or suggestions to the discussions, visited appropriate Web sites and participated in the activities located on the Web site. The student constructed acceptable graphs.

- **Fair:** The student participated in most activities and discussions. The student visited appropriate Web sites, but did not gather detailed information or much supporting detail. He or she participated in the research, activities. and construction of graphs. The student may have required a great deal of help, shown much frustration with the task, been slow to complete the tasks or failed to complete the assignment.

- **Poor:** The student participated in a few or none of the classroom activities and discussions. He or she only visited some Web sites, did little research and developed little or no written assignments and/or graphs.

Name _____

A Variety of Graphs: Sample Data

Line Graph

Title: _____

Time (sec)	Volume (ml)
0	300
10	260
20	220
30	180
40	140
50	100
60	60

Check for understanding:

• Will this graph show an increasing or decreasing trend?

• What real-life example might this data represent?

Circle Graph

Title: _____

Flavor	Number of Boxes Sold
Chocolate Chip	36
Sugar	47
Oatmeal	18
Coconut	63
Mint	132
Other	23

Check for understanding:

• How many boxes of cookies were sold altogether?

• Could this data be shown using another type of graph? If yes, which type?

• What percent of the cookies sold were sugar cookies?

Bar Graph

Title: _____

School	Pupil Population
Ravenna HS	930
Theodore Roosevelt HS	1,300
Hoover HS	1,700
McKinley HS	900
Stow-Munroe Falls HS	2,000

Check for understanding:

- If this data were to be presented in pictograph form, what symbol might you use?

- How many pupils would each picture represent?

Histograms

Title: _____

Grade	Minutes of Homework per Day
K-2	10
3-5	30
6-8	45
9-11	70

Check for understanding:

- Will this graph show an increasing or decreasing trend?

- Could this data be shown using another type of graph? Explain your answer.

Overview

Students respond to the All About You Survey. They then make at least three graphs, all showing the same data in different ways.

Objective

Students will be able to create a frequency table of data and create three graphs, one of which is a circle graph.

All About You Survey
Which Graph Is Best?

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark A

01. Read, construct and interpret frequency tables, circle graphs and line graphs.

Data Collection, Benchmark E

04. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.

Grade 6

Data Collection, Benchmark A

01. Read, construct and interpret line graphs, circle graphs and histograms.

Statistical Methods, Benchmark B

05. Describe the frequency distribution of a set of data, as shown in a histogram or frequency table, by general appearance or shape; e.g., number of modes, middle of data, level of symmetry, outliers.

Data Collection, Benchmark D

03. Compare representations of the same data in different types of graphs, such as a bar graph and circle graph.

Data Collection, Benchmark E

02. Select, create and use graphical representations that are appropriate for the type of data collected.

Grade 7

Data Collection, Benchmark A

01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots and other types of graphs, when appropriate.

Statistical Methods, Benchmark B

04. Construct opposing arguments based on analysis of the same data, using different graphical representations.

Grade 8

Data Collection, Benchmark B

02. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an identified purpose; e.g., line graph for change over time, circle graph for part-to-whole comparison, scatter plot for relationship between two variants.

Materials

- Graph paper
- Rulers
- Protractors
- Colored markers or pencils

Procedure

1. Tell the students that they are going to find out about the things that they like and don't like. Distribute the student handout, All About You Survey and have the students make their selections.

2. When the students have completed this, ask them to cut apart the eight questions and place them in eight separate piles.

3. Divide the class into eight groups. Give each group one of the questions and have them make a frequency table of the answers that were given.

4. Each group needs to make at least three graphs using the data from their question. One of their choices must be a circle graph. Their other choices could be a line plot, a bar graph (with percents or counts) or a picture graph. Students should show all calculations. Remind the students of the following:

   a. Graphs always have a title.

   b. Intervals are always consistent.

   c. Axes should be labeled.

   d. Neatness counts — use a ruler!

5. Ask the students to compare the graphs that they created and discuss if they think one graph better shows the data than the other. Each person in the group must write at least three sentences that explain his or her opinion of the best graph and why it is best.

6. When all of the graphs are complete, display them around the room.

7. Have a discussion about the graphs. Ask the students these questions:

   a. What was the procedure for making a circle graph?

   b. If you made a line plot, did you use percent or count on the y-axis (vertical axis)? Does this make a difference in how the plot looks?

   c. If you made a picture graph, how many items does each picture represent? Did everyone use the same picture? Does the picture chosen change the data?

   d. Did everyone use the same intervals?

8. **Technology application:** If the students know Excel, this activity could be done with a spreadsheet. If they don't know it, this is a good chance to show them how to use the program. If they make a picture graph or a line plot, they will still need to do that by hand.

Evaluation

Rubric for Graphs
(Can be used three times – once for each graph made.)

	4	3	2	1
Chart/Graph Title	Title was present, appropriate and correctly written.	Title was present and appropriate but contained misspelled words or other errors.	Title was not appropriate.	There was o title.
Legend	Legend was present, complete and easy to read and understand.	Legend was present and complete but not easy to read.	Legend was present but not complete and not easy to read.	There was no legend.
Y and X axes	Both axes were labeled and easy to understand.	One axis was labeled and the other was incomplete.	One axis was labeled.	Axes were not labeled.
Percentages and Labels	All percentages and labels were present and easy to read.	One or more percentages or labels were included.	One percentage or label was included.	No percentages or labels were included.
Visual	Chart was colored appropriately, is neat and is easy to understand.	Chart had minimal color and was neat and was easy to understand.	Color was not present or appropriate. Chart was not neat but was easy to understand.	Color was not present or appropriate; chart weas sloppy and difficult to understand.

Created by April Jones for the Science Ambassador's Program

Name _____

All About You Survey

1. What is the average amount of television you watch in one day?

    a. One hour

    b. Two hours

    c. Three hours

    d. Five hours

    e. More than five hours

2. Which of these sports do you like best?

    a. Baseball or softball

    b. Football

    c. Soccer

    d. Wrestling

    e. Volleyball

3. Which of these do you like best?

    a. Red

    b. Blue

    c. Purple

    d. Green

    e. Yellow

4. What is the average amount of homework you do in one day?

    a. Less than 30 minutes

    b. Between 30 minutes and 1 hour

    c. One hour

    d. One and one-half hours

    e. More than 1-½ hours

5. Which of these snacks do you like best?

    a. Potato chips

    b. Pretzels

    c. A candy bar

    d. Ice cream

    e. Doritos

6. Which of these subjects do you like best?

    a. Math

    b. Reading

    c. Science

    d. Social studies

    e. Language arts

7. Which of these subjects do you like least?

    a. Math

    b. Reading

    c. Science

    d. Social studies

    e. Language arts

8. Which of these is do you like to do the most?

    a. Read

    b. Play video games

    c. Be with your friends

    d. Skateboard

    e. Create an art piece

Name _____

All About You Graphs

Directions: Using the data from your group, complete the following tasks:

1. Make a frequency table.

2. Make a circle graph.

3. Make two additional graphs using the same data.

4. Write two or three sentences explaining which graph is "best" and why.

Item	Tally	Frequency	Percent

Circle Graph
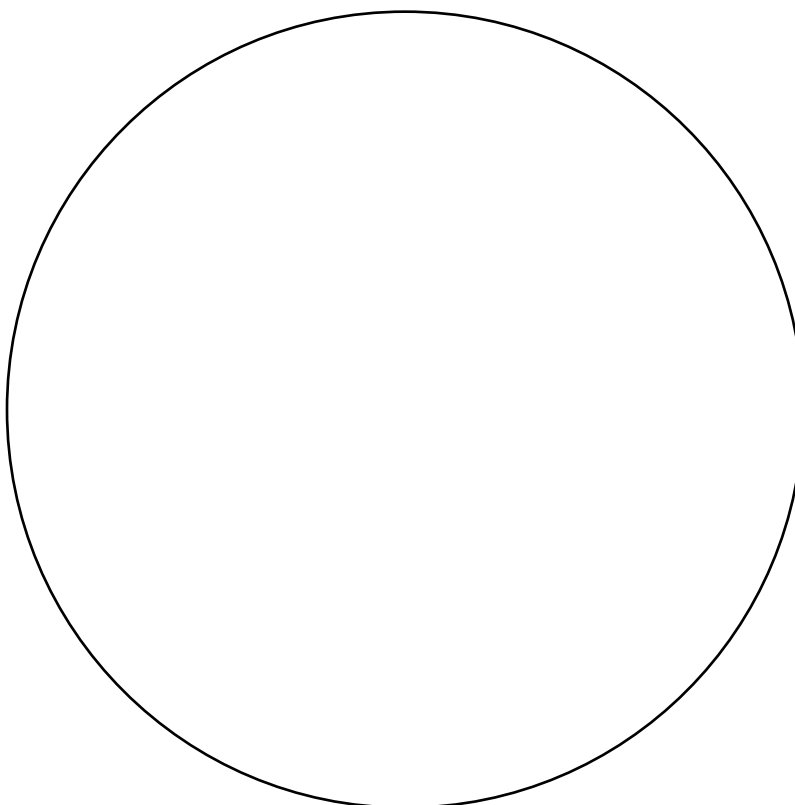
Graph 2
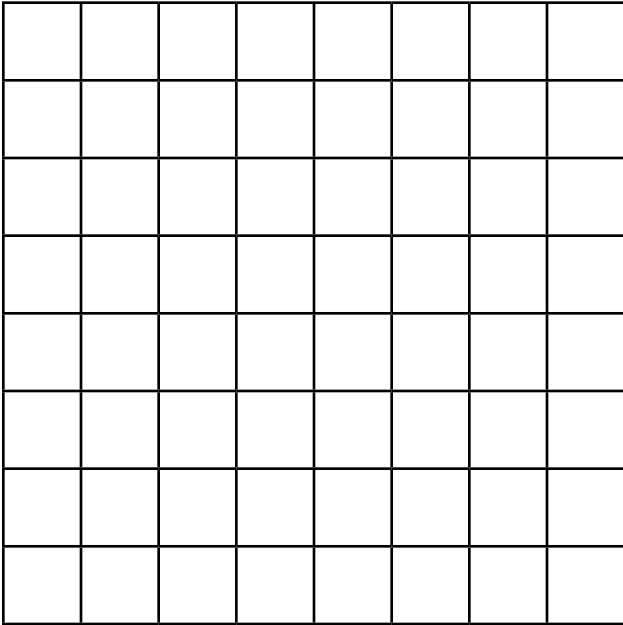
Graph 3
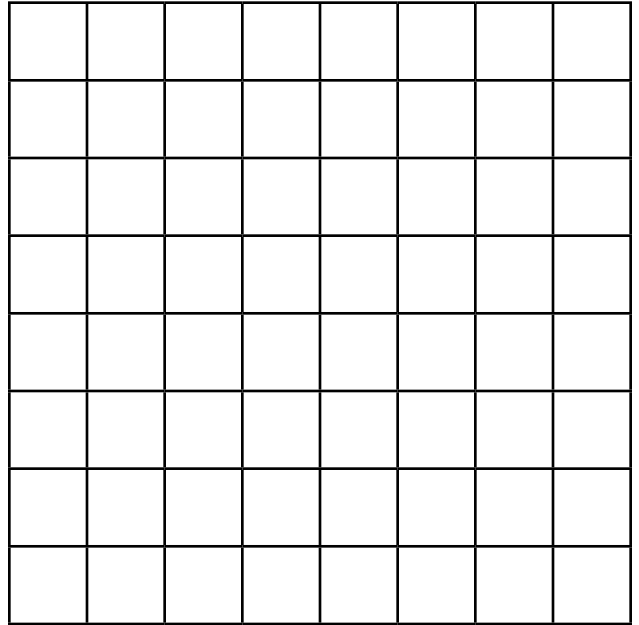
Video 3

Stem-and-Leaf Plots, Box-and-Whisker Plots and Scatter Plots

http://www.WesternReservePublicMedia.org/quizbus

Stem-and-Leaf Plots

Overview

Students create a stem-and-leaf plot using the number of calories in fast-food breakfasts.

Objective

Students will understand stem-and-leaf plots, with stems in the hundredths place.

Standards Address

Mathematics — Data Analysis

Grade 7

Data Collection, Benchmark A

01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate.

Materials

- Rulers

Procedure

1. To start this lesson, show the class an example of what a stem-and-leaf plot looks like. One example might be test scores.

2. Ask a few willing students to find their grades and explain how they found it to the class. Students will learn very quickly how to read this plot.

3. Explain a little about the plot:

   a. The stem can be whatever you determine it to be and the leaves are the remainder of the numbers.

   b. There is a legend to explain the plot.

   c. Generally the plot is written twice, once with the leaves in any order and secondly with the leaves in order from smallest to largest.

4. Distribute the student handout and ask students to make a stem-and-leaf plot using the data given.

5. Remind the students of the need to make a legend explaining the data and to include a title.

6. When this has been completed, give the students the data about the calories in fast-food sandwiches.

7. Introduce the concept of back-to-back stem-and-leaf plots.

8. Have the students complete the graph by plotting the sandwich calories on the left. Review putting the second part of the legend.

9. Ask students to write at least two comparisons between the calories in the breakfast items and the sandwiches.

Answers

Stem-and-leaf Plot

Calories in Fast-Food Breakfast Items

Stem	Leaves
1	30, 50, 60, 70
2	40, 60, 90
3	00, 70
4	00, 10, 20, 40, 40, 50
5	10, 50, 50
6	00, 40
7	00, 10, 80
8	
9	
10	
11	90

5|10 means 510

Back-to-Back Stem-and-leaf Plots

Calories in Fast-Food Sandwiches		Calories in Fast-Food Breakfasts
	1	30, 50, 60, 70
80	2	40, 60, 90
50, 30, 30, 30, 10, 00	3	00, 70
90	4	00, 10, 20, 40, 40, 50
90, 40, 40, 10	5	10, 50, 50
00	6	00, 40
70	7	00, 10, 80
	8	
	9	
	10	
	11	90

|4|00 means 400

90|4| means 490

Evaluation

Breakfast Graph

_____ Stems are in order   5 points

_____ Leaves are in order   5 points

_____ Legend is correct   5 points

Sandwich Graph

_____ Stems are in order   5 points

_____ Leaves are in order   5 points

_____ Legend is correct   5 points

Name _____

How Many Calories?
Stem-and-Leaf Plots

Directions: Using data about fast-food breakfast items, make a stem-and-leaf plot.

Fast-Food Breakfast Items	Calories
Bagel with ham, egg and cheese	550
Two scrambled eggs	160
Biscuit	240
Sausage burrito	290
Egg and sausage on an English muffin	450
Hash browns	130
English muffin with sausage	370
Pancakes and sausage	780
One egg on an English muffin	300
Cinnamon roll	440
Deluxe breakfast	1190
Bagel with steak, egg and cheese	640
Biscuit with sausage	410
English muffin	150
Pancakes, sausage, egg and cheese	550
Spanish omelete on a bagel	710
Sausage	170
Plain bagel	260
Big breakfast	700
Bacon, egg and cheese	440
Deluxe cinnamon roll	510
Pancakes with margarine and syrup	600
Pancakes and sausage	420
Sausage biscuit with egg	400

Stem	Leaves

Make a back-to-back stem-and-leaf plot using both the breakfast data and the sandwich data.

Fast-Food Sandwiches	Calories
Big double burger	600
Big burger	430
Loaded quarter-pound burger	540
Double cheeseburger	490
Loaded big cheeseburger	590
Cheeseburger	330
Loaded quarter-pound burger with cheese	540
Hamburger	280
Loaded double quarter pounder with cheese	770
Loaded fried chicken sandwich	510
Fried chicken sandwich	430
Spicy chicken sandwich	450
Grilled chicken sandwich	400
Fish sandwich	410

Human Box-and Whisker-Plots

Overview

Students learn about box-and-whisker plots through a class activity that compares their heights. As an extension of this activity, they learn how to use two different forms of technology to check their answers.

Objective

Students will be able to design and construct a box-and-whisker plot.

Standards Addressed

Mathematics — Data Analysis

Grade 5

Statistical Methods, Benchmark F

06. Determine and use the range, mean, median and mode, and explain what each does and does not indicate about the set of data.

Grade 6

Data Collection, Benchmark E

02. Select, create and use graphical representations that are appropriate for the type of data collected.

Statistical Methods, Benchmark F

04. Understand the different information provided by measures of center (mean, mode and median) and measures of spread (range).

Grade 7

Data Collection, Benchmark A

01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate.

Statistical Methods, Benchmark F

03. Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion of exclusion of outliers affects those measures.
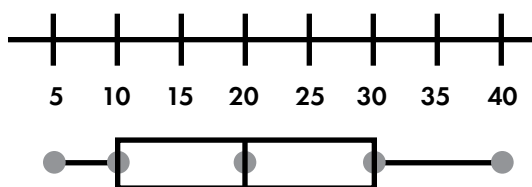
Materials

- Index cards
- Meter sticks
- Construction paper
- Cash register tape or string
- Long strip of bulletin board paper
- Three flags — two red and one blue (can be handmade out of rulers or straws and construction paper)

Procedure

1. Make three flags — one blue and two red — with "median" written on them.

2. Explain that the class is going to learn how to make an interesting graph with an interesting name — a box-and-whisker plot. The students are going to do this based on their heights.

3. Group students in pairs and pass out one meter stick to each pair. Give instructions to have each person measure the other in centimeters and write the height on an index card.

4. Instruct students to order themselves from shortest to tallest (shoulder to shoulder) across the front of the room.

5. Explain that the class needs to find the median student (the student in the middle). To find the median, or middle number, have students at each end of the line say "1" at the same time and sit on the floor. Ask students next to them to say "2." Have students count off in this fashion until only one or two students are standing. If there is an odd number of students, there will be one student; if there is an even number, there will be two students.

6. Give the remaining student the blue flag with "median" written on it. If by chance you have an even number of students in your class, then have the class find the mean of these two heights. These two students must hold the flag between them.

7. At this point, explain to the students that we have divided the class into two groups or halves — the short half and the tall half.

8. Explain that the class is now going to find the quartiles of our data set. Ask the class what quartile means, for example: What does it sound like? A quarter? What is a quarter — 25 cents? One fourth? What is the relationship between one fourth and one half?

9. The quartiles of a data set are the middle (half) of each half. Who is in the middle of the short half? This person is the lower quartile. Give him or her a red flag. Who is in the middle of the tall half? This person is the upper quartile and gets a red flag as well. Once again, if there are two students in the middle, the mean of the two would be used.

10. At this point, students of the same height need to stand behind one another.

11. Explain that there are two other important data points/people in the making of our graph — the endpoints or the maximum and the minimum — in this case the shortest person and the tallest person in our class. These people are the lower and upper endpoints, respectively.

12. Use a piece of yarn or register tape to make a box around the students in the lower to upper quartile. Have students locate the median student in relationship to the box. Discuss that the median student should be in the box but not necessarily in the middle of the box.

13. Now for the whiskers. Explain that the whiskers run from quartile to endpoint. Unroll each roll of register tape or string so that it goes from lower quartile to lower endpoint and upper quartile to upper endpoint. Students should assist in holding paper.

14. Review the process with students, answering any questions they have. Record the steps on the board/overhead for reference.

15. **Technology Extension:** Students can check their box-and-whisker plot in two different ways. First, they can go to the following Web site and follow the directions for putting in their own data and drawing the box plotter. This site also lets you print out the box plot.

http://illuminations.nctm.org/ActivityDetail.aspx?ID=77

Second, if computers are not readily available, students can use a graphing calculator to check their work. If the classroom is equipped with a white board use the graphing calculator software installed and show the students exactly how to make the box plot on the white board.

16. **Extensions:**

    a. To develop their understanding further, ask students how the box-and-whisker plot would change if the teacher's height was included in the data set.

    b. Suppose a new student came into the class. How would that change the plot we made?

    c. Suppose (student name) moved away. How would that change the plot? (Repeat with other names.)

Evaluation

In order to assess students' comprehension of the activity, give them a similar data set (you might want to use another class's heights) and have them go through the process on paper. They should identify the median, upper and lower quartiles and upper and lower endpoints, then draw the graph on a number line.

Box-and-Whisker Plots

Overview

Students count the number of drops of two different solutions that a penny can hold. They then make a box-and-whisker plot of each solution, one as a class and one on their own and analyze the results.

Objective

Students will be able to create and interpret a box-and-whisker plot.

Standards Addressed

Mathematics — Data Analysis

Grade 7

Data Collection, Benchmark A

01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate.

Statistical Methods, Benchmark F

03. Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion or exclusion of outliers affects those measures.

Materials

- Pennies
- Paper towels
- Two pitchers
- Clear liquid soap
- Eye droppers or pipettes

Procedure

1. The night before class, get two pitchers. Label one pitcher A and the other one B. Pour plain water in pitcher A. In pitcher B, put a few of clear liquid soap fill it with water. This needs to be done the night before so that the soap bubbles have a chance to disappear and the solutions look the same.

2. Review the five key data points of a box-and-whisker plot: median, lower extreme, upper extreme, lower quartile and upper quartile.

3. Have students work with a partner. Each pair needs an eye dropper or a pipette, a paper towel, two pennies, two cups and the Penny Drop handout.

4. Have the class read the scenario on the handout.

5. Instruct the students to label one of their cups "A" and the other "B." Then they should get a few drops of each solution from the corresponding pitchers.

6. The students should then place a penny on the paper towel and drop as many drops of the solution onto the penny until it overflows. They should record the number of drops (counting the one when it overflowed). It's important to have as few variables as possible, so you will need to talk about how far from the penny they should drop the solution, whether to use the head or the tail side, etc. One partner drops and the other records, and then they switch jobs.

7. After the students are finished, you can go around the room and have them tell how many drops they had for A and for B. They should record this on their handout.

8. Instruct the class to find the median. They will need to put the number of drops in order. Review their answers to make sure they are correct before continuing.

9. On the handout, have the students make a number line using the lowest and the highest points from either A or B.

10. Do these next steps for Solution A as a class.

11. Once the numbers are in order, the students need to find the median of A. The best way to do this is to divide the number by two and count down from the top and draw a line. Then count up from the bottom and draw a line. The line will either be between two numbers, which means that you will have to find the mean of those two numbers, or above and below a number, meaning that number is the median.

12. Instruct the students to find the lower and upper quartiles and the two extremes and record these on the handout.

13. Have the students create the box-and-whisker plot for Solution A.

14. Be sure they label the plot and put a title above the line.

15. Once they have done this, students will then make a box-and-whisker plot for solution B on their own.

16. Once the plots have been made, you can ask several questions to the class.

    a. Were the medians for Solutions A and B the same?

    b. What percent of the data is in the box?

    c. What percent of the data is in each whisker?

    d. Based on their plots, are the solutions the same?

17. Have the students write a few sentences about why they think the solutions are or are not the same.

Sample Box-and-Whisker Plot

Evaluation

Rubric for Solution B Plot

	11-15 points	6-10 points	1-5 points	0 points
Scale and Interval	Scale and interval were appropriate and best fit the page.	Scale and intervals were appropriate.	Scale and interval were shown but were not best suited for the data.	No scale or interval was given.
Titles	Graph had a detailed title and the axes were labeled correctly.	Graph had an appropriate title and the axes were labeled correctly.	Either graph was titled or axes were labeled.	There were no titles.
Accuracy	All points were correct and everything was spelled correctly.	One point was not in the correct location.	Two points were not in the correct location.	More than two points were not in the correct location.
Visual	Graph was neat (no eraser marks or unnecessary lines). Handwriting was clear. Spacing was appropriate.	Graph was neat. Extra lines were erased. Printing was neat.	Graph showed eraser marks or there were extra lines. Words were legible but not neat.	Graph was messy. Words and numbers were messy and hard to read.

Adapted from **http://bg017.k12.sd.us/Old_Team/Olympic_final_assessment.htm**

Sample Box-and-Whisker Plots

Liquid A   **Liquid B**

Liquid A		Liquid B	
17	lower extreme	25	
18		25	
18		25	
21		26	
23	lower quartile	26	
27		30	
27		31	
30		32	
30		32	
30.5	mean	34	
31		36	
31		37	
31		37	
33		38	
34	upper quartile	39	
35		40	
36		43	
36		43	
37	upper extreme	45	

Are the box-and-whskers plots alike?

Are the liquids the same?
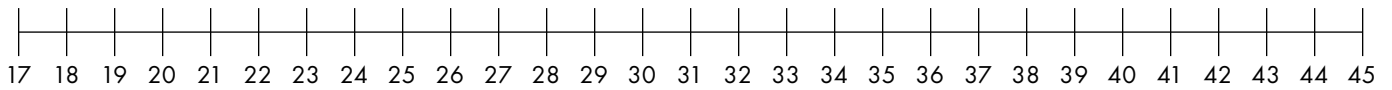
Liquid A

Liquid B

Name _____

Penny Drop

While cleaning my room, I found two pitchers of water. One was labeled A and the other B. Are they the same? Can I combine them? Let's experiment to find if there is a difference in the number of drops of Solution A and the number of drops of Solution B that can be placed on a penny?

Directions:

1. Place a paper towel on a level surface. Place two pennies heads-up on the towel.

2. You or your partner should label one cup "A" and the other "B." Pour some of Solution A into Cup A and some of Solution B into Cup B.

3. Fill the dropper with solution from Cup A.

4. Hold the dropper straight up over the center of one of the pennies.

5. Keep the end of the dropper one penny diameter from the surface of the penny.

6. Drop the solution onto the penny, one drop at a time. Count the drops needed to cause the solution to run over the edge of the penny. The drop that makes the solution run off the penny should be counted.

7. Record the number.

8. Rinse and clear the dropper. Run a second trial with solution from Cup B. Record the number.

Solution A trial: Number of drops _____

Solution B trial: Number of drops _____

Let's make a box-and-whisker plot with the data from Solution A together.

Solution A	In Order		Solution B	In Order

Solution A

Median = _____

Low Extreme (Minimum) = _____

High Extreme (Maximum = _____

Lower Quartile = _____

Upper Quartile = _____

Solution B

Median = _____

Low Extreme (Minimum) = _____

High Extreme (Maximum = _____

Lower Quartile = _____

Upper Quartile = _____

Make box-and-whisker plot here:

Are the solutions alike? Why or why not?

Scatter Plots and Median Fit Line

Overview

The class makes a table and scatter plot of all students' arm spans vs. heights. Students then investigate the effect of outliers on central tendency and find the line of best fit using medians (or median fit line).

Outcome

Students will create a scatter plot and find the line of best fit of the data.

Standards Addressed

Mathematics — Data Analysis

Grade 8

Data Collection, Benchmark A

01. Use, create and interpret scatter plots and other types of graphs as appropriate.

Statistical Methods, Benchmark C

05. Explain the mean's sensitivity to extremes and its use in comparison with the median and mode.

Statistical Methods, Benchmark F

06. Make conjectures about possible relationship in a scatter plot and approximate line of best fit.

Materials

- Tape measures
- Rulers
- Graph paper

Procedure

Day 1:

1. Divide students into pairs. Each student will use a tape measure to measure the other's height and arm span. You may want to demonstrate how the students should conduct the measurement.

2. On the board draw a table, with the first entry being your height and your arm span as an ordered pair. As the groups finish, they will add their measurements to the table. Have students recall that a "regular" polygon has the same height as width. If their own height and arm span are equal, they would be considered "regular."

3. When all students' numbers are recorded on the board, begin drawing a large scatter plot. Each student will come up front and plot his or her own point where it belongs. As the students add their numbers, discuss the following:

a. How do you know where to plot the point?

b. What do the x-axis and y-axis represent?

c. What intervals should we use for our graph?

d. Discuss labels and title for the graph. How does each point being plotted relate to the table?

4. **Option:** Have students make their own scatter plot using the graph paper on p. 162.

5. Have the students rewrite their measurements as ordered pairs as they come up.

6. The pairs of students should also draw the scatter plot on their own graph paper. This way, they will have the information for the next part of the lesson.

7. Have the students complete the Day 1 handout with their partners.

Day 2:

1. Discuss the results of the central tendency and the positive correlation of the data. Discuss the effect of any outliers on the mean. Students should understand that this is the reason they will use the median in the next step, as opposed to the mean or mode.

2. Instruct the students to follow these steps for creating the line of best fit:

a. Count the total number of points and divide by three. Draw two vertical dashed lines so there are approximately the same number of points in each of the three sections. The two outer sections should have the same number of points, if possible. Notice where the two occurs, there are two identical points. The following example uses 13 points, so the graph is divided into 4-5-4 points.

arm span vs. height
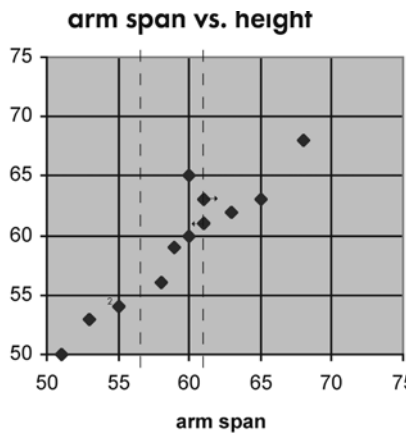
b. Now use a ruler to find the middle horizontally among the four points on the left (between the second and third point). Draw a small vertical line. Then find the middle vertically among the four points on the left. Draw a small horizontal line.

arm span vs. height
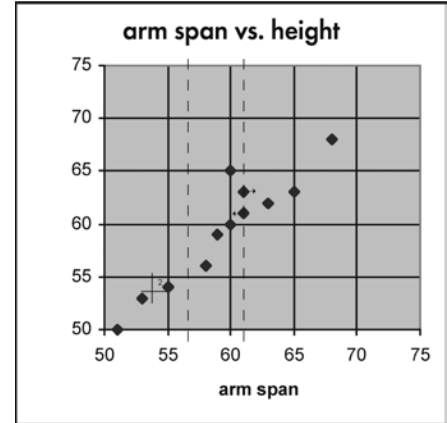
c. Do the same with each section.

arm span vs. height
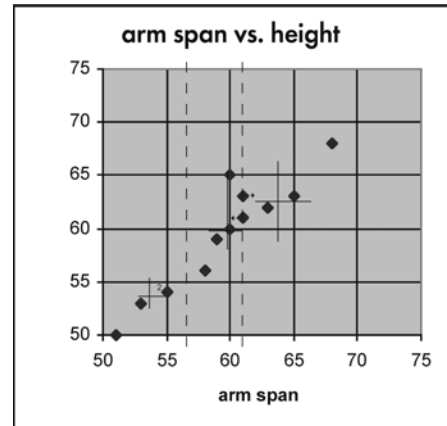
d. Use a ruler and try to line up the three x's you have drawn. If the x's lie approximately on a straight line, connect the first and last x with your ruler and then slide the rule one-third of the way to the middle x. Draw the line.

arm span vs. height
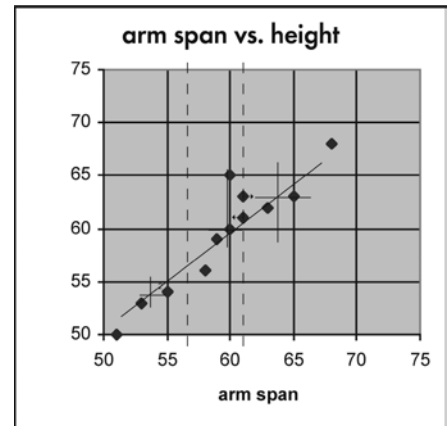
3. Guide students through this process with the first day's data. The data should yield a strong positive correlation, but you can discuss the effect of outliers with them.

4. Have students complete the Day 2 student handout with their partner.

Evaluation:

Category	4	3	2	1
Scatter Plot Construction	Student constructed the scatter plot correctly and paid attention to scale, labels, etc.	Student constructed the scatter plot correctly but missed attention to details.	Scatter plot had mistakes or unclear scale; there is minimal attention to detail.	Student does not understand scatter plot construction or how to form the scale.
Central Tendency	Student correctly calculated all three measures of central tendency and understood the change to the mean with an outlier present.	Student calculated the scatter plot correctly but misinterpreted change to the mean, or student made an error in calculation.	Student made a significant error in calculation and does not understand effect of outliers on mean.	Student does not understand how to calculate measures of central tendency and does not understand outliers effect on mean.
Line of Best Fit	Student correctly constructs line of best fit and is able to interpolate correctly.	Student made a minor error in line of best fit, but understands the process.	Student made an error in line of best fit and is not able to interpolate correctly.	Student does not understand how to find line of best fit and cannot interpolate correctly with the line.
Concepts	Student has a clear understanding of scatter plots and line of best fit and has communicated that effectively.	Student has satisfactory understanding of the major concepts, but has small misunderstandings.	Student has major misunderstandings of the concepts and cannot complete work on his own.	Student does not display understanding of the major concepts or did not complete the assignment.

Step 1

arm span vs. height

Step 2

arm span vs. height

Step 3

arm span vs. height

Step 4

arm span vs. height

Name _____

Day 1: Are You Regular?

A "regular" shape is defined as having the same measurement for all the sides. After measuring your arm span and height in inches, determine if you are "regular."

1. Copy down the table of the class's measurements.

Arm Span	Height	Ordered Pair

Arm Span	Height	Ordered Pair

2. Find the three measures of central tendency (mean, median and mode) for both arm span and height.

Arm Span

Mean: _____

Median: _____

Mode: _____

Height

Mean: _____

Median: _____

Mode: _____

3. Is there someone's height and arm span that you would consider an outlier (sticks out from rest of data)? _____

    _____

    _____

4. Add an extreme outlier to the data set; pick any numbers you want within reason (i.e., pick an extremely tall or short person).

    Then recalculate the measures of central tendency.

    I added in: _____

    Arm Span   **Height**

    Mean: _____   Mean: _____

    Median: _____   Median: _____

    Mode: _____   Mode: _____

5. Was the mean, median or mode affected by your outlier? Explain why or why not. _____

    _____

    _____

    _____

Here are some examples of correlation (the relationship between two variables). How would you label our class's data?

I would classify our class's data as having: _____
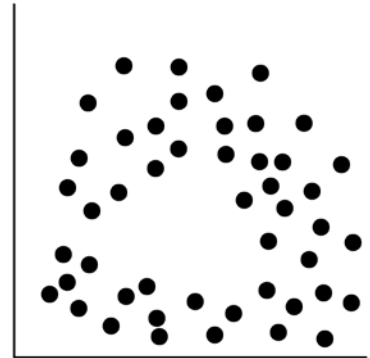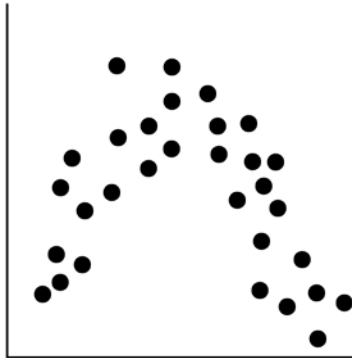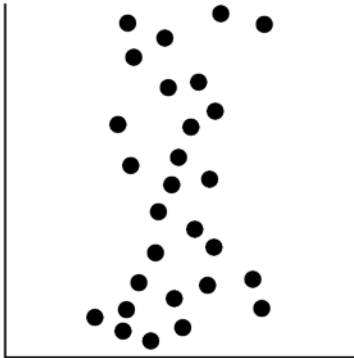
No linear correlations
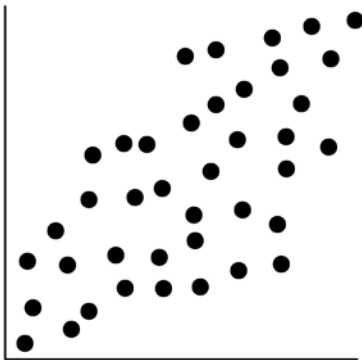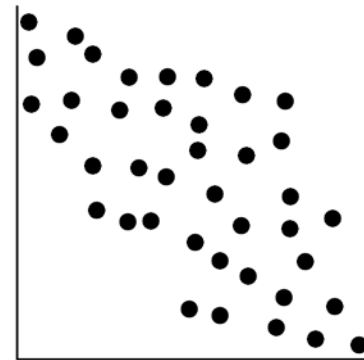
Weak positive linear correlations

Weak negative linear correlations
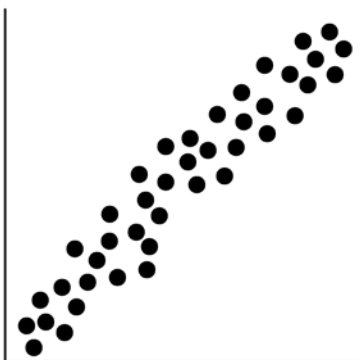
Strong positive linear correlations
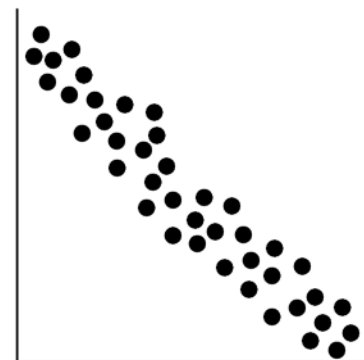
Strong negative linear correlations

Name _____

Day 2: Are You Regular?

Students of all ages were asked how many "best" friends they had. The results are listed in the table and in the scatter plot. Find the line of best fit for the data. Show all work.

Age	Friends
7	3
13	10
14	11
6	5
14	15
15	15
4	7
8	10
7	4
9	9
14	11

Age vs. best friends

Friend's age (y-axis): 0 to 16

Age (x-axis): 0 to 16
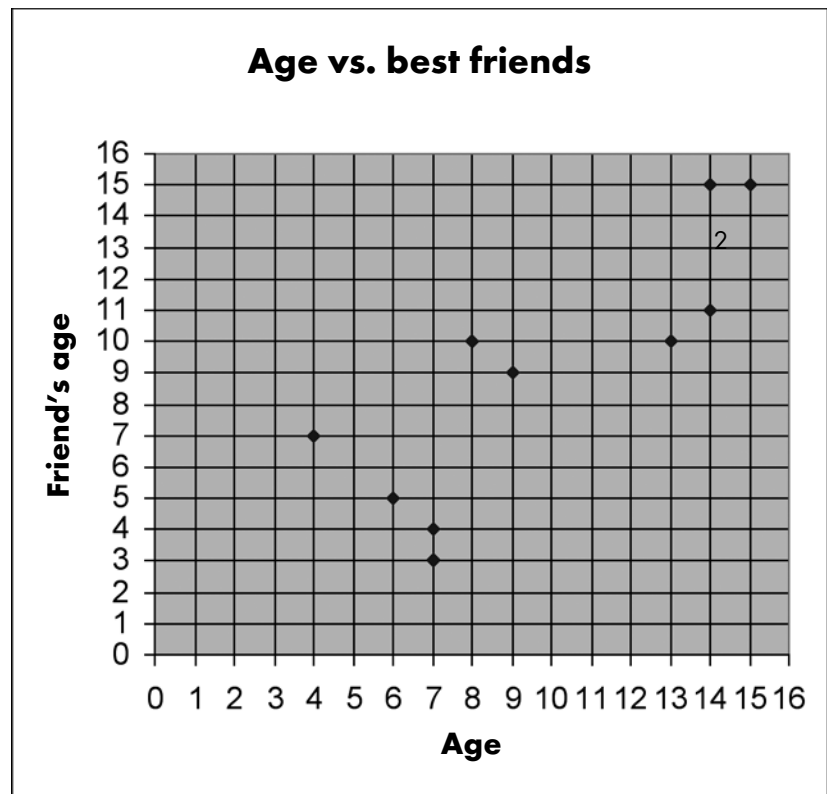
1. How would you classify the correlation for this data?

_____

2. If a child is 5 years old, how many friends would you expect him to say he has?

_____

3. If a student is 12 years old, how many friends would you expect her to have?

_____

Day 2: Are You Regular?

Answer Key

Students of all ages were asked how many "best" friends they had. The results are listed in the table and in the scatter plot. Find the **line of best fit** for the data. Show all work.

Age	Friends
7	3
13	10
14	11
6	5
14	15
15	15
4	7
8	10
7	4
9	9
14	11

Age vs. best friends

11 points

$$3\overline{)11} \quad \frac{3R2}{}$$
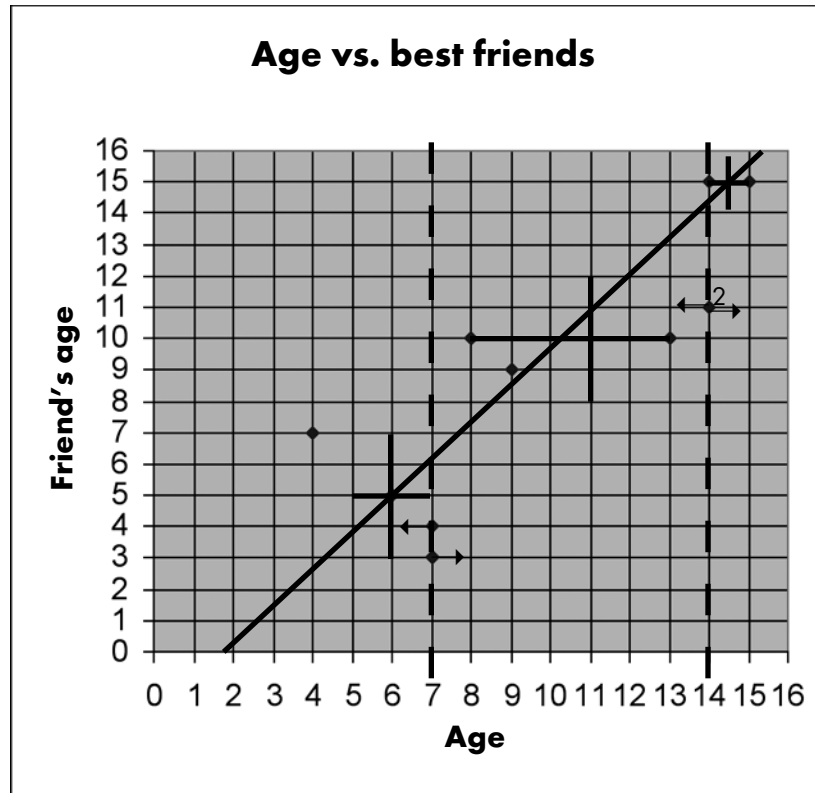
1. How would you classify the correlation for this data?

   Positive – high degree

2. If a child is 5 years old, how many friends would you expect him to say he has?

   Between three and four

3. If a student is 12 years old, how many friends would you expect her to have?

   12

Overview

Using information from the game Monopoly, students compare the distance from "Go" and the cost of the property using a scatter plot, make a median fit line and determine why certain points are away from the line. Students can also determine if this line could be used for prediction.

Objective

Students will show that they can create a scatter plot and make a median fit line.

Monopoly Madness

Standards Addressed

Mathematics — Data Analysis

Grade 7

Data Collection, Benchmark A

01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate.

Grade 8

Data Collection, Benchmark A

01. Use, create and interpret scatter plots and other types of graphs as appropriate.

Statistical Methods, Benchmark F

06. Make conjectures about possible relationship in a scatter plot and approximate line of best fit.

09. Construct convincing arguments based on analysis of data and interpretation of graphs.

Materials

- Graph paper
- Rulers

Procedure

1. Ask how many students have played Monopoly and what they know about the game board.

2. Allow the students to work with a partner or in groups of three, but make sure each student makes his or her own graph.

3. Distribute the Monopoly Madness handout and ask the students to make scatter plots that compare the distance of a property from "Go" and the cost of the property. (Distance is the independent variable because cost is determined by distance; therefore, distance will be on the x-axis.)

4. Once graphs are completed, share them with the class. Find out if everyone used the same intervals and how the graphs with different intervals might look different even though the same data are

displayed. Have students look for points that look "out of whack" with the rest of the data. They should be able to identify these points as the railroads and the utilities.

5. Review the steps in making a median fit line:

    a. Divide the number of points by three and draw a line showing each third. If the number of points is not divisible by three, the middle group will have the different number of points.

    b. Find the median of each third vertically.

    c. Find the median of each point horizontally.

    d. Lay your ruler on the intersection of the two means in the first and last third. Move the ruler one-third of the way to the middle intersection and draw your line.

6. Advanced students can find the slope of the line.

Evaluation

Rubric for Scatter Plot

Category	4	3	2	1
Scatter Plot Construction	Student constructed the scatter plot correctly and paid attention to scale, labels, etc.	Student constructed the scatter plot correctly but missed attention to details.	Scatter plot had mistakes or unclear scale; there was little attention to detail.	Student did not understand scatter plot construction or how to form the scale.
Central Tendency	Student correctly calculated all three measures of central tendency and understood the change to the mean with an outlier present.	Student calculated correctly, but misinterpreted change to the mean, or there was an error in calculation.	Student made a significant error in calculation and did not understand the effect of outliers on mean.	Student did not understand how to calculate measures of central tendency and did not understand outliers effect on mean.
Line of Best Fit	Student correctly constructed line of best fit and was able to interpolate correctly.	Student made a minor error in line of best fit, but understood the process.	Student made an error in line of best fit and was not able to interpolate correctly.	Student did not understand how to find line of best fit and could not interpolate correctly with the line.
Concepts	Student had a clear understanding of scatter plots and line of best fit and communicated that effectively.	Student had okay understanding of the major concepts, but had small misunderstandings.	Student had major misunderstandings of the concepts and could not complete work on his own.	Student did not display understanding of the major concepts or did not complete the assignment.
Line	Line was correct. Thirds were correctly placed. Vertical and horizontal medians were correct in each third.	Line was correct and thirds were correct, but vertical and horizontal medians were not correctly placed.	Line was okay. Thirds and vertical and horizontal medians were not accurate.	Line was incorrect.

Monopoly Madness

Monopoly was created in 1935. Since then it has been published in 26 languages and is available in 80 countries. For those of you who have never played, you move around a board with the option to purchase the property you land on. As a property owner you are trying to bankrupt your fellow players and take home all of the money.

Directions: Make a scatter plot with the data below.

Name	Spaces from "Go"	Cost
Mediterranean Ave.	1	$60
Baltic Ave	3	$60
Reading Railroad	5	$200
Oriental Avenue	6	$100
Vermont Avenue	8	$100
Connecticut Avenue	9	$120
St. Charles Place	11	$140
Electric Company	12	$150
States Avenue	13	$140
Virginia Avenue	14	$160
Pennsylvania Railroad	15	$200
St. James Place	16	$180
Tennessee Avenue	18	$180
New York Avenue	19	$200
Kentucky Avenue	21	$220
Indiana Avenue	23	$220
Illinois Avenue	24	$240
B. & O. Railroad	25	$200
Atlantic Avenue	26	$260
Ventnor Avenue	27	$260
Water Works	28	$150
Marvin Gardens	29	$280
Pacific Avenue	31	$300
North Carolina Avenue	32	$300
Pennsylvania Avenue	34	$320
Short Line	35	$200
Park Place	37	$350
Boardwalk	39	$400

Answer these questions:

What is the relationship between the distance from "Go" and the cost of the property?

What is the independent variable? Why?

What points look out of place on the graph? Why?

89

Video 4

Doing Data Projects

Data Projects — Basic Information

What Is a Data Project?

A data project is an exercise in carrying out a statistical investigation. It includes the formation of a question, the collection of data, the analysis of data and a conclusion that answers the original question. Sounds kind of like the scientific method, doesn't it?

Why Do a Data Project?

Data projects allow students to see and do all phases of a statistical investigation. It integrates information the students have learned with real-life problems that they are trying to solve. The concept should help them understand that they can use information from data projects to make life decisions.

What Types of Projects Are There?

Projects can either be formed around a survey or around an experiment. A **survey** asks participants questions that will help the surveyor to solve the problem. If a survey asks every member of a **population**, that survey becomes a **census**. We're all familiar with the U.S. Census, which is supposed to get data from every person in the United States. Another example of a census is if you want to know what the favorite food is of the people in your class, and you ask everyone in your class, your class becomes the **population.** If you only ask some of the people in the population, or a **sample** of the population, that is called a **sample survey**. The wording of the questions is very important. An **experiment** is an "event" that is designed to get information about the question you have posed.

What Are the Essential Concerns of a Data Project?

When creating a data project, these concepts should be considered:

1. What is the **question** to be answered?

2. How will you select your **sample** (from the target population) and how many will you ask?

3. How will you **collect** your data? How will you assure **randomness**?

4. What **graphs and charts** will you make to show your data?

5. What does each graph say?

6. What **conclusions** can you draw from your data?

7. Are there things you would do differently or are there future topics that should be studied?

What Are Some Key Concepts in Doing Data Projects?

1. Collect your own data.

2. Remember the difference between measurement data (quantitative) and categorical data (qualitative). Use measurement data as much as possible.

3. Projects are best done in groups, with everyone sharing both the original idea and the work in finding the conclusion.

4. Make sure the following basic elements of graphs are complete:
   • The type of graph you make fits the data you gathered
   • The axes are labeled
   • The graph has a title
   • The intervals on the axes are consistent

5. The data collected really supports the conclusion you reach.

6. An oral presentation of the project gives the experience of speaking mathematically about project ideas.

Overview

Students attempt to find the mean area of a set of 100 rectangles, first as an estimate, second by making a judgment and last by using a random sample.

Objective

Students will learn how to find the mean of a rectangle using three different methods: guess, judgment sample and random sample.

Standards Addressed

Mathematics — Data Analysis

Grade 4

Data Collection, Benchmark C

02. Represent and interpret data using tables, bar graphs, line plots and line graphs.

Data Collection, Benchmark C

04. Compare different representations of the same data to evaluate how well each representation shows important aspects of the data, and identify appropriate ways to display the data.

Statistical Methods, Benchmark E

07. Identify the median of a set of data and describe what it indicates about the data.

Grade 6

Statistical Methods, Benchmark G

06. Make logical inferences from statistical data.

Grade 8

Statistical Methods, Benchmark D

08. Describe how the relative size of a sample compared to the target population affects the validity of predictions.

Statistical Methods, Benchmark F

09. Construct convincing arguments based on analysis of data and interpretation of graphs.

Materials

- Graphing calculator (optional)

Procedure

1. As a class, introduce this scenario and ask the students to tell why it was or was not an appropriate statistical study:

    > The school's athletic booster club offered $1,000 to the team that was most popular in the school. The students decided to do a survey to find the most popular team. Students conducted their survey in the hall after wrestling practice. It turned out that wresting was the most popular sport in the school.

2. Pass out face-down the 100 Random Rectangles handout or show it on the overhead or on the computer.

3. Have each student number a separate paper from one to three and label number one as Guess, number two as Judgment Sample and number three as Random Sample.

4. Review the concept of area as the number of squares it takes to cover an object. Give an example on the board or overhead.

5. Tell the students that they are going to try to find out what the mean or average area is for the rectangles using three different methods:

    a. Guess: Have the students turn over the 100 Random Rectangles page and have the students study it for 30 seconds. On the guess line, they need to write what they think the average or mean number of squares on the page is.

    b. Judgment Sample: Now the students need to study the 100 Random Rectangles page and write the numbers of five rectangles that they think are representative of the rectangles on the page. They then write the area of each of the rectangles they found and find the mean of those five rectangles.

    c. Random Sample: Using a random number generator (either a graphing calculator or the handout), students should get five random numbers between 1 and 100. They will then write the area of the five rectangles that were randomly generated and find the mean.

6. Students should make three number lines in a row, as indicated below, making sure that all have the same intervals and are the same size.

7. Have students make a line plot for each set of data. They should round their means to the nearest whole number. Record their means on the board under the appropriate titles of Guess, Judgment and Random.

8. Instruct students to write a few sentences that explain what their graph is showing them. They should find that the mean of the random number area is the closest to the actual mean which is 7.29.

9. Ask students whether the results would be different if your sample was smaller or larger than five. **Answer:** If the sample is random, the greater the sample, the closer to the actual number it will be.

10. Help the class understand why it is important when conducting a survey to have a random sample.

One Classroom's Answers

Sample Answers

Line Plots of Tree Sample Methods
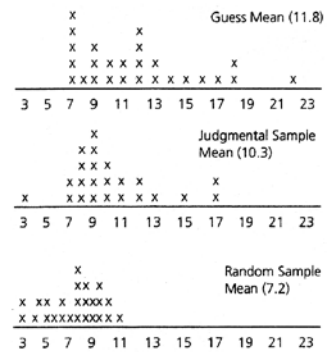
This activity was printed with permission from Dick Scheaffer who authored it. It was also published in *Activity-Based Statistics*, Key College Publishing.

Evaluation

Number lines have consistent intervals	5 points
Intervals are lined up	5 points
Number lines are labeled	5 points
Analysis of their graph is accurate	10 points
	TOTAL: 25 points

100 Random Rectangles

Overview

When you taste sour milk you know right away that the rest of the milk is sour — you have used a sample to make a decision. This lesson helps students understand when it would be necessary to use a sample.

Objective

Students will understand how to analyze if a sample was gathered appropriately and what situations justify the use of samples.

Learning About Sampling

Standards Addressed

Mathematics — Data Analysis

Grade 7

Statistical Methods, Benchmark D

05. Compare data from two or more samples to determine how sample selection can influence results.

Grade 8

Statistical Methods, Benchmark D

08. Describe how the relative size of a sample compared to the target population affects the validity of predictions.

Procedure

1. Introduce the vocabulary words population, sample and census, which are listed in the Choosing a Sample handout. Ask the class the following: Is population always people? **Answer:** No, population is any group where 100% of it is used. It could be all the fish in a lake or all the students in a school. Is there only one census? When is this census done? **Answer:** There is only one US Census every 10 years, however a census is anytime you use the whole population.

2. Divide students into pairs.

3. Ask the students to read the advertisement from Benecol, discuss the statements made and complete the handout ith their partners.

4. Discuss the responses as the class.

Possible Answers

Situation	Sample	Census	Why
Length of battery life	x		Could not test every battery
Accurate count of the number of people in the world		x	Would be very difficult to achieve, but would be a census
Your blood	x		Would merely want a sample of your blood to be tested rather than all of your blood
Reasons for absence from school	x	x	Could be either, depending on how data is to be used
Safety crash tests on cars	x		Wouldn't want to crash all of the cars
Best pie contest	x		Don't want to eat the whole pie

You want to tell people about your city so you decide to sample the population. Tell if they are good or bad samples and why.

Sample	Good or Bad and Why
Teenagers	Bad — not representative of your entire city
People whose name begin with P	Good — it is assumed that names beginning with P would cover all ages and genders, but would be difficult to accomplish
People at the local airport	Bad — there would be a lot of travelers at the airport so your city might not be represented
People in restaurants	Bad — would be random, but would omit people who could not afford to eat at restaurants
Every 10th person in the telephone book	Bad — omits people who don't have phones or have unlisted numbers

Evaluation

The goal of this lesson is discussion. Answers will vary on the student handout.

If you choose to grade it, two points could be given for each of the first six questions answered correctly and one point could be given for each of the last five, so there are 17 possible points. A percentage of those correct could be used.

Name _____

Choosing a Sample

Three important definitions:

1. **Population:** The entire group of people, animals or things about which we want information.

2. **Sample:** A part of the population from which we actually collect information that is used to draw conclusions about the whole population. There should be an equally likely chance for everything or everyone in the population to be selected.

3. **Census:** When every member of the population is represented in a data collection.

This text is from an advertisement for a cholesterol medicine:

"Research Backs Benecol

It's reassuring to know that plant stanol ester has been the subject of over 20 published scientific studies in the leading medical journals. The studies confirm the cholesterol-lowering effect of plant stanol ester.

One of the most widely renowned published studies is the North Karelia Project, which took place in Finland during the early 1990s. The study looked at 153 people aged between 25 and 64, all with cholesterol levels slightly above recommended healthy levels." Source: Census at School **http://www.censusatschool.ntu.ac.uk/files/censusorsample.doc**

What do you think about the size of the sample? Big enough? Too big?

Check whether you would use a sample or the population if you were doing these studies.

Situation	Sample	Census	Why
Length of battery life			
Accurate count of the number of people in the world			
Your blood			
Reasons for absence from school			
Safety crash tests on cars			
Best pie contest			

You want to tell people about your city so you decide to sample the population. Tell if they are good or bad samples and why.

Sample	Good or Bad and Why
Teenagers	
People whose name begin with P	
People at the local airport	
People in restaurants	
Every 10th person in the telephone book	

Adapted from Census at School **http://www.censusatschool.ntu.ac.uk/curriculum1b.asp**

Taking a Survey

Overview

Students look at survey questions and decide what is good or bad about them. They then think of some general rules for writing survey questions.

Objective

Students will understand the basics of developing survey questions and write some general rules for writing survey questions.

Standards Addressed

Mathematics — Data Analysis

Grade 5

Data Collection, Benchmark E

04. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.

Procedure

1. Divide students into five groups.

2. Distribute the student handouts and ask the class to write answers for the first four questions.

   Answers:

   1. The word "family" is not defined and is open to many interpretations.

   2. You are giving one of the choices a better chance of being selected because you've made the other seem less desirable.

   3. The question "leads" the person to the answer you want.

   4. The word "forbidden" is much stronger than the word "allow." People tend to not want to "forbid" something.

3. Assign one section of the fifth question to each of the groups. Each group will arrive at a group opinion and present their answer to the class.

4. Ask students to think of rules that they should follow when writing survey questions. Make a master list of rules, which might include the following:

   • Make sure all of the words in the question are defined.

   • Don't use emotionally charged words.

   • Make sure the question will generate the type of answers that you need.

- Don't ask questions that you think people will answer in a way to please the questioner.

- Try not to ask personal questions. People will hesitate to answer them or may not answer them at all.

- Don't put your own value judgment into the question.

5. Ask each group to select a topic of interest to them and write two survey questions about the same topic — one that is biased in some way and one that they think is good. Ask your first question to about 20 people and record the results. Now ask your second question to about 20 different people and record the results.

6. Write one paragraph that tells about the results of your responses to these two questions.

Evaluation

Rubric for Paragraph on One-Question Survey

Category	4	3	2	1
Focus on Topic (Content)	There was one clear, well-focused topic. Main idea stood out and was supported by detailed information.	Main idea was clear but the supporting information was general.	Main idea was somewhat clear but there was a need for more supporting information.	The main idea was not clear. There was a seemingly random collection of information.
Support for Topic (Content)	Relevant, telling, quality details gave the reader important information that went beyond the obvious or predictable.	Supporting details and information were relevant, but one key issue or portion of the storyline was unsupported.	Supporting details and information were relevant, but several key issues or portions of the storyline were unsupported.	Supporting details and information were typically unclear or are not related to the topic.
Conclusion (Organization)	The conclusion was strong and left the reader with a feeling that they understood what the writer intends.	The conclusion was recognizable and tied up almost all the loose ends.	The conclusion ws recognizable but left several loose ends.	There was no clear conclusion; the paper just ended.

Asking Good Survey Questions

When conducting a data project the first step is to clearly define your question. Once you know what information you need, you must design your survey to get that information. When creating questions, you should follow these guidelines:

- **Use as few questions as possible.** It is, however, better to have data that you don't use than to need data that you don't have.

- **Use simple words.** The people who you are surveying should understand what you are asking.

- **Don't ask leading questions.** If you ask what kind of cake you want, that assumes that you want cake in the first place.

- **Avoid double negatives**. The statement, "True or false: You don't have no computer at home" really says, "True or false: You have a computer."

- **Don't make the list of choices too long**.

- **Try to get measurement data from your survey**. For example, instead of saying, "What is your favorite soda, Coke or Pepsi?" ask, "Rate Coke on a scale of one to five, with one being least favorite and five being most favorite." You can ask the same about Pepsi. You can then use many more graphs to illustrate the responses.

- **Use close-ended questions instead of open-ended.** This limits the choice of answers and allows you to more easily display the results.

- **Put your questions in logical order**.

- **Don't use biased words.** For example, in the question, "Should we forbid prayer in schools?" the word "forbid" connotes a strong feeling.

- **Always pretest your survey.**

Name _____

Surveys
Asking the Questions

1. One of the most important concepts of getting the answer to the question you are asking is the way you word your question. You want to make sure you get the exact data you need to answer your question. "How many people are in your family?" Good question? Why or why not?

2. "Would you like the newest edition of the MacIntosh computer, or would you rather have the older, less robust version?" Good question? Why or why not.

3. "You don't eat carbohydrates, do you?" Good question? Why or why not?

4. Choose which of these questions is better: "Do you think that free speech in school should be forbidden?" or "Do you think free speech in school should not be allowed?" Why?

5. Could these situations cause you difficulties when conducting a survey?

   a. Your school wants to know if alcohol use is common at your school. They ask the DARE officer to ask each student individually if he or she uses alcohol.

   b. The school district wants to put a levy on the ballot, so they want to know the mean income of the people in the district. The send someone door to door and ask for the income of each household.

   c. You're running against Bob for president of your class. You ask your friends to do a survey. They go to students and say, "Bob is really a creep. You're voting for Mary, aren't you?"

   d. You want to get a DJ to work your school dance. He wants to know what kind of music you want, so you send out representatives to ask other students if they want rock, hard rock, country or rap to be played at the dance.

   e. You want students to tell you which of two magazines they like. You tell them to peruse the issues and elucidate their responses.

Write some general rules about writing survey questions.

Overview

This lesson is the culminating activity in the study of data analysis. Students use data analysis skills that they have learned to collect, analyze and interpret data about a topic of their choice.

Objective

Students will successfully complete a data project.

Standards Addressed

Mathematics — Data Analysis

Grade 4

Data Collection, Benchmark A

01. Create a plan for collecting data for a specific purpose.

Data Collection, Benchmark C

04. Compare different representations of the same data to evaluate how well each representation shows important aspects of the data, and identify appropriate ways to display the data.

Grade 5

Data Collection, Benchmark E

04. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.

Statistical Methods, Benchmark F

06. Determine and use the range, mean, median and mode, and explain what each does and does not indicate about the set of data.

Grade 6

Data Collection, Benchmark E

02. Select, create and use graphical representations that are appropriate for the type of data collected.

Statistical Methods, Benchmark F

04. Understand the different information provided by measures of center (mean, mode and median) and measures of spread (range).

Statistical Methods, Benchmark G

06. Make logical inferences from statistical data.

Grade 7

Statistical Methods, Benchmark B

04. Construct opposing arguments based on analysis of the same data, using different graphical representations.

Statistical Methods, Benchmark D

05. Compare data from two or more samples to determine how sample selection can influence results.

Data Collection, Benchmark E

02. Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.

Statistical Methods, Benchmark F

03. Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion or exclusion of outliers affects those measures.

Data Collection, Benchmark G

02. Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.

Grade 8

Data Collection, Benchmark A

01. Use, create and interpret scatter plots and other types of graphs as appropriate.

Data Collection, Benchmark B

02. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an identified purpose; e.g., line graph for change over time, circle graph for part-to-whole

comparison, scatter plot for relationship between two variants

03. Differentiate between discrete and continuous data and appropriate ways to represent each.

Statistical Methods, Benchmark D

08. Describe how the relative size of a sample compared to the target population affects the validity of predictions.

Statistical Methods, Benchmark F

06. Make conjectures about possible relationship in a scatter plot and approximate line of best fit.

09. Construct convincing arguments based on analysis of data and interpretation of graphs.

Materials

- Large envelope

- Index cards

- Computer with Internet or Excel

- Colored markers

- Graph paper

- Poster board (optional)

- Graphing calculator (optional)

Procedure

1. Have the students choose one or two partners with whom to work, or select teams of two, three of four.

2. Hand out the evaluation rubric for students' reference. Also distribute the Project Requirements handout (suitable for younger students) or Statistics Project handout (for older students).

3. Decide whether you want the students to conduct experiments or surveys, or whether they have a choice. Seventh and eighth graders need to do experiments that allow them to gather measurement data. Younger students can do surveys and use counts or frequencies to create univariate (one variable) data.

4. Show some examples of data projects. These can be accessed on the Web at **http://www. WesternReservePublicMedia.org/quizbus**.

5. Describe to the class the different types of data they will create. Remind them that they can only make the following types of graphs with the data they collect:

Categorical	Measurement
Pie Graphs	Histograms
Bar Graphs	Stem-and-leaf plots
Picture Graphs	Dot plots
	Line plots
	Box-and-whisker plots
	Scatter plots (two variables)

6. The next step is to go over the project requirements. First. each group needs to select a topic. They may have difficulty with this, so allow them time to find ideas by visiting the following Web sites:

- **Resources for Science Fairs and Projects — http://members.ozemail. com.au/~macinnis/scifun/resource. htm**

- **Science Fair Hotlist — http://groups. yahoo.com/group/innovative-teaching/message/294**

- **Science Fair Projects and Experiments — http://www. juliantrubin.com/fairprojects.html**

- **Your Science Fair Resource Guide — http://www.ipl.org/youth/ projectguide**

The project does not need to be science-related but the topics listed can give them ideas.

Have the students in each group write their names and ideas on an index card. Review their ideas, being watchful that they will be able to use measurement data.

7. Give each group a large envelope so they can keep their supplies and data together. Staple the Project Requirements Sheet to the outside of this envelope.

8. Students should make a hypothesis about what they think the results of their experiment will be. Be sure to remind them that because they think the result may end up one way, it doesn't have to. They're not trying to prove a point but to find the answer.

9. Tell the students that they should collect data (like gender, grade or age) about the people they use in their experiment. For example, they could find the difference between boys and girls on a task, or between grade levels or teams. It is better to collect more data than you need than to not have enough.

10. The students need to try their experiment out to make sure it is giving them the answer to the question that they have asked.

11. Instruct the groups to select their samples. This is another difficult task. They have to make sure that their sample is random. For example, they might select every third person who walks out of class or the person at the end of every table in the cafeteria. There is also a question of how many should be in the sample. For purposes of this project, a reasonable number will work. If they're comparing one grade with another, a random sample of 15 to 20 per grade would be sufficient.

12. Have the students collect their data over several days.

13. Once the data is collected, the students need to organize and graph the data. It is necessary for students to write an explanation of every graph they make.

14. They need to find and report the significant numbers: mean, median, mode and range.

15. Using their graphs, they need to answer the question that they originally proposed. Further, they need to tell what they would have done differently if they were doing it over and they need to tell what else they could do to get more or better information.

16. Teams will then show their graphs and present their data to the class.

17. **NOTE:** This is a great time to have the students use technology. Excel can be used to keep data and create graphs. Create a Graph is a government site that is very child-friendly and allows students to create their graphs online: **http://nces.ed.gov/nceskids/createagraph/default.aspx**.

18. **NOTE:** Instead of doing a project, students could create a poster of their graphs. There are some examples of posters at **http://www.WesternReservePublicMedia.org/quizbus**.

19. **NOTE:** If you have excellent projects or posters, you can enter them into a national contest put on annually by the American Statistical Association. For information, go to **http://www.amstat.org/education/index.cfm?fuseaction=poster1**.

20. **NOTE:** If the students have graphing calculators, graphs can be made on the calculator and sent to the computer or shown during the presentation.

Evaluation

Rubric for Graphs

It is best to use a holistic approach to grading the projects with comments throughout the project that address specific issues.

Category	20-16	15-11	10-6	5-0
Accuracy of Plot	All points were plotted correctly and were easy to see. A ruler was used to neatly connect the points or make the bars, if not using a computerized graphing program.	All points were plotted correctly and were easy to see.	All points were plotted correctly.	Points were not plotted correctly, or extra points were included.
Type of Graph Chosen	Graph fit the data well and made it easy to interpret.	Graph was adequate and did not distorted the data, but interpretation of the data was somewhat difficult.	Graph distorts the data somewhat and interpretation of the data is somewhat difficult.	Graph seriously distorted the data, making interpretation almost impossible.
All Graphs	There was a title. Two axes were labeled appropriately. Intervals on the axes were consistent and appropriate.	Four of these are present in graphs: There is a title. Two axes are labeled appropriately. Intervals on the axes are consistent and appropriate.	Three of these are present in graphs: There is a title. Two axes are labeled appropriately. Intervals on the axes are consistent and appropriate.	Fewer than three of these are present in graphs: There is a title. Two axes are labeled appropriately. Intervals on the axes are consistent and appropriate.
Directions	Student followed directions. All necessary pages were included and correct.	Student followed directions. All but one necessary page were included and correct.	Student followed directions. All but two necessary pages were included and correct.	Student did not follow directions. More than two required pages were missing or incorrect.
Grammar and Spelling	Grammar and spelling were correct throughout project.	Most of the grammar and spelling were correct throughout project.	There were some errors in grammar and spelling.	There were many errors in grammar and spelling.
Neatness and Attractiveness	Graph was exceptionally-well designed, neat and attractive. Colors that go well together are used to make the graph more readable. A ruler and graph paper (or graphing computer program) were used.	Graph was neat and relatively attractive. A ruler and graph paper (or graphing computer program) were used to make the graph more readable.	Lines were neatly drawn but the graph appeared to be quite plain.	Graph was messy and appeared to be thrown together in a hurry. Lines were visibly crooked.

Project Requirements

Select a Topic

1. Design a survey. Ask about some "like" or preference. Be sure that you have two or three groups so that you can make comparisons.

2. Design an experiment. Make up an event about which to test people. An example might be to see how long people can stand on one leg.

Select Your Sample

Your goal is that every person gets an equal opportunity of being chosen. Try to select different target groups so that you can make comparisons — sixth grade, seventh grade, eighth grade or males and females

Test Your Idea

Determine the kinds of questions you need to ask to test the truth of your statement or to test the way you will perform your experiment.

Check for Completeness

Page 1: Your cover page must include the name of your study and the names of the group with whom you are working. You should include some type of artwork that represents your study.

Page 2: Write the question you are trying to answer. Write your hypothesis (what you think will happen).

Page 3: Tell how you selected your sample and what you actually did to gather your data.

Pages 4-6 or more: You must have at least three graphs. Each graph must have the axes labeled, consistent intervals and a title. There must be an explanation for each graph specifying what the graph is telling you. Be sure to use numbers in your explanation. You will get bonus points if you include extra graphs.

Following pages: Include all statistics you have found, including mean, median, mode, range, minimum and maximum, if appropriate. Include all raw data.

Final page:

1. List any findings or conclusions that you made from the study. In other words, what is the answer to the question that you posed? Be sure to use data figures in your explanation.

2. Tell what you would have done differently if you were doing the study over again.

3. Tell what else could be done with the study.

Name _____

Statistics Project

I. Preliminary Presentation   Due _____

On an index card, print the following information:
1. Your name and your partner's name, if you are working as a team.
2. What question you are investigating and your hypothesis.
3. What your population is.
4. How you will gather your data.
5. How you will get a random sample.

II. Personal Progress Report   Due _____

In a large envelope organize the following items:
1. Your data in its original form.
2. A copy of any questionnaires or surveys that you developed, or an explanation of your experiment..
3. Graphs that helped you explore your data.
4. Computer printouts that helped you analyze your data.
5. A brief progress report typed or in ink.
6. A list of any references that you used.

III. First Draft   Due _____
1. A cover sheet with project title, your name and the date.
2. A table of the data that you used and the method that you used to gather the data.
3. Graphs that reveal information about your data.
4. Analysis of the data.
5. Additional questions that your data generated.
6. A summary statement that answers your original question.

IV. Final Draft   Due _____
1. The finished report on 8½" by 11" white paper.
2. A font that is easy to read.
3. All graphs and tables mounted carefully on standard paper.
4. An illustrated final cover sheet.
5. A clear and concise statement of your conclusions.

V. Evaluation
1. Good organization and following of directions.   25   _____
2. Clarity of tables and graphs.   25   _____
3. Quality of written report.   25   _____
4. The quality of the oral presentation.   25   _____
5. Additional points for creativity.   10   _____

Adapted from statistics teacher Gretchen Davis of Santa Monica, Calif.

QuizBus

Dealing with Data

Video 5
Probability

Overview

First students make a line that goes from "impossibility" (0) to "certainty" (1) and place where they believe events belong on the line. Then they play an extrasensory perception game.

Objective

Students will understand the definition of probability and use correct symbolism when writing the probability of an event.

An Introduction to Probability

Standards Addressed

Mathematics — Data Analysis

Grade 4

Probability, Benchmark F

09. Conduct simple probability experiments and draw conclusions from the results; e.g., rolling number cubes or drawing marbles from a bag.

10. Represent the likelihood of possible outcomes for chance situations; e.g., probability of selecting a red marble from a bag containing 3 red and 5 white marbles.

11. Relate the concepts of impossible and certain-to-happen events to the numerical values of 0 (impossible) and 1 (certain).

12. Place events in order of likelihood and use a diagram or appropriate language to compare the chance of each event occurring; e.g. impossible, unlikely, equal, likely, certain.

Grade 5

Probability, Benchmark H

07. List and explain all possible outcomes in a given situation.

Probability, Benchmark I

08. Identify the probability of events within a simple experiment, such as three chances out of eight.

09. Use 0, 1 and ratios between 0 and 1 to represent the probability of outcomes for an event, and associate the ratio with the likelihood of the outcome.

Grade 7

Probability, Benchmark K

08. Make predictions based on theoretical probabilities, design and conduct an experiment to test the predictions, compare actual results to predicted results, and explain differences.

Materials

- Multiple red, white and blue game tokens

- Paper bag

- Index cards

Procedure

1. Ask students to take out a piece of paper and draw a line about half-way down. Ask them to label the left side of the line as "Impossible" and the right side of the line as "Certain."

2. Read each of the sentences below and ask them to put the letter of the sentence where they think it goes on the line.

   a. You will grow another head.

   b. You will take at least one more breath.

   c. You will toss a penny and it will land heads-up.

   d. You will go on a vacation next summer.

   e. You will go to the moon sometime during your lifetime.

3. Have a discussion about the students' placements. "A" should be considered impossible; "b" would be certain (although they sometimes argue that it's not absolutely certain); "c" should be in the center because there's an equally likely chance of getting either; and "d" and "e" are variable.

4. After this has been discussed, ask the students what percent of the time they could expect to toss a head on a penny. They should say 50 percent. Write 50 percent as a decimal and as a fraction and put ½ on the line above the letter "c."

5. If this is one-half of the line, they should draw the conclusion that ½ is halfway between 0 and 1; therefore, an impossible event has a value of 0 and a certain event has a value of 1. All other events will have a value somewhere between 0 and 1 and can be written as a decimal, a fraction (ratio) or a percent.

6. Place five red, one white and three blue game tokens in a paper bag and record the quantities on the board.

7. Ask a student to choose a token and tell what he or she thinks the probability is for getting one of that color. Do this several times (replacing the token each time).

8. Ask the class to build a definition of probability from this activity. Record their ideas. Following is the correct definition:

   $$P(Event) = \frac{\text{\# of observations favorable to the event}}{\text{Total possible observations}}$$

9. Point out that the following equation is the correct way to write the probability of tossing a coin heads-up:

   $$P(heads) = \frac{1}{2} \text{ or } P(heads) = .5 \text{ or } P(heads) = 50\%$$

10. Go back to you bag of tokens. This time, have the first student pull out a token and record the probability of the color drawn. Do not replace the token. Have a second student pull out a token and record the probability. Repeat this several more times. The students should see immediately that the total will change with each draw.

11. If the students need further help, use the following simulation: Put a number of tokens of different colors into the bag, only make each color equal to a letter grade. For example, red equals an A, blue equals a B, etc. Make sure you have the same number of tokens in the bag as there are number of people in the class. Tell the class that they are going to choose their report card grade by picking a token. Do this once with replacement and once without replacement. You don't have to repeat the exercise many times — they catch on quickly.

12. Make sets of cards (one set for every two students) using index cards as follows:
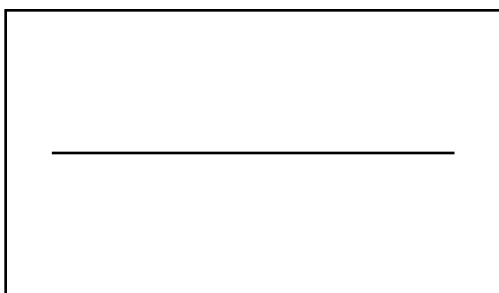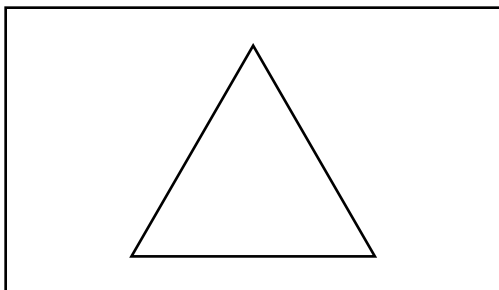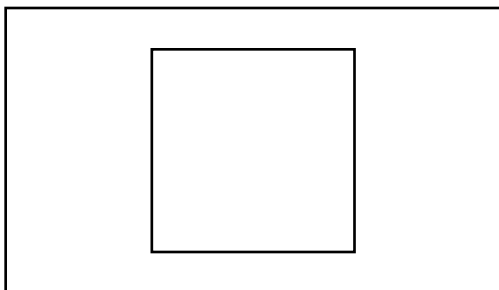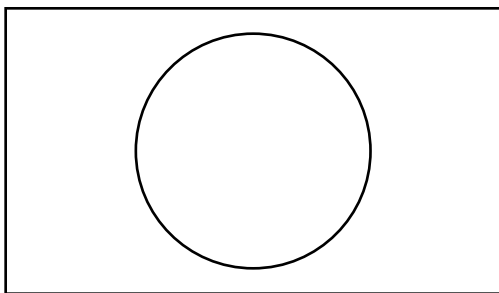
13. Tell the students that we are going to test their extra-sensory perception (ESP) using probability.

14. Ask the students what the probability would be for picking each of these items by chance. The answer is P(shape) = ¼ or .25.

15. Have the students pair up with a partner and each take out a piece of paper. On the paper each student should make a table like the following:

Correct	Incorrect

16. One partner mixes the cards up and concentrates on the symbol he or she is looking at. The other partner tries to guess what the card is and records if they answer correctly or incorrectly.

17. Allow about two minutes and instruct the students to change positions so the other partner is guessing.

18. Have the students calculate the percent they got correct.

19. By chance, they should have gotten 25 percent correct.

20. Students should compare the experimental probability (what actually happened) with the theoretical probability (what is supposed to happen) of .25.

- Students who guessed with greater than 25 percent accuracy have "good ESP." Watch out! They could know what you're thinking.

- Students who guessed with less than 25 percent accuracy probably shouldn't go to Las Vegas today!

Evaluation

At the end of class, give the students the following scenario: "A student has five hats. Two are blue, two are red and one is white."

Have them write the probability that they will pick a blue hat when choosing randomly. Check their responses and make sure that they have used correct symbolization.

Tree Diagrams

Overview

Students review the basic concepts of probability and move on to complementary events, independent and dependent events and compound events. They then create tree diagrams showing the sample space or the number of possible outcomes.

Objective

Students will be able to write the probability and complement of an event. They will be able to tell if the event is dependent or independent.

Standards Addressed

Mathematics — Data Analysis

Grade 4

Probability, Benchmark G

13. List and count all possible combinations using one member from each of several sets, each containing two or three members; e.g., the number of possible outfits from three shirts, two pairs of shorts and two pairs of shoes.

Grade 5

Probability, Benchmark H

07. List and explain all possible outcomes in a given situation.

Probability, Benchmark I

08. Identify the probability of events within a simple experiment, such as three chances out of eight.

09. Use 0,1 and ratios between 0 and 1 to represent the probability of outcomes for an event, and associate the ratio with the likelihood of the outcome.

Grade 7

Probability, Benchmark I

07. Compute probabilities of compound events; e.g., multiple coin tosses or multiple rolls of number cubes, using such methods as organized lists, tree diagrams and area models.

Grade 8

Probability, Benchmark J

11. Demonstrate an understanding that the probability of either of two disjoint events occurring can be found by adding the probabilities for each and that the probability of one independent event following another can be found by multiplying the probabilities.

Procedure

1. On the board, draw this circle:
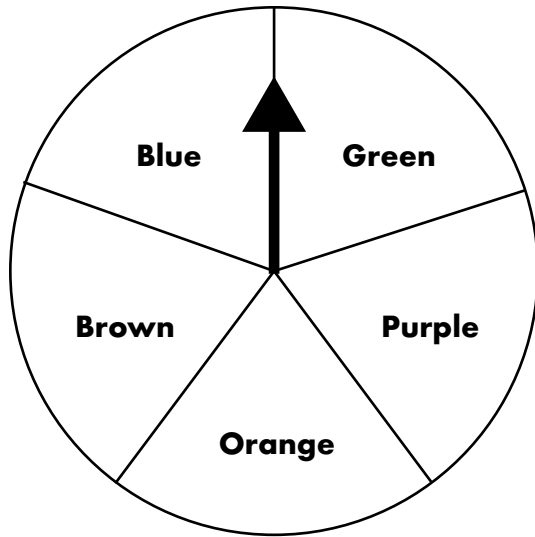
2. Ask the students to take out a piece of paper and number it from one to five. Have them answer using correct symbolism.

   If you were to spin this spinner, determine the following:

   a. What is the probability that you would land on the green section? **P(green) = ⅕**

   b. What is the probability that you would land on blue or green? **P(blue or green) = ⅖**

   c. What is the probability you would land on red? **P(red) = ⁰⁄₅ (an impossibility)**

   d. What is the probability that you would not land on brown? **P(not brown) = ⅘**

   e. What is the probability that you would get the blue, brown, purple, orange or green sections? **P(blue, brown, purple, orange or green) = ⁵⁄₅ or 1 (a certainty)**

3. Have the students exchange and correct each others' papers.

4. Discuss the following concepts:

   a. **Complementary events** are ones that are equal to one. For examples, the probability of orange is one-fifth and the probability of not orange is four-fifths. These are complementary because added together they equal one.

   b. **Independent events** are when two events have nothing to do with each other. For example: "It's raining and I'm going to the movie."

   c. **Dependent events** are when the occurrence of one event depends upon the other. For example: "If it rains, I'm going to the movie."

5. Introduce the concept of **compound events** as two or more independent events that have a single outcome.

6. Ask the students to list all of the possible outcomes of getting heads-up when tossing a coin and getting a five when rolling a die.

7. Have them label this list the **sample space**.

8. Ask the students if they can think of a way to graph this.

9. Introduce **tree diagrams** using the following example.

Students can get either heads or tails when they toss a coin (two outcomes on the first event). They can get a one, two, three, four, five or six when they throw a die (six outcomes on the second event). To show all of the possible outcomes, ask the students to make a tree diagram with you and list the sample space.
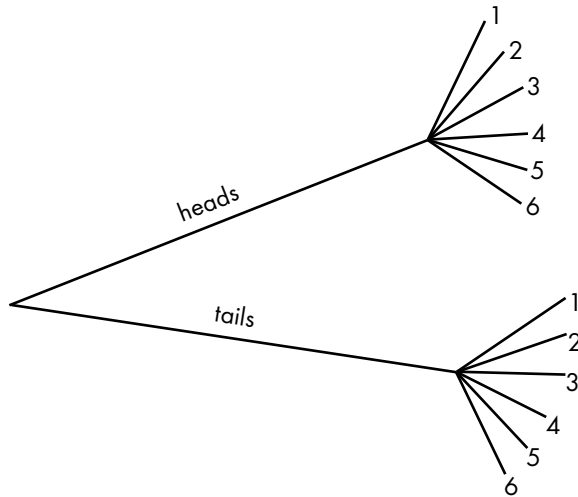
Sample Space		Number of Events
H,1	T,1	12
H,2	T,2	
H,3	T,3	
H,4	T,4	
H,5	T,5	
H,6	T,6	

10. Have the students make a tree diagram of the following problem.

You want an ice cream cone. You have a choice of a waffle cone or a regular cone. You have the choice of chocolate, vanilla or butter pecan ice cream. How many different ice cream cones could you have? List the sample space.
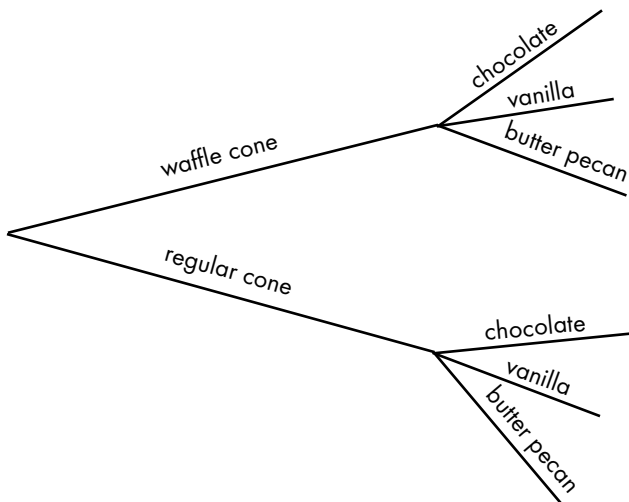
Sample Space	Number of Events
waffle cone, chocolate	Six
waffle cone, vanilla	
waffle cone, butter pecan	
regular cone, chocolate	
regular cone, vanilla	
regular cone, butter pecan	

11. Give the student the following example with three events:

You are going to a ball game. You have shorts or jeans; a blue, yellow or pink T-shirt; and a cap or scarf to wear. How many different outfits could you have? List the sample space.
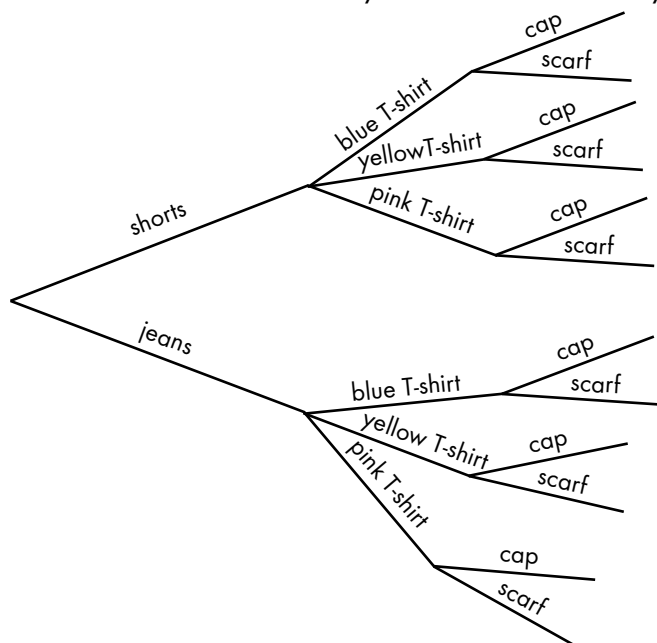
Sample Space

shorts, blue T-shirt, cap	jeans, blue T-shirt, cap
shorts, blue T-shirt, scarf	jeans, blue T-shirt, scarf
shorts, yellow T-shirt, cap	jeans, yellow T-shirt, cap
shorts, yellow T-shirt, scarf	jeans, yellow T-shirt, scarf
shorts, pink T-shirt, cap	jeans, pink T-shirt, cap
shorts, pink T-shirt, scarf	jeans, pink T-shirt, scarf

Number of Events

12

12. Ask the students how they could find out the number of items in the sample space. Make a table of the three problems they just did.

Event 1	Event 2	Event 3	# in Sample Space
2 (coin sides)	6 (1, 2, 3, 4, 5, 6)		12
2 (cone types)	3 (ice cream flavors)		6
2 (pants)	3 (T-shirts)	2 (outerwear)	12

Students should understand that when you have compound events, all you need to do to find out how many events are in the sample space is to multiply the number in each related event together.

13. Assign the following problem for homework or for assessment:

Maria has one green, one pink, one red and one yellow shirt. She also has one pair each of black jeans and white jeans. Make a tree diagram. List the sample space. Tell how many events there are.
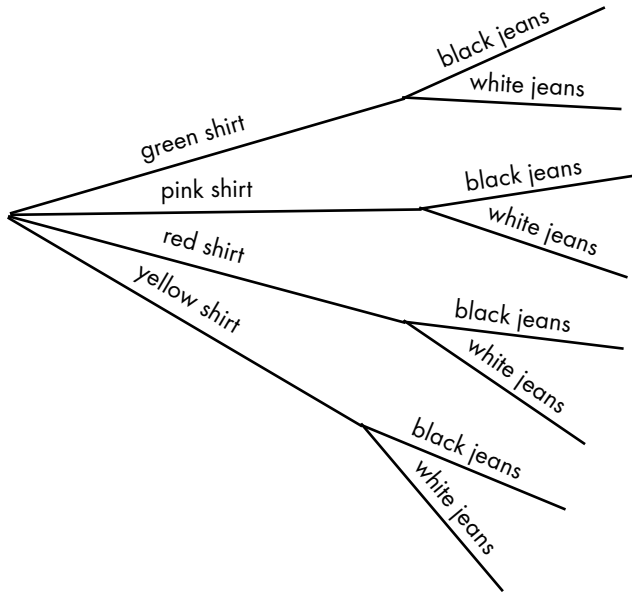
Sample Space

green shirt, black jeans

green shirt, white jeans

pink shirt, black jeans

pink shirt, white jeans

red shirt, black jeans

red shirt, white jeans

yellow shirt, black jeans

yellow shirt, white jeans

Number of Events

4 x 2 = 8

Evaluation

Give the students the following problem:

Jean and Joe wanted to join the band. They could pick marching band or concert band. The instruments available to them were flute, trombone, drums or oboe. How many possible options could they have? Draw a tree diagram and list the sample space.

Sample space correct	10 points
Tree diagram correct	10 points
Correct number of events	5 points
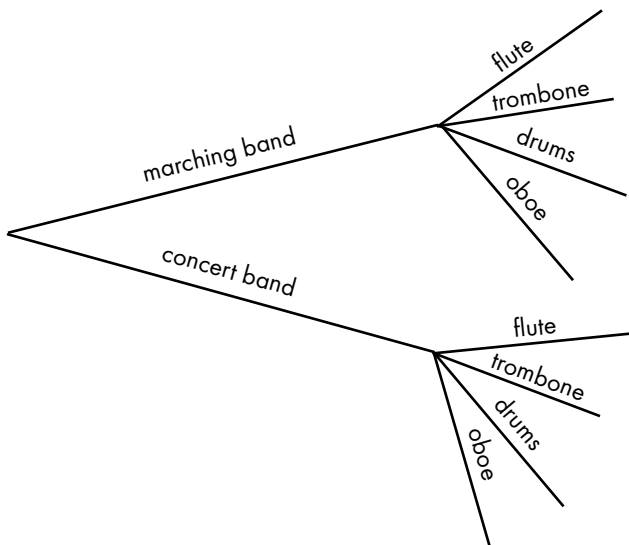
Sample Space

marching band, flute

marching band, trombone

marching band, drums

marching band, oboe

concert band, flute

concert band, trombone

concert band, drums

concert band, oboe

Number of Events

2 x 4 = 8

Overview

Students create a table to determine the probability of two events happening together (compound probability). They learn the definitions of complementary events, independent events, dependent events and compound events.

Objective

Students will be able to demonstrate an understanding of compound events.

Multiplying the Probability

Standards Addressed

Mathematics — Data Analysis

Grade 7

Probability, Benchmark I

07. Compute probabilities of compound events; e.g., multiple coin tosses or multiple rolls of number cubes, using such methods as organized lists, tree diagrams and area models.

Grade 8

Probability, Benchmark J

11. Demonstrate an understanding that the probability of either of two disjoint events occurring can be found by adding the probabilities for each and that the probability of one independent event following another can be found by multiplying the probabilities.

Materials

- Large model of a die

- Coin

Procedure

1. Review the following definition of probability:

   $$P(event) = \frac{\text{possibility of event}}{\text{total possible outcomes}}$$

2. Review tree diagrams, experimental vs. theoretical probability, the concept of certainty vs. impossibility and the fact that probability is shown as a fraction or decimal between 0 and 1.

3. Have a large die that the students can see as they answer the following questions.

   a. Write the sample space for tossing this die. **Answer:** 1, 2, 3, 4, 5 and 6.

   b. The probability of rolling each number on the die is P(1) = $\frac{1}{6}$; P(2) = $\frac{1}{6}$, etc. Ask the students if the probability of rolling a one is one in six, then what would be the probability of not getting a one? **Answer:** P(not 1) = $\frac{5}{6}$. This is called the complement of the event. When two complementary events are added together, they must equal one.

   c. Ask what the probability would be of rolling a seven on this die. **Answer:** P(7) = $\frac{0}{6}$ or 0. This would be called an impossibility.

4. Ask the students to tell what the words dependent and independent mean. **Answer:** Dependent means conditioned or determined by something else or contingent upon. Independent means not influenced or controlled by others or standing alone.

5. Give the student theses two scenarios:

   a. I'm going to the movies if it rains on Tuesday.

   b. I'm going to the movies on Tuesday whether it rains or not.

   Ask which is dependent and which is independent. **Answer:** A is dependent because attending the movie depends on whether or not it rains. B is independent because both going to the movies and whether it rains or not are stand-alone events.

6. Review compound events — when two or more independent events are thought of as a single unit. Have the students figure out the probability of throwing a one on the die along with tossing heads with a coin. Give them about five minutes to figure it out and then ask someone to explain how they got the answer. **Answer:** Students can use a variety of ways to solve this problem. A tree diagram is one way. P = $\frac{1}{6}$ x $\frac{1}{2}$ = $\frac{1}{12}$. So theoretically, you should roll a one on a die plus get heads when a coin is tossed once in every 12 times. This is a compound event.

7. Have the students compute one more example. A girl has three sweaters: red, blue and yellow. She has two pairs of pants: jeans and shorts. What is the probability that she will choose a red sweater and jeans? **Answer:** P(red sweater and jeans) = $\frac{1}{3}$ x $\frac{1}{2}$ = $\frac{1}{6}$.

8. Remind the students that to find the compound probability, you would multiply the probability of the two independent events.

9. Review the concept of using a geometric shape to help you solve the problem (area models).

10. Have the students work with a partner on the Compound Probability student sheet. If you think they will have difficulty with this concept, you could do Box A with them.

Evaluation

There are 16 possible answers that the student could get right or wrong on this sheet. A percentage of the number correct would be one way of giving a grade for this worksheet.

Name _____

Compound Probability

Problem 1: Today in gym class, you were learning to play tennis. All that was left when it was your turn to choose were three white balls and one orange ball. You also had the choice of two metal rackets and one wooden one. Fill in the area model below to figure the probability of each compound event.

Box A will tell you the probability of getting a white ball and a wooden racket.

P(white ball and wooden racket) = _____

	Probability of white ball is _____	Probability of orange ball is _____
Probability of wooden racket is _____	**A**	**B**
Probability of metal racket is _____	**C**	**D**

Box B = P(_____, _____) = _____

Box C = P(_____, _____) = _____

Box D = P(_____, _____) = _____

Problem 2: Michael wants a to buy his girlfriend some flowers for her birthday. The problems are that he doesn't know what kind of flowers she likes and he only has enough money for two flowers. There are two vases with flowers in the store. Michael closes his eyes and picks one flower from each vase. Vase 1 has three red roses and two yellow roses. Vase 2 has three white carnations and one red carnation. Determine the probability of each outcome by creating an area model like the one above.

Compound Probability — Answers

Problem 1: Today in gym class, you were learning to play tennis. All that was left when it was your turn to choose were three white balls and one orange ball. You also had the choice of two metal rackets and one wooden one. Please fill in the area model to figure the probability of each compound event.

Box A will tell you the probability of getting a white ball and a wooden racket.

P(white ball, wooden racket) = _____ $\frac{1}{4}$ _____

	Probability of white ball is $\frac{3}{4}$	Probability of orange ball is $\frac{1}{4}$
Probability of wooden racket is $\frac{1}{3}$	**A** $\frac{3}{4} \times \frac{1}{3} = \frac{3}{12}$ or $\frac{1}{4}$	**B** $\frac{1}{4} \times \frac{1}{3} = \frac{1}{12}$
Probability of metal racket is $\frac{2}{3}$	**C** $\frac{3}{4} \times \frac{2}{3} = \frac{6}{12}$ or $\frac{1}{2}$	**D** $\frac{1}{4} \times \frac{2}{3} = \frac{2}{12}$ or $\frac{1}{6}$

Box B = **P(orange ball, wooden racket) = 1/12**

Box C = **P(white ball, metal racket) = 6/12 or 1/2**

Box D = **P(orange ball, metal racket) = 2/12 or 1/6**

Problem 2: Michael wants to buy his girlfriend some flowers for her birthday. The problems are that he doesn't know what kind of flowers she likes and he only has enough money for two flowers. There are two vases with flowers in the store. Michael closes his eyes and picks one flower from each vase. Vase 1 has three red roses and two yellow roses. Vase 2 has three white carnations and one red carnation. Determine the probability of each outcome by creating an area model like the one above.

	Probability of red rose is $\frac{3}{5}$	Probability of yellow rose is $\frac{2}{5}$
Probability of white carnation is $\frac{3}{4}$	**A** $\frac{3}{5} \times \frac{3}{4} = \frac{9}{20}$	**B** $\frac{2}{5} \times \frac{3}{4} = \frac{6}{20}$ or $\frac{3}{10}$
Probability of red carnation is $\frac{1}{4}$	**C** $\frac{3}{5} \times \frac{1}{4} = \frac{3}{20}$	**D** $\frac{2}{5} \times \frac{1}{4} = \frac{2}{20}$ or $\frac{1}{10}$

Probability

Native American Stick Game

Overview

This game is based on a Native American game of chance. Students compare what happened in their game (experimental probability) with what is supposed to happen (theoretical probability).

Objective

Students will be able to explain theoretical and experimental probability.

Standards Addressed

Mathematics — Data Analysis

Grade 4

Probability, Benchmark G

13. List and count all possible combinations using one member from each of several sets, each containing 2 or 3 members; e.g., the number of possible outfits from 3 shirts, 2 shorts and 2 pair of shoes.

Grade 5

Probability, Benchmark J

10. Compare what should happen (theoretical/expected results) with what did happen (experimental/actual results) in a simple experiment.

Probability, Benchmark K

11. Make predictions based on experimental and theoretical probabilities.

Grade 7

Probability, Benchmark I

07. Compute probabilities of compound events; e.g., multiple coin tosses or multiple rolls of number cubes, using such methods as organized lists, tree diagrams and area models.

Materials

- Four sticks (tongue depressors or Popsicle sticks) per player

- 12 game tokens per group of three or four students

- Colored markers or paint

Procedure

1. Have each student decorate one side of four sticks to show symmetry or Native American glyphs, which can be found at **http://www. WesternReservePublicMedia.org**.

2. If the sticks are tossed in the air, here are the possible outcomes:
   a. One colored side and three plain sides
   b. One plain side and three colored sides
   c. Four colored sides
   d. Four plain sides
   e. Two plain and two colored sides

3. Students will determine how many points they will give for each possible outcome and write it down. There are many possible point totals.

4. Divide students into groups of three or four.

5. Twelve game tokens are placed in the center of the group. The first player drops the four colored sticks onto the table or tosses them in the air. He or she then takes the number of tokens from the pile that was assigned in step 3. If there are not enough tokens, the player can take the number earned from an opponent. This continues until one person has all of the tokens. That person is declared the winner.

6. Students should keep a record of the outcome of each of their turns.

7. Discuss with the students what point system they used and why. This could be done with a tree diagram and writing the sample space. If they have kept a record, you can have the students compare the experimental and theoretical probability. **Answer:** The fair scoring system is as follows: four alike equals eight points, two alike equals four points and three of a kind equals three points.

Stick 1	Stick 2	Stick 3	Stick 4	Sample Space
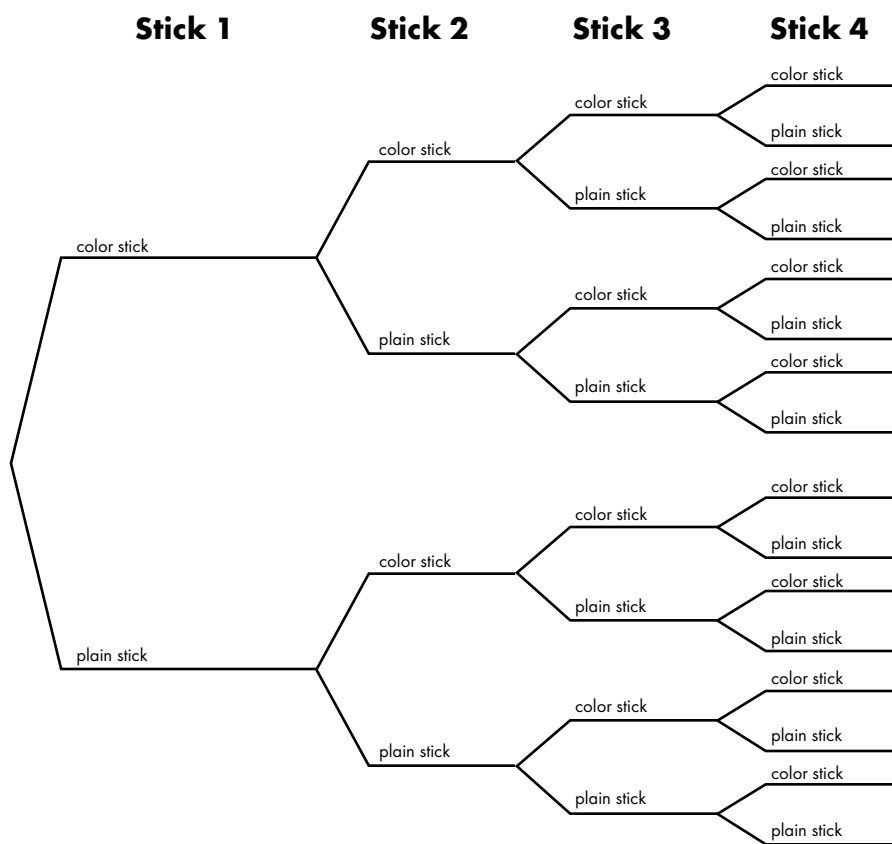
Sample Space

color, color, color, color
color, color, color, plain
color, color, plain, color
color, color, plain, plain
color, plain, color, color
color, plain, color, plain
color, plain, plain, color
color, plain, plain, plain
plain, color, color, color
plain, color, color, plain
plain, color, plain, color
plain, color, plain, plain
plain, plain, color, color
plain, plain, color, plain
plain, plain, plain, color
plain, plain, plain, plain

$2 \cdot 2 \cdot 2 \cdot 2 = 16$
$P(4 \text{ color}) = \frac{1}{16}$
$P(4 \text{ plain}) = \frac{1}{16}$
$P(2 \text{ color, 2 plain}) = \frac{6}{16}$
$P(3 \text{ color, 1 plain}) = \frac{4}{16}$
$P(3 \text{ plain, 1 color}) = \frac{4}{16}$

NOTE: There are many variations of this game. One variation is to use six sticks and 10 game tokens. The scoring is as follows:

1. If all six sticks land on the colored side, the player takes three tokens.

2. If all six sticks land on the plain side, the player takes three tokens.

3. If three are plain and three are colored, the player takes one token.

4. If any other combination comes up, the player gets no tokens.

Players can take tokens from each other when none are in the middle. The winner is the person who collects all the tokens. The probability for this game is more difficult to determine.

Evaluation

Made a frequency table showing their tosses.	5 points
Made a tree diagram.	5 points
Wrote the sample space.	5 points
Calculated the theoretical probability.	5 points
Made a fair scoring system.	5 points

There are many versions of this game online. One version can be found at **http://educ.queensu.ca/~fmc/april2003/NativeAmericanGame.html**.

Name _____

Native American Stick Game

This game is based on a Native American game of chance. In the original game, sticks were 25 cm or about 10 inches long and carved with intricate designs.

How to Play

1. Decorate one side of four sticks using either symmetrical designs or Native American glyphs. Examples can be found online at **http://www.WesternReservePublicMedia.org**.

2. Play the game in groups as directed by your teacher. Put 12 game tokens at the center of your group.

3. Decide on how many points each possible toss will get. The possibilities are

    a. All four sides are the same – four colored or four plain   _____ points

    b. Two are plain and two are colored   _____ points

    c. Three sides are the same (colored or plain)   _____ points

4. Toss your sticks up and see what sides are facing up when they land on the table. Take as many tokens from the center as you decided above. If there are not enough, you can take them from someone else in your group. Keep track of your tosses.

5. The winner is the person who gets all of the tokens.

Event	Tally	Frequency	Probability*	Percent
4 sides alike				
Two plain- two colored				
3 sides colored or plain				

*Remember: Probability is the event divided by the total. For example, when tossing a coin, P(heads) = $\frac{1}{2}$.

Let's figure theoretical probability.

1. Make a tree diagram that shows this problem.

2. Write the sample space.

3. What would a fair point system be?

Overview

Students learn about the difference and relationship between theoretical and experimental probability through several activities, including a game and an area model.

Objective

Students will be able to compute and describe theoretical probabilities for an event.

Standards Addressed

Mathematics — Data Analysis

Grade 5

Probability, Benchmark J

10. Compare what should happen (theoretical/expected results) with what did happen (experimental/actual results) in a simple experiment.

Probability, Benchmark K

11. Make predictions based on experimental and theoretical probabilities.

Grade 6

Probability, Benchmark K

07. Design an experiment to test a theoretical probability and explain how results may vary.

Grade 7

Probability, Benchmark K

08. Make predictions based on theoretical probabilities, design and conduct an experiment to test the predictions, compare actual results to predicted results, and explain differences.

Grade 8

Probability, Benchmark H

10. Calculate the number of possible outcomes for a situation, recognizing and accounting for when items may occur more than once or when order is important.

Materials

- Game tokens

Procedure

1. Give students the Checkout Game Directions handout, along with the game board. After reviewing the rules, divide the class into teams of two and hand out game tokens. Have students play the game four times. Discuss frequency tables and have them record their data on the Frequency Table handout as they play the game.

2. Give the students the Area Model worksheet to complete as a class or individually. Ask them to use this information and play the checkout game two more times with the same partner and add the outcomes to their frequency tables.

3. Have students figure experimental probability of various outcomes for their games. Have them compare with their partner from previous rounds. Combine all results to get class experimental probability of at least one outcome. Discuss how the greater the number of trials, the closer the experimental probability will be to the theoretical probability.

Evaluation

Evaluate the student handouts.

Name _____

The Checkout Game

Music Mart											
1	2	3	4	5	6	7	8	9	10	11	12

Parking Lot

The Sound Store											
1	2	3	4	5	6	7	8	9	10	11	12

The Checkout Game
Directions

This is a two-player game. Each player receives 12 game tokens representing music CDs. Each player places the tokens in any of the checkout aisles marked 1-12 in the store on his/her side of the board. Choose any of the aisles you desire, putting any number of tokens on a space as you would like.

Take turns rolling two dice. On each roll, determine the sum of the dice. If you have CDs in that numbered checkout aisle, move **one** CD to the parking lot. The winner is determined by the first player to have all of their CDs in the parking lot.

Problem: What is the best arrangement for the CDs?

Name _____

Experimental Probability
Sums — rolling two dice

Frequency table		Percent
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Name _____

Area Model
Possible Sums With Two Dice

1st die

+	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

2nd die

Prob(2)=

Prob(3)=

Prob(4)=

Prob(6)=

Prob(7)=

Prob(8)=

Prob(9)=

Prob(10)=

Prob(11)=

Prob(12)=

Prob(even sum)=

Prob(multiple of 3)=

Prob(odd sum)=

Prob(sum $\geq$ 5)=

Prob(sum < 7)=

Name _____

The Checkout Game: What Did You Learn?

1. Did you change the placement of your CDs after playing The Checkout Game several times? Explain why or why not.

2. Did you change the placement of your CDs after making the area model of all the outcomes for the sum of the two dice? Explain why or why not.

3. Suppose you roll a pair of dice 100 times. How many times would you expect to get the following?

    - A sum of six? _____

    - a sum of one? _____

    - a sum of 11? _____

    - a sum greater than seven? _____

    - a sum less than seven? _____

    - an odd sum? _____

    Explain how you found the answers to these questions.

4. Was there anything that you found surprising in The Checkout Game? What was it?

5. Write a note to a friend on the back of this sheet. Explain the game to your friend. Tell your friend what you think is the best placement for the 12 CDs and why.

Area Models or Geometric Probability

Overview

Students toss coins and then use mathematical reasoning to determine if a geometric game board is fair. Then they work in partners to find theoretical probabilities of area models.

Outcome

Students will be able to calculate theoretical probability of area models by finding the ratio of wanted areas to total area.

Standards Addressed

Mathematics — Data Analysis

Grade 7

Probability, Benchmark I

07. Compute probabilities of compound events; e.g., multiple coin tosses or multiple rolls of number cubes, using such methods as organized lists, tree diagrams and area models.

Materials

- Pennies — enough for 20 per pair of students

Procedure

1. Begin the class with a discussion of games the students have played with other children. What does it mean to have a fair game? They should understand that each child would have an equal chance of winning, in other words, a 50-50 chance, or 50 percent probability of winning.

2. Divide students into pairs. Hand out the game board. One player will pick shaded and the other white. They will each toss 20 pennies onto the game board. If the majority of the penny lands on their color, they score a point. After 40 tosses, the player with the highest score wins.

3. As a class, record how many shades won and how many whites won. (There should be more whites.) Ask if the game is fair or rigged. This should promote discussion. By dividing the grid into one-sixteenths, they should see there are nine-sixteenths white areas and seven-sixteenths shaded areas. Write out the probability for the students, showing that white's probability is more than 50 percent and shade's is less than 50 percent, definitely unfair.

4. Discuss experimental vs. theoretical probability. In the long run, the player who picked white should always win, even if the experiment didn't show that.

5. After this initial discussion, hand out the second handout and have the students work in partners to calculate the probabilities of the area models.

6. **Extension:** Have the students create their own game boards. Ask for both a triangle and rectangle to be included. They can create both a fair and unfair game.

Answers for Penny Tossing Fools

1. P(shade) = 8/16 or ½ or .5

   P(white) = 8/16 or ½ or .5

2. P(red) = 1/25

   P(white) = 8/25

   P(blue) = 16/25

3 a. P(shade) = 17/36

  b. P(shade) = 6/18 or 1/3

4 a. P(white) = 7/16

  b. P(shade) = 9/16

Evaluation

All 9 correct	Clear evidence of understanding probability.
8-7 correct	Adequate evidence of understanding probability.
6-5 correct	Some evidence of understanding probability.
4-0 correct	Little evidence of understanding probability.

Penny Tossing Fools? Game Board
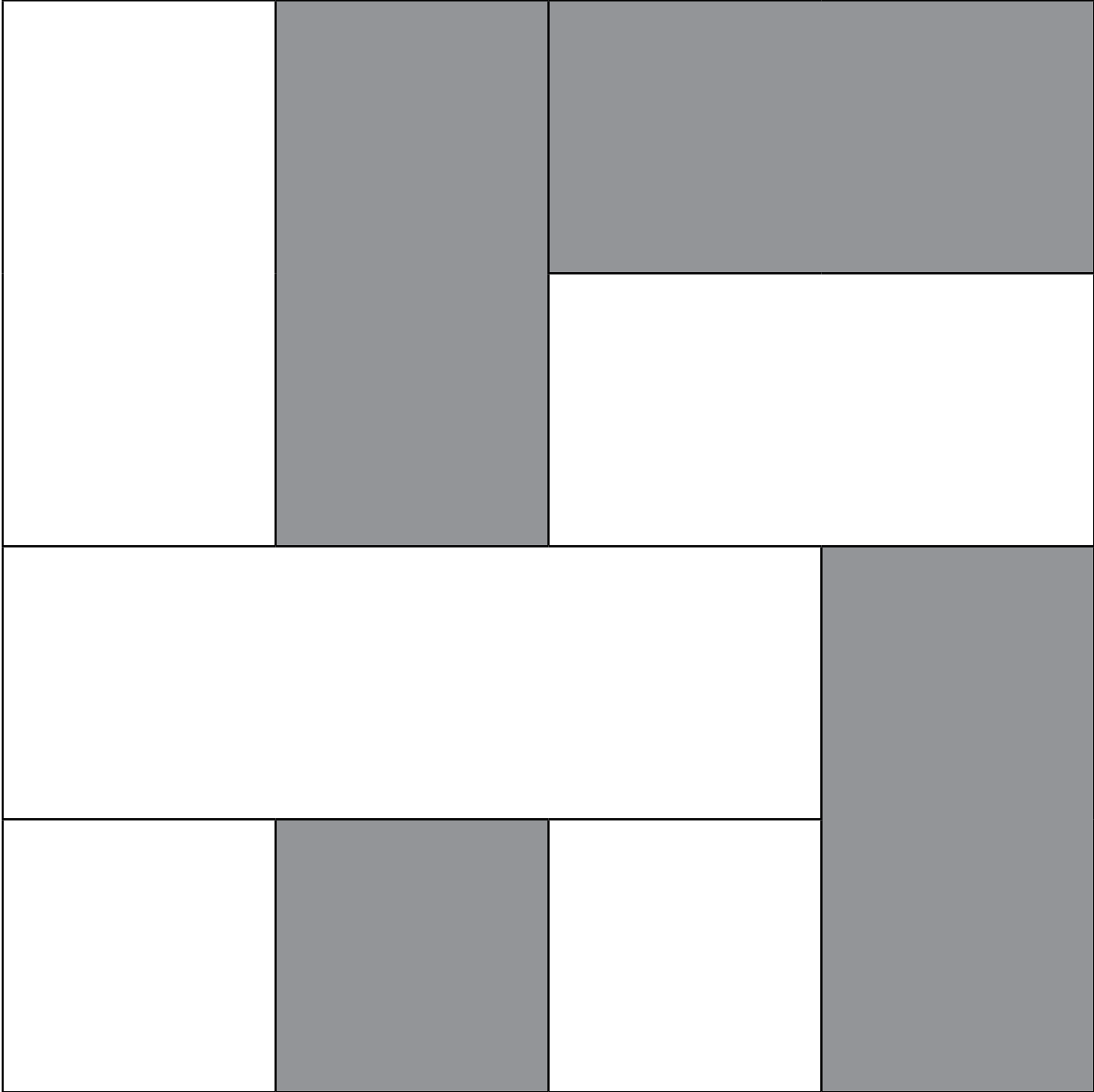
Name _____

Penny Tossing Fools?

1. Find the probabilities for this board. Is this a fair game? Explain.

   P(shaded)=_____   P(white)=_____
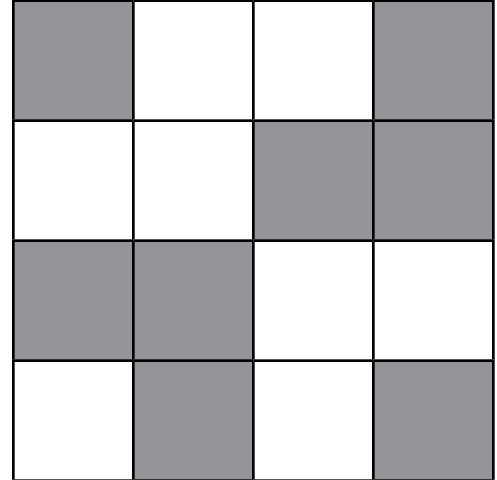
2. Find the probabilities for this board.

   P(red)=_____   P(white)=_____   P(blue)=_____

   If a penny lands in the red for a score of one point, how many points should a penny landing in the blue score equal to make the scoring fair?
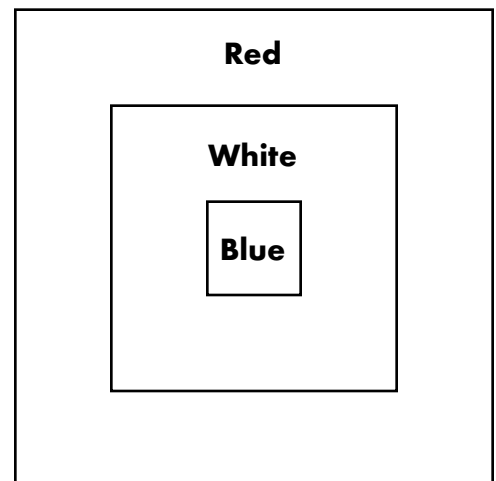
3. Find the probability the penny will land in the shaded areas:
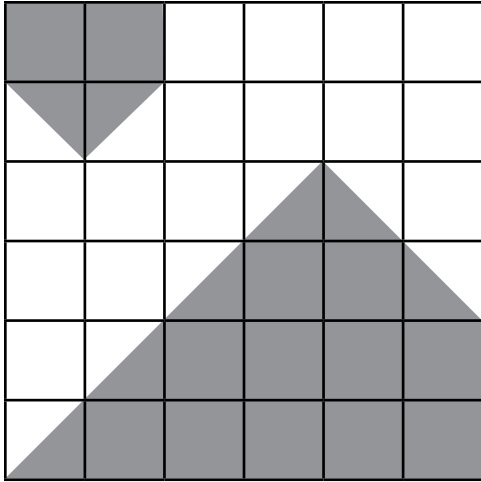
(a) P=_____
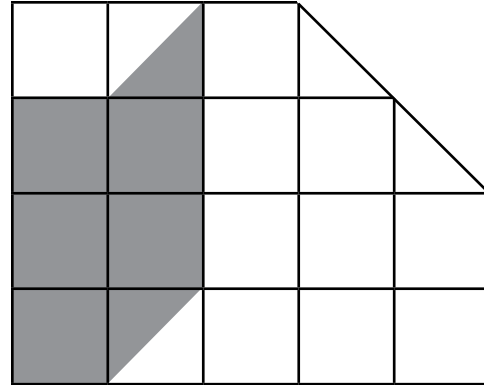
(b) P=_____

4. Find the probabilities for this game board.

P(white)=_____   P(shaded)=_____
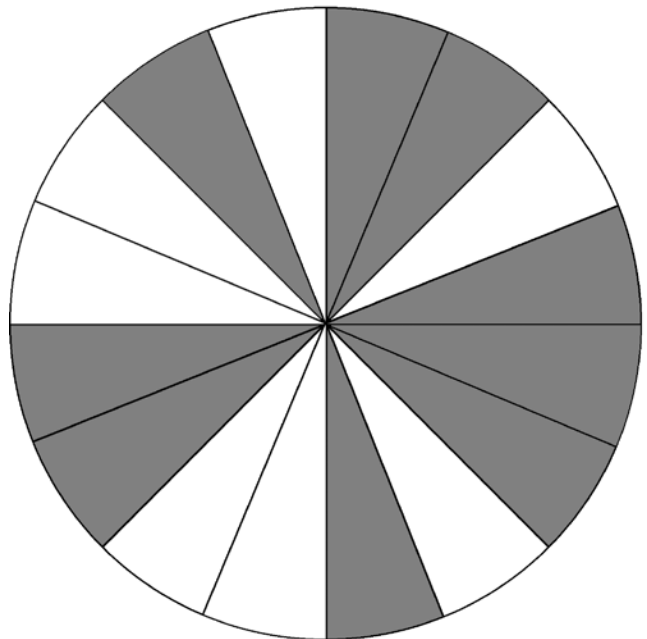
Resources

Categorical and Measurement Data
(Qualitative and Quantitative Data)

Categorical Data (Qualitative) — Categorical data identifies a class or category for an object or an observation based on some qualitative trait. (e.g. , gender, male and female, rankings like good or bad)

Measurement Data (Quantitative) — Measurement data has a numerical value based on quantitative data that could be placed on a number line.

How can you DISPLAY the different types of data?

Categorical	Measurement
Pie Graphs	Histograms
Bar Graphs	Stem-and-Leaf Plots
Picture Graphs	Dot Plots
	Line Plots
	Box-and-Whisker Plots
	Scatter Plots (two variables)

How can you analyze the different types of data?

Categorical	Measurement
Counts	**Measures of Center** — mean, median, mode, mid range
Percents	**Measures of Spread** — range, standard deviation, interquartile range
	Prediction (sometimes)

Discrete and Continuous Data

Discrete data is data that can be counted. (You can't have a half a person).
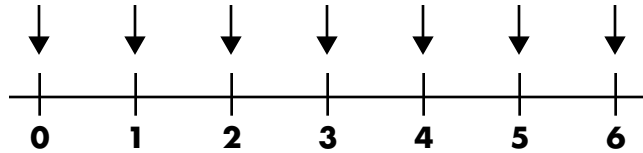
If your data shows that you have six red cars, seven blue cars and three white cars, you can put six, seven and three on a number line. However, if you were graphing it, the data is car color, therefore it is categorical data. The axis would show blue, red and white, not the numbers. The number would be shown on the vertical axis of a graph.

Continuous data can be assigned an infinite number of values between whole numbers.
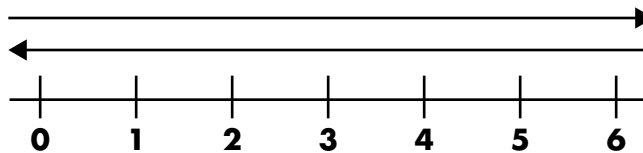
Examples

Discrete Data	Continuous Data
Unpopped kernels of popcorn in a bag	Age
Class size	Weight
Family size	Height
Calories in a hamburger	Time it takes to get to school
	Temperature
	Grade-point average
	Calories in a hamburger

Excel XP/2003

Naming the Cells

- Use letter and number

Cursors

- Fat Plus Sign – takes you to the cell you want (click and drag to get multiple cells)

- Skinny Plus Sign – allows you to copy (called autofill)

- Arrow – moves the cell(s) to a different location

- Line with two arrows (must be on the line between letters and numbers) increases the cell size

Alignment

- Numbers to the right

- Letters to the left

Highlighting

- Click on a number on the left to highlight an entire row

- Click on a letter on the top to highlight an entire column

- Click in the corner box to highlight the entire worksheet

To Insert Rows, Columns or Sheets

- Go to **Insert**

- Select row, column or worksheet

To Merge Columns and Center

- Highlight item

- Select [icon] to center the entry

To Undo

- Select the **Undo** button [icon] and continue to press it until you get to the place you want to be

Selecting Noncontiguous Cells

- Select one, hold the **Control** key down and select another to highlight both

Formulas

- **Always** start with an equal sign

- ∑ means summation. The default is to add vertically. Be careful to highlight anything that you want to add horizontally.

- ƒ**x** is the button that gives you the menu of formulas that you might want to use and is directly in front of the formula bar.

- **$** changes entries to dollars

- **%** changes entries to percents

- [icon] increases or decreases the number of decimal places

- [icon] moves blocks of text to the left or to the right

- When inputting your own formula:

  - Start with =

  - Use ƒ**x** to get the name of what you want to use, or just click on the cell to input the cell location

  - Put cell name where you want the computation to start–then a colon- and then the cell name where you want the computation to end. (e.g. =SUM(A1: A7) This will add all of the row from cell A1 to cell A7)

- To keep a number in the same place for a formula (such as when computing a percent):
    - You need to use an **Absolute Reference**, so put a **$** before both the letter and the number of the cell you wish to keep (e.g. **A5/A8**)
    - This will divide the number in cell A5 by A8
    - It will also divide other numbers by A8

Spell Check

- Click the button that looks like this ✓ to check your spelling

Formatting

- Select **Format**
    - **Cells** lets you change the format of individual cells or rows or columns of cells
    - Select **Rows**, **Columns** or **Sheet** and then select what you would like to do
    - Select **AutoFormat** to change the entire worksheet to the style you would like

Printing

- If you only want a section of the spreadsheet to print, highlight the section
- Go to **File**, **Print Area** and then **Select Print Area**
- If you want to center your spreadsheet when you print it, go to **File** and then **Page Setup**
- Select **Margins** and at the bottom of the sheet, select **Vertically** and **Horizontally** and then select **OK**
- If you want your sheet to go on the horizontal layout, select **File** and then **Page Setup**
- Select **Page**, and then **Landscape**.
- If you want the gridlines to show, go to **Page Setup**. Select **Sheet** and then select **Gridlines**

To Insert a Picture

- Go to **Insert**
- Select **Picture**
- Select **ClipArt** or **From File**, depending upon where the picture you want is located.
- Select the picture you want
- Select the top button and close the **ClipArt** page.

To Put in a Border

- Go to the button that looks like this.
- Select the arrow at the right and then select the border you want to use.
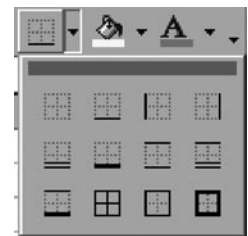
Making a Chart

- Select the Chart icon
- Follow the steps of the wizard

Changing Your Chart

- Select the part of your chart you would like to alter and right-click on it
- Select **Format Chart Area** or **Format** and make changes
- Select **Fill Effects** for many variations
- If the legend reads **Series** and you want to change it to reflect what is on your graph, select **Chart**, **Source Data** and then **Series**

Graphs and Plots
Bar Graphs

You would use bar graph for the following reasons:

- They are easy to make.

- They organize data so information is easily understood.

- They show each bar representing counts for a category .

- They show that the length of the bar represents the percent of the total that falls into that category.

This is how to make a bar graph:

1. Determine if you want to make a horizontal or vertical bar graph.

2. Make two axes:

    a. In a horizontal bar graph, the horizontal line (the x-axis) represents the individual categories and the vertical line (the y-axis) represents the scale.
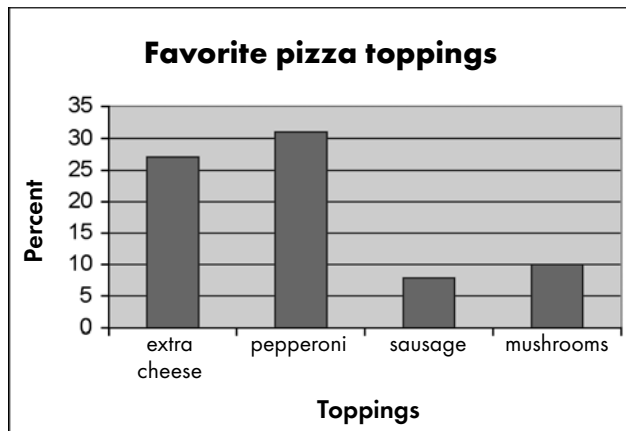
Favorite pizza toppings:

extra cheese 27

pepperoni 31

sausage 8

mushrooms 10

b. In a vertical bar graph, the horizontal line (the x-axis) represents the scale and the vertical line (the y-axis) represents the individual categories.

Favorite pizza toppings
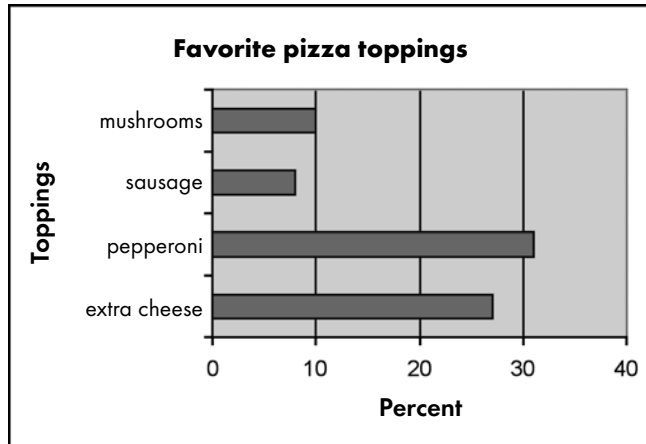
Favorite pizza toppings:

extra cheese 27

pepperoni 31

sausage 8

mushrooms 10

3. Be sure that the axes are labeled.

4. Be sure the axes have consistent intervals (that the intervals are all equal).

5. Be sure the graph has a title.

Graphs and Plots
Box-and-Whisker Plot

You would use box-and-whisker plots for the following reasons:

- They are good for large data sets (values of at least 15).

- They give the five key data points: maximum, minimum, median, upper quartile and lower quartile.

- They can compare two or more data sets.

- They show the similarities and differences among plots.

- They show outliers.

- They can be used to compare sets with different number of data points.

This is how to make a box-and-whisker plot:

1. Organize the data in sequential order. You can use a stem-and-leaf plot or arrange data from largest to smallest.

2. Determine the summary values — maximum, minimum, median, upper quartile, and lower quartile.

3. Make a number line with consistent intervals.

4. Construct the box-and-whisker plot:

    a. Put in the mean and the upper and lower quartile. Make this into your box.

    b. Determine if there are outliers by subtracting the lower quartile from the upper quartile. Multiply this amount by 1.5, subtract that amount from the lower quartile and add it to the upper quartile. If there are points that are beyond these values, make stars at those points to indicate outliers.

    c. Make whiskers from the LQ and UQ to the extremes.

    d. Label your plot.

5. If you are comparing plots, be sure that you use one number line.

The data: Math test scores 80, 75, 90, 95, 65, 65, 80, 85, 70, 100

Write the data in numerical order and find the first quartile, median, third quartile, smallest value and largest value.
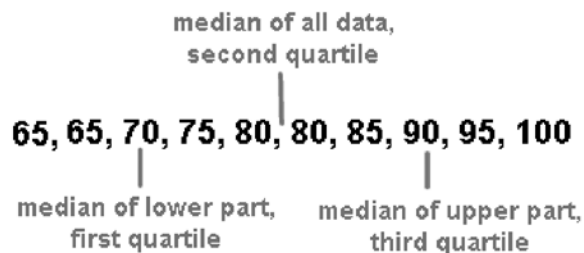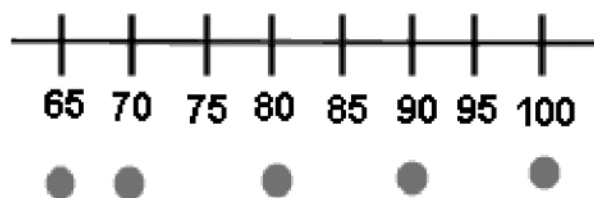
Median = 80

Lower quartile = 70

Upper quartile = 90

Minimum value = 65

Maximum value = 100

median of all data,
second quartile

65, 65, 70, 75, 80, 80, 85, 90, 95, 100

median of lower part,
first quartile

median of upper part,
third quartile

Place a circle beneath each of these values on a number line.

65 70 75 80 85 90 95 100

Draw a box with ends through the points for the lower and upper quartiles. Then draw a vertical line through the box at the median point. Now, draw the whiskers (or lines) from each end of the box to the smallest and largest values.

Math Test Scores

65 70 75 80 85 90 95 100
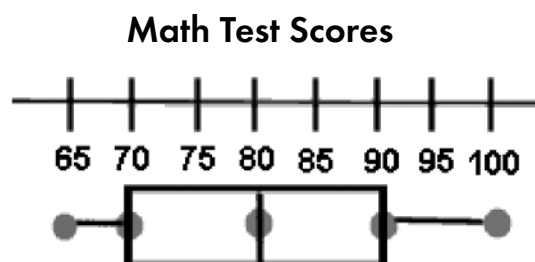
Graphs and Plots
Circle Graphs or Pie Charts

You would use circle graphs for the following reasons:

- They are easy to read because each piece of the pie represents a percentage of the whole.

- They use the concepts of calculating percents and measuring using degrees, both essential math skills.

- They show the whole as being 100 percent.

This is how to make a circle graph:

1. Change each of the data values into a decimal and a percent by dividing the part by the total.

2. Convert decimals to degrees by multiplying 360° by the decimal value.

3. Using the center of your circle, draw one radius.

4. Put the foot of your protractor on the radius with the center point of the circle touching the center foot of the protractor.

5. Measure the number of degrees for the first data point and draw a line.

6. Continue this process until all of the segments are drawn.

7. Label the segments or make a key for the graph.

Mr. Jordon surveyed his class about their favorite sport. Here are the results.

Baseball	Basketball	Soccer	Football	Wrestling
10	5	5	6	2

Favorite Sport

Wrestling 7%
Football 21%
Baseball 36%
Soccer 18%
Basketball 18%

Key: Baseball, Basketball, Soccer, Football, Wrestling
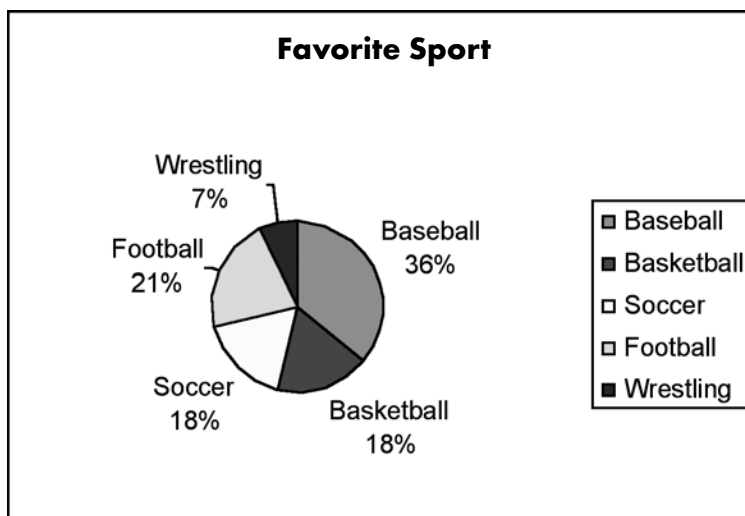
Graphs and Plots
Histograms

You would use a histogram for the following reasons:

- They are a kind of bar graph.

- They are easy to make.

- They organize data so information is easily understood.

- They show that each bar represents an interval of data for a category.

- They show that the length of the bar represents the amount of the total that falls into that category.
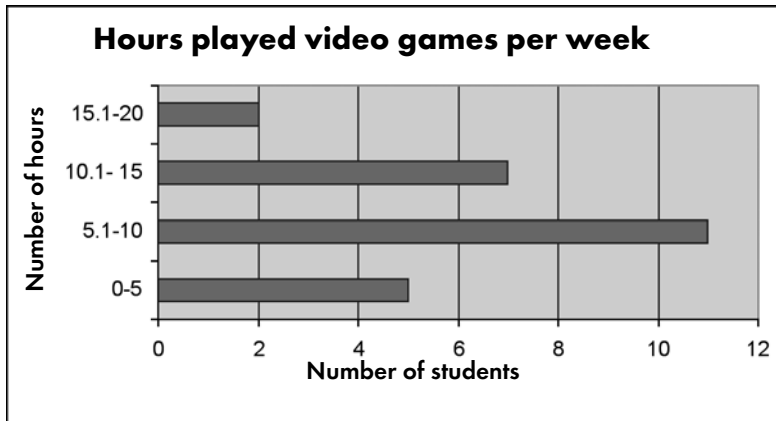
This is how to make a histogram:

1. Determine if you want to make the bars be horizontal or vertical.

2. There will be two axes.

   a. In a horizontal histogram graph, the horizontal line (the x-axis) represents an interval of data in a category and the vertical line (the y-axis) represents the scale.
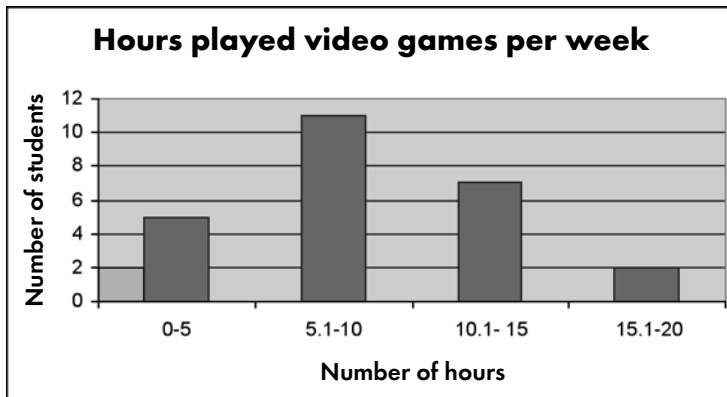
Hours students in Ms. Mastro's class played video games per week:

1, 2, 2, 3, 5, 6, 7, 7, 7, 8, 8, 9, 9, 9, 10, 10, 11, 12, 14, 14, 15, 15, 15, 17, 19

b. In a vertical histogram graph, the horizontal line (the x-axis) represents the vertical line (the y-axis) represents an interval of data in a category.

Hours played video games per week

Number of hours (y-axis): 15.1-20, 10.1-15, 5.1-10, 0-5
Number of students (x-axis): 0, 2, 4, 6, 8, 10, 12

Hours students in Ms. Mastro's class played video games per week:

1, 2, 2, 3, 5, 6, 7, 7, 7, 8, 8, 9, 9, 9, 10, 10, 11, 12, 14, 14, 15, 15, 15, 17, 19

3. Label the axes.

4. Make sure that the axes have consistent intervals (that the intervals are all equal).
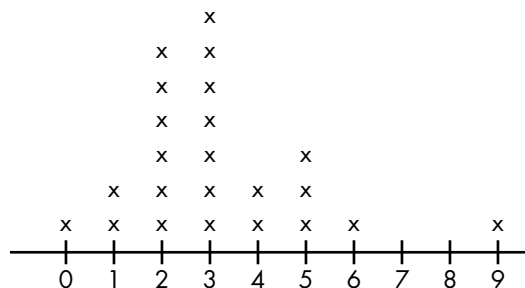
5. Put a title on your graph.

Graphs and Plots

Line Plots

You would use line plots for the following reasons:

- They are easy to read

- They are easy to make

- They are best when you have fewer than 25 points

- They can be turned into histograms

- They show the following information:

    - **Clusters** — isolated groups of points

    - **Gaps** — large spaces between points

    - **Outliers** — data values that are substantially bigger or smaller

    - **Variability** — how spread the data is

This is how to make a line plot:

1. Gather data.

2. Determine the highest and lowest values.

3. Make a number line showing consistent intervals.

4. Put x's or some symbol above the line to show a data point.

5. Use a code or abbreviation to recognize different data categories, if so desired.

```
                    x
            x       x
            x       x
            x       x
            x       x           x
        x   x   x   x   x
    x   x   x   x   x   x   x               x
    |———|———|———|———|———|———|———|———|———|
    0   1   2   3   4   5   6   7   8   9
```

Cookies eaten at a party

Graphs and Plots
Scatter Plots

You would use a scatter plot for the following reasons:

- They organize data using bivariate data (two variables).

- They are similar to coordinate plane graphing.

- They show association between the variables being graphed:

    - Positive association-Points show a trend of moving up an to the right

    - Negative association-Points show a trend of moving down and to the right

    - No association-Points show no trend

- Need to stress the difference between association and causation.

- They show clusters and outliers.

- You can use time on either axis, but it is generally the independent variable and is on the x-axis.

- In time-series plots, you may connect points.

You would use lines on a scatter plot for the following reasons:

- The line divides the plot into two regions by using a 45° line called the y = x line.

- The line distinguishes characteristics between points on, above, or below the line.

- The line can be used to make predictions, especially for algebraic equations of lines, slopes, intercepts, etc.
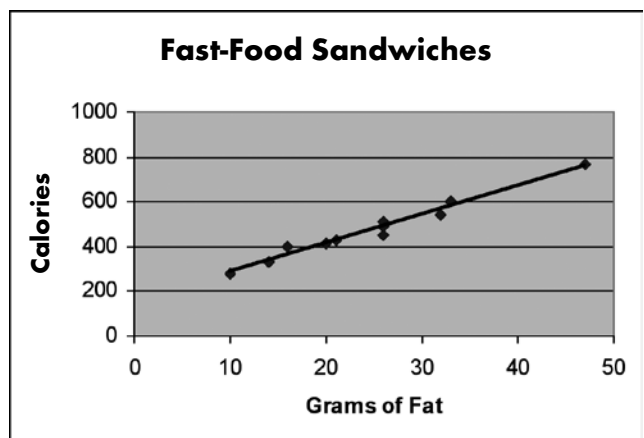
This is how to make a median fit line:

1. Count the total number of points.

2. Draw two vertical dashed lines so there are approximately the same number of points in each of the three sections. The outer strips should have the same number of points if possible.

3. Find the median point both vertically and horizontally and put a vertical line and a horizontal line at that point, forming an x.

4. Decide whether or not the three x's lie close to a straight line. Use your ruler to help you decide.

5. Place your ruler so that it connects the two x's in the outside strips. Now slide the ruler one-third of the way to the middle x and draw the line.

Information About Fast-Food Sandwiches

Sandwich	Fat grams	Calories
Hamburger	10	280
Cheeseburger	14	330
Double cheeseburger	26	490
Grilled chicken sandwich	16	400
Fish sandwich	20	410
Quarter-pound hamburger	21	430
Quarter-pound hamburger with cheese	47	770
Spicy chicken sandwich	26	450
Fried chicken sandwich	26	510
Deluxe double burger	32	540
Deluxe double burger with cheese	33	600

Fast-Food Sandwiches
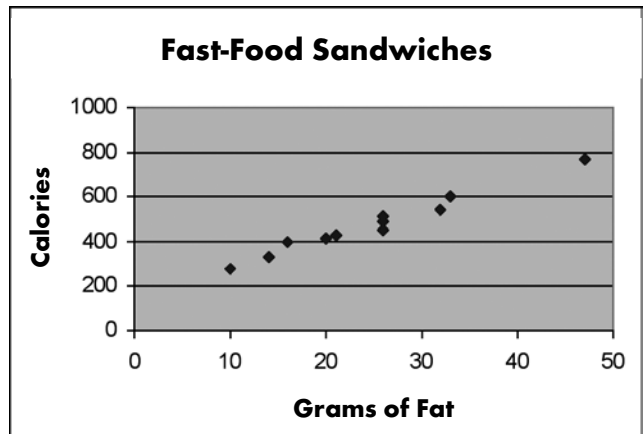
**Scatter plot with LINEAR trend line**

Fast-Food Sandwiches

To make a median fit line on your graphing calculator

- Go to **Stat**

- Select **Calc**

- Select **Med-med** or **#3**

- **Second List1** (using the list you want to use)

- **Comma**

- **Second List2** (using the list you want to use)

- **Enter** (You'll get the line information on the screen)

- Go to **y=** (select the "y" you want to use)

- Go to **Vars**

- Select **Statistics** or **#5**

- Arrow over to **EQ**

- **RegEQ** will be highlighted so **Enter**

- Then hit **Graph** (make sure your window has been set)

Graphs and Plots

Scatter Points
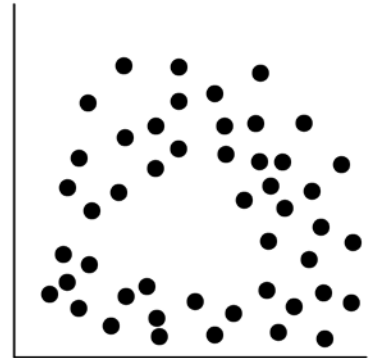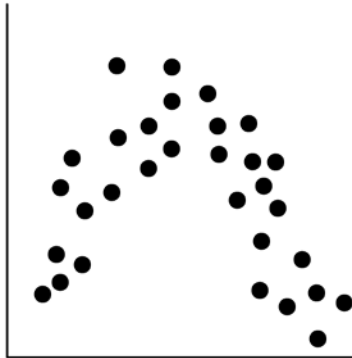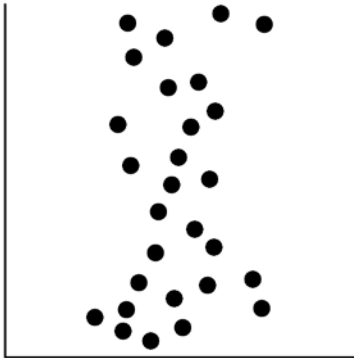
No linear correlations
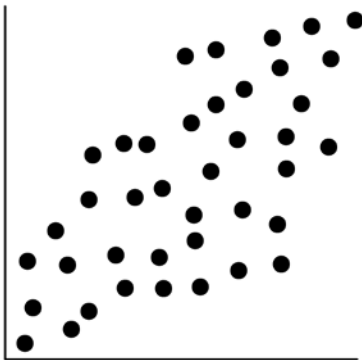
Weak positive linear correlations

Weak negative linear correlations

Strong positive linear correlations
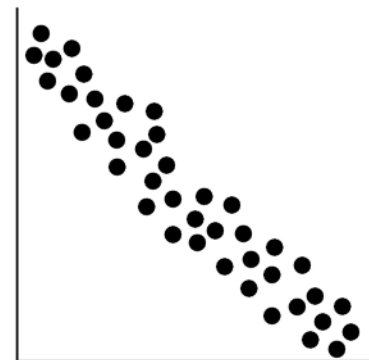
Strong negative linear correlations

Graphs and Plots
Stem-and-Leaf Plots

You would use stem-and-leaf plots for the following reasons:

- They are easy to make.

- They are best with values greater than 25.

- They retain the original data.

- They have several variations:

  - Back-to-back

  - Spread out

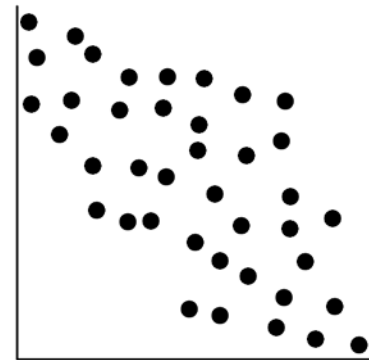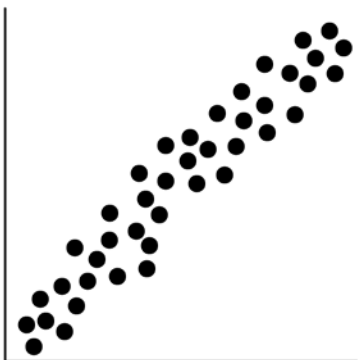 - Truncated or rounded

- They allow easy identification of the largest and smallest values, clusters, gaps and outliers.

This is how to make a stem-and-leaf plot:

1. Find the smallest and the largest values.

2. Determine the stems and write them vertically on the left.

3. Add the leaves.

4. Arrange the leaves in order from smallest to largest.

5. Make a legend.

Fat Content in Grams for Fast Food

Fat Content in Grams in Fast-Food Breakfasts		Fat Content in Grams in Fast-Food Sandwiches	
Breakfast meal	39	Mega hamburger with cheese	26
Double bacon and egg English muffin	23	Double hamburger with cheese	24
Bacon and egg English muffin	18	Big burger	21.5
Pancakes with syrup	16	Double cheeseburger	21
Hash browns	15	Spicy chicken sandwich	20
Bacon roll	14	Vegetable sandwich	18
Egg and English muffin	12.5	Chicken sandwich	17
		Cheeseburger	12
		Hamburger	7.5

Fat Content in Grams in Fast-Food Breakfasts

Stems	Leaves
1	2, 4, 5, 6, 8
2	3
3	6

A stem-and-leaf plot shows the shape and distribution of data. In the legend, |2|3 means 23. A Double Bacon Egg McMuffin has 23 grams of fat. The numbers 12, 14, 15, 16 and 18 are from the row with a stem of 1. It can be clearly seen in the diagram above that the data clusters around this row. 2|3

Back-to-Back Stem-and-Leaf Plots

If you are comparing two sets of data, you can use a back-to-back stem-and-leaf plot.

Fat Content in Grams in Fast Food

Fat Content in Grams for Breakfasts	Stems	Fat Content in Grams for Sandwiches
	0	7
8, 6, 5, 4, 2	1	2, 7, 8
3	2	0, 1, 1, 4, 6
6	3	

In the Fat Content for Sandwiches column, |6|3 means 36. The three represents the tens place (the stem) and the six represents the units place (the leaf). A Big Breakfast has 36 grams of fat. In the row with a stem of 1, the numbers are 12, 14, 15, 16 and 18. This diagram clearly shows that there are data clusters around the rows with stems of 1 and 2.

Graph Paper
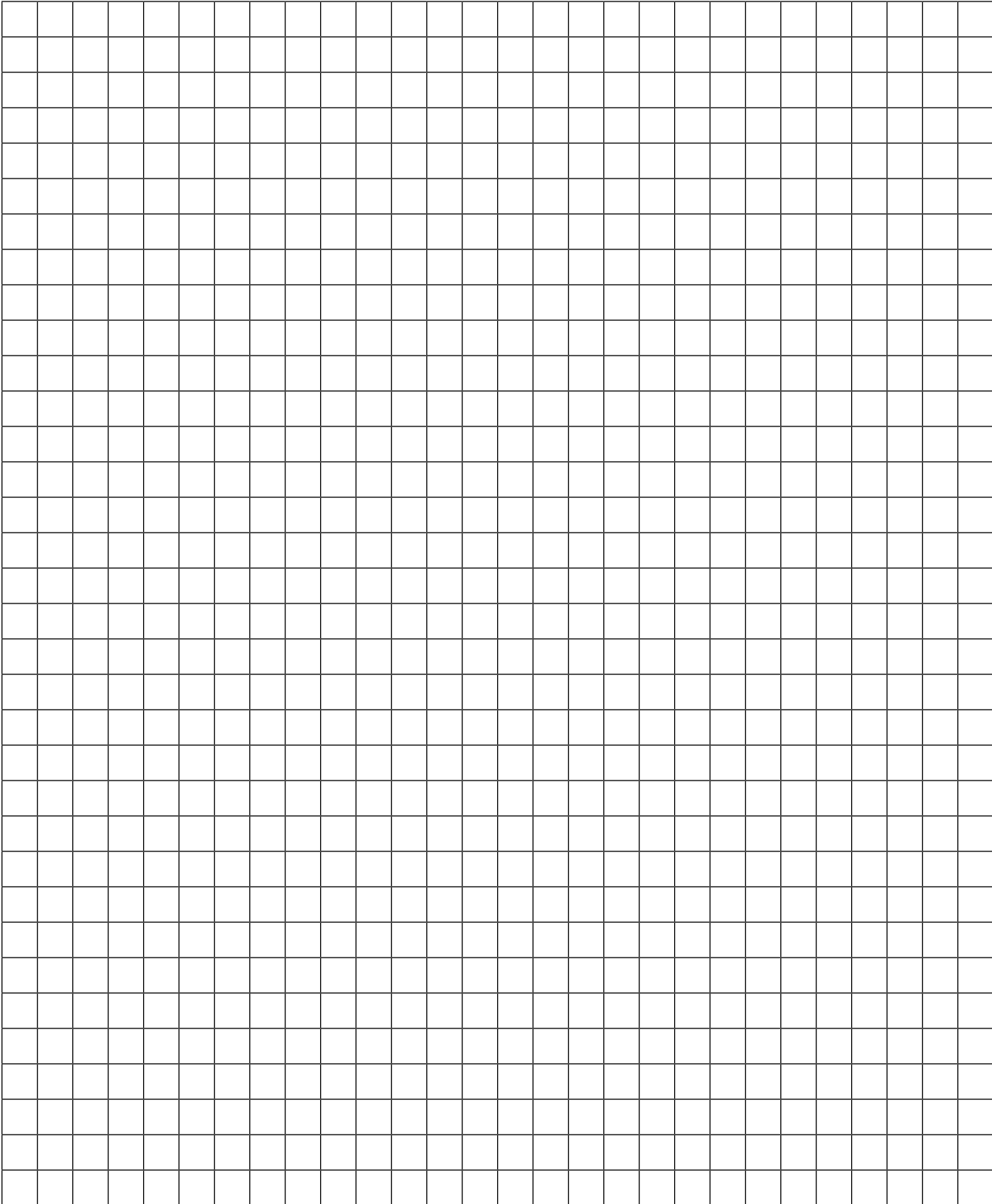
Selecting a Sample

When you get a blood test, does the nurse take out all of your blood and look at it? (All of your blood would be the population of blood.) Obviously, they take a sample. Do you have to drink all of the milk in a gallon to see if it is spoiled? Once again, it is logical to just take a small sample to get the information that you need.

If you are doing a project and don't want to work with the entire population, you too can use a sample of the population. While it is true that anyone who is part of the population can be asked to participate, the only way your project will get accurate information is if you randomly select people to be involved. If you want to know the favorite sport in school and your sample all comes from the wrestling team, will the answer to your question really reflect the favorite sport of the population?

A **random sample** means that everyone in the population has an equally likely chance of being selected. Let's pretend that you want to compare the number of hours each grade works on homework. Here are some ways you might get a random sample.

- Go to the cafeteria and ask the person at the left corner seat of every table their grade and the average number of hours they do homework each day.

- Give every student a number. Write the numbers on a paper and randomly select the numbers of students to participate. You could also use a random number table or a graphic calculator or computer to generate a list of random numbers

What other ways might you get a random sample?

The most difficult question is how many should be included in the sample? There is a method based on the Central Limit Theory that can tell you about how big your sample should be, but for our purposes, we will say that you don't want your sample to be too small. If you have a question about sample size, you may want to ask your teacher to help you determine the number of people you should use in your project.

There is generally some error if you are conducting an experiment or a survey. This is called sampling error and the amount of error is generally told to you when you read about the project. The bigger your sample, the less error you should expect. For example, a survey might say that 55 percent of the people in the U.S. have football as their favorite sport (with a sampling error of ±3 percent. This means that the real number is between 52 percent (55 - 3) and 58 percent (55 + 3).

TI-84 Graphing Calculator

Some Tips

- **Second Quit** takes you to the home screen

- **Second Enter** replays your earlier steps on your home screen

- **Second 0** gives you a catalog of commands

To Clear the List

- Arrow up to list name

- Hit **Clear**

- Hit **Enter**

To Make a Plot

- Enter the data by going to **Stat** and **Edit**

- Enter data and hit **Enter** key with each entry

- To make a graph:
  - Hit **Second**
  - Hit **Stat Plot**
  - Pick #1, #2 or #3
  - Turn it on
  - Select type of plot you want
  - Select list you want (the default puts List 1 as the x-axis)

- Set the **Window**

To See Specific Points

- Hit the **Trace** key to move around on the screen

To Get Statistics From One List

- Go to **Stat**

- Select **Calc**

- Select **1-var stat**

- Enter List name

To Get a Median Fit Line

- Go to **Stat**

- Select **Calc**

- Select **Med-med** or **#3**

- **Y=**

- Select **Vars**

- Arrow down to **Statistics** and **Enter** or Select **#5**

- Select **EQ (Equations)**

- Select **REG EQ (Regular Equation)** and **Enter** or Select #1

- Hit **Graph**

OR

- Go to **Stat**

- Select **Calc**

- Select **Med-med** or **#3**

- Hit **Second** and whatever columns you are going to use.

- Put a comma between entries and after the second entry.

- Hit **Vars**

- Select **y-vars and Enter**

- Select whichever function you want to use (e.g. y1)

- Select **Graph** (make sure you have the screen set correctly)

- Use **Zoom** and select **9** if necessary.

To Input a Formula

- Arrow up to the list name and write formula

  - Example List1 + List2

To Generate Random Numbers

- Select **Math**

- Select **PRB**

- Select **RandInt**(

- Insert starting number, ending number, and how many in each series, for example:

  - RandInt(1,100,5)

To Seed New Calculators for Random Numbers

- Pick a four-digit number

- Select **STO**

- Select **Math**

- Select **PRB**

- Select **rand**

- **Enter**

To Name a List

- Go to **Stat**

- Select **Edit**

- Arrow to the top of the list

- Right arrow to the right to **List** 7

- Make sure the cursor box has an A showing and type in name of list

- If no letter A is showing, go to **Alpha** and type in name of list

To Get a List Back That You Have Lost

- Select **Stat**

- Select **5—Set Up Editor**

To Use a Named List in a Formula

- While your cursor at any list name, Go to **Second List**

- Select the name you want to use.

To Use a Name You Have Given a List in a Plot

- Select **Second**

- Stat **Plot**

- Select **#1, #2**, or **#3**

- Where it says **xlist** or **ylist**, select **Second Stat**

- Arrow down to the list you named

- Select **Enter**

- Select **Graph**

To Delete a List Name You Have Entered

- Go to **Second** and then **Mem**

- Go to **Delete**

- Select what you want to delete by hitting **Enter**

- Be really careful with this. You could erase everything in the memory.

To Trace

- Use the left or right arrows (this goes in the order of putting them in)

- Select **Down Arrow** to go between two graphs on the screeen

To Link

- To send:

    - Choose **Second Link**

    - Select what you want to sent by hitting **Enter**

    - Select **Transmit**

    - Do not press **Enter** until your partner presses receive

- To receive:

    - **Second Link**

    - Select **Receive**

    - Hit **Enter** before the sender does.

    - Your calculator should display **Waiting**

    - After the sender hits **Enter**, select **Overwrite**

If You get an Error Message

- Check what you have turned on by going to y= and see what is highlighted

- Check your window

- Check to see if the same number of items in the lists you are using if you are making a scatter plot

APPS Button

- Go to the **APPS button** and select **Probability Simulation (#6)**

- Press any key and you get a menu that includes these choices:

    1. Toss Coins

    2. Roll Dice

    3. Pick Marbles

    4. Spin Spinner

    5. Draw Cards and Random Numbers

- Once you have selected a game, the line of blue buttons directly under the screen becomes active. For examples, in **Toss Coins**, the **y=** button allows you to escape, the **Window** button lets you toss one coin, the **Zoom** button tosses 10 coins, the **Trace** button tosses 50 coins and the **Graph** button clears the screen.

- If you see the word **Set** in any game, this lets you set the preferences.

Table of Random Numbers

7	1	1	0	1	0	1	1	2	9	4
9	5	8	6	8	8	9	0	3	9	0
3	0	7	2	7	3	5	2	3	3	6
8	4	0	7	0	6	2	6	4	0	6
0	7	1	3	0	7	3	9	1	3	1
7	0	5	8	0	1	6	7	3	7	2
7	4	9	2	6	8	3	4	0	1	1
5	2	2	1	7	2	7	8	3	2	8
3	7	9	1	7	7	5	0	2	1	3
6	2	1	0	1	7	9	8	5	4	9
9	4	5	9	0	1	4	5	8	4	9
7	1	8	4	5	7	7	8	4	5	0
6	1	5	0	3	0	1	9	7	9	4
4	6	0	4	8	7	3	6	2	2	0
9	5	0	1	3	6	6	9	1	1	9
2	9	2	9	2	6	4	1	1	8	1
8	0	9	2	7	5	7	0	3	0	5
4	7	4	2	0	5	1	7	9	6	4
3	5	7	2	8	7	1	6	6	8	6
6	8	0	9	1	2	7	7	7	5	5
1	8	8	6	6	2	0	5	2	9	6
6	9	0	6	7	0	6	8	6	3	0
4	1	7	5	8	6	7	5	1	6	1
4	9	0	0	1	3	2	7	2	9	1
9	3	9	1	8	1	7	4	5	7	1
9	6	8	0	3	7	7	2	7	9	7
7	1	0	5	4	8	1	1	4	8	2
3	6	7	8	1	3	2	6	6	1	2

Vocabulary

Association: The trend in a graph that shows the effect on one measure by a second measure.

Biased sampling: A sample that overrepresents or underrepresents part of the population.

Bar graph: A graph of data with parallel bars used for comparing information on categories where each bar represents a category and the height or length of the bar represents the number of events in that category.

Bivariate data: Data or events described using two variables.

Box-and-whisker plot: A diagram that shows pictorially the median and measures of spread (upper and lower interquartile ranges and the range) for one set of data.

Broken-scale symbol (⪜): Is used at the end of the axis to indicate that the graph does not begin at the origin (0,0).

Causation: The relationship between two variables where a change in one variable affects the outcome of the other variable.

Categorical data: Data that can be classified by type; e.g., color, types of dogs. These types of data are typically represented using bar chart, pie charts or pictographs.

Census: When every member of the population has data collected from them.

Clusters and gaps: Numbers that tend to crowd around a particular point in a set of values. The spaces between the clusters are called gaps.

Combination: A selection of a group of items or events from a set without regard to order; e.g., the number of three-piece outfits from the set of clothes in the closet.

Complementary events: Two or more *mutually exclusive events* that together cover all possible outcomes. The sum of the probabilities of complementary events is one.

Compound events: Combining two or more independent events or outcomes and considering it as one single event or outcome.

Conditional probability: The probability of an event occurring given that another event has already occurred. For example: What is the probability that the total of two dice will be greater than eight given that the first die is a six?

Continuous data: Data that can be assigned an infinite number of values between whole numbers, the assigned values are approximated; e.g., the size of the apples on an apple tree is continuous data. See *discrete data* for a counterexample.

Convenience data: Data that has been gathered with the group at hand.

Coordinate plane: A plane determined by the intersection of two perpendicular number lines in which any point can be located.

Coordinates: An ordered pair of numbers used to show a position on a graph. The first number (X) gives the place left or right and the second number (Y) gives the place up or down (X,Y).

Correlation: The relation between two sets of data, a positive or direct correlation exists when both sets vary in the same direction (both sets decrease); a negative or inverse correlation exists when one set of data increases as the other decreases.

Correlation coefficient: A measure of the *correlation* between two *variables* or sets of data. The value of the correlation coefficient, r, is always -1 to 1, where 1 is perfect positive correlation, 0 is no correlation, and -1 is perfect negative correlation.

Cumulative frequency: A running total of frequencies.

Datum: A single piece of data. The singular form of data.

Dependent events: A statement or probability for one event affects a statement or probability for another event.

Descriptive statistics: Gathered and described data using probability, statistical methods and concepts like graphs and measures of center.

Discrete data: Data that can be counted; e.g., the number of people in a town is discrete (there is no such thing as a fractional person). See *continuous data* for a counterexample.

Disjoint events: Two events that have no outcomes in common.

Dispersion: How data is spread out around some central point.

Distribution: A graph or table showing how many pieces of data there are in each class, or of each type.

Equation: A statement that shows two mathematical expressions that are equal to each other.

Event: An outcome of a probability experiment.

Experiment: The collecting of data through a planned investigation.

Experimental probability: The probability based on a series of trials. The experimental probability, P, can be found using the following equation:

$$P(event) = \frac{\text{\# of trials w/favorable outcomes}}{\text{number of trials in experiment}}$$

Experimental results: The outcome as a result of a probability experiment or test. These outcomes are sometimes called actual results.

Extrapolation: A term used in interpreting scatter plots that predicts the location of points extending beyond the data displayed.

Frequency: The number of times an occurrence takes place as expressed in a count. The count is the frequency.

Frequency distribution: A collection of data that represents the number of times a set of numbers, items or events has occurred.

Frequency table: A table that shows how often each item, number or range of numbers occurs in a set of data.

Geometric probability (area models): The probability that a random point is located in a particular part subregion or larger region.

Glyph: A picture that represents data.

Histogram: Shows how measurements spread out across a real number line, marked off in equal intervals. The height of the bar represents the frequencies of measurements contained in that interval.

Independent event: Two events in which the outcome of the first event does not affect the outcome of the second event.

Intercepts: The value of y on the *coordinate plane* where x = 0, called the y-intercept. The value of x on the coordinate plane where y = 0, called the x-intercept.

Interpolation: A term used in interpreting scatter plots that predicts the location of points that would lie between those points of the data already displayed.

Interquartile range: The difference between the upper quartile and the lower quartile.

Interval: The distance on a real number scale between two consecutive tick marks or the space between the two points.

Line of best fit: A line drawn in the midst of the points on a scatter plot in an attempt to estimate the mathematical relationship between the *variables* used to generate the plot.

Line plot: A graph that indicates the location of data points along a segment of the real number line.

Linear equation: An equation whose graph on a coordinate grid is a straight line.

Lower extreme: The lowest value in a set of data.

Lower quartile: When data is ordered from smallest to largest and divided into four quarters, the values that are in the lower quarter of the data.

Matrix: A rectangular array of numbers or symbols.

Measurement data (quantitative): Has a numerical value and could be placed on a number line.

Measures of center: Numbers that provide information about cluster and average of a collection of data. They include the *mean*, *mode* and *median*.

Measures of spread or variability: A term used to refer to how much numbers are spread, varied or dispersed in a set of data. They include range, quartile and interquartile range.

Mean: The sum of a set of numbers divided by the number of elements in the set.

Median: The middle number or item in a set of numbers or objects arranged from least to greatest, or the mean of the two middle numbers when the set has two middle numbers.

Mode: The number or object that appears most frequently in a set of numbers or objects.

Mutually exclusive events: Two events that cannot occur at the same time.

Negative association: A pattern in the shape of the data that shows when one measurement grows larger, the second measure grows smaller. A negative association will be slanted downward from left to right.

Odds of an event: The ratio of favorable outcomes to unfavorable outcomes.

Ordered pairs: A pair of numbers that gives the *coordinates* of a point on a grid in this order (horizontal coordinate, vertical coordinate). Also called paired data or paired coordinates.

Origin: The point on a coordinate plane where the x-axis and the y-axis meet and have the ordered pair (0,0).

Outcome: Any possible result of an activity or experiment.

Outlier: A data point in a sample widely separated from the main cluster of points in the sample.

Parallel box plots: Two or more box plots using the same number line to allow comparison of the data.

Population: A whole set of individuals, items or data from which a sample is drawn.

Permutations: Possible orders or arrangements of a set of events or items.

Positive association: The pattern in the shape of data that shows when one number gets larger, the second also gets larger. It will be slanted upward from the left to right.

Probability: The chance of an event occurring. The probability of an event is equal to the number of favorable outcomes divided by the number of possible outcomes.

Pictograph: The use of a repeat picture in a bar graph form, to represent data.

Quadrants: The four separate sections formed by the two axes of a coordinate system. These are identified as the first, second, third and fourth quadrants.

Qualitative data: Data that can be assigned qualities or categories. They are nonnumerical data.

Quantitative data: Data that are numerical. The data can be *discrete* or *continuous*.

Quartile: In conjunction with the median, the quartiles divide the set of data into four groups of equal size.

Random sample: A *sample* in which every event has an equal chance of selection and each event is chosen by a random process.

Random variable: A *variable* that takes any of a range of values that cannot be predicted with certainty.

Range: The difference between the greatest and the least numbers in a set of data.

Rank: Placing a numerical order according to scale or value.

Relative frequency: The number of times an event occurs divided by the total number of trials.

Sample: A set of data taken from a larger set used to create or test theories about the data as a whole.

Sample space: A list of all possible outcomes of an activity.

Sampling method: The process used to collect data; see *random sample*.

Scale: The regular intervals of the number line that are chosen to represent the full range of data on a graph.

Scatter plot: A graph with one point for each item being measured. The coordinates of a point represent the measure of two attributes of each item.

Simple event: A subset of the sample space that contains only one outcome that cannot be broken down into a simpler, more basic outcome.

Simulation: The study of probability by collecting mathematically appropriate data that models an actual event.

Slope of 1: A line that contains points where the abscissa (x value) and the ordinate (Y value) are equal. (The rise equals the run.)

Stem-and-leaf plot: A frequency diagram that displays the actual data together with its frequency, by using a part of the value of each piece of data to fix the class or group (the stem), while the remainder of the value is actually listed (the leaves).

Survey: A question or set of questions answered by a population of people.

Symbolic form: A representation of something using numbers and symbols.

Target population: The set from which a sample will be selected.

Theoretical probability: Identifying, using mathematical expectations, the number of ways an event could happen compared to all the events that could happen.

Theoretical results: The expected results given the *theoretical* probability of an event.

Tree diagram: A graphic representation that resembles the branching out of a tree. It is used to illustrate outcomes of an event.

Trend: An emerging pattern in the shape of a data display that can be seen on a scatter plot.

Univariate data: Having one *variable*.

Upper extreme: The largest value in a set of data; the maximum.

Upper quartile: When data is ordered from smallest to largest and divided into four quarters, the values that are in the upper quarter of the data.

Variable: A changing quantity, usually a letter in an algebraic equation or expression, that might have one of a range of possible values.

Variance: A measure of the *dispersion* of the *distribution* of a *random variable*.

Variants: A quantity whose value may change or vary.

X-axis: The horizontal axis on a coordinate grid.

Y-axis: The vertical axis on a coordinate grid.

Standards

Data Standards

Grade Four

03-04 Benchmark   **A.** *Gather and organize data from surveys and classroom experiments, including data collected over a period of time.*

Data Collection / Y2003.CMA.S05.G03-04.BA.L04.I01

    01. Create a plan for collecting data for a specific purpose.

        Doing a Data Project, p. 106

03-04 Benchmark   **B.** *Read and interpret tables, charts, graphs (bar, picture, line, line plot), and timelines as sources of information, identify main idea, draw conclusions, and make predictions.*

Data Collection / Y2003.CMA.S05.G03-04.BB.L04.I02

    02. Represent and interpret data using tables, bar graphs, line plots and line graphs.

        Interpreting Graphs Using CBR and Graphing Calculator, p. 13

Data Collection /Y2003.CMA.S05.G03-04.BB.L04.I05

    05. Propose and explain interpretations and predictions based on data displayed in tables, charts and graphs.

        Interpreting Graphs Using CBR and Graphing Calculator, p. 13

03-04 Benchmark   **C.** *Construct charts, tables and graphs to represent data, including picture graphs, bar graphs, line graphs, line plots and Venn diagrams.*

Data Collection / Y2003.CMA.S05.G03-04.BC.L04.I02

    02. Represent and interpret data using tables, bar graphs, line plots and line graphs.

        The Need to Use a Random Sample, p. 94

Data Collection / Y2003.CMA.S05.G03-04.BC.L04.I04

    04. Compare different representations of the same data to evaluate how well each representation shows important aspects of the data, and identify appropriate ways to display the data.

        Doing a Data Project, p. 106

        The Need to Use a Random Sample, p. 94

03-04 Benchmark   E.   *Describe data using mode, median and range.*

Statistical Methods / Y2003.CMA.S05.G03-04.BE.L04.I07

> 07. Identify the median of a set of data and describe what it indicates about the data.
>
> **Mean, Median, Mode and Range, p. 21**
>
> **The Need to Use a Random Sample, p. 94**

Statistical Methods / Y2003.CMA.S05.G03-04.BE.L04.I08

> 08. Use range, median and mode to make comparisons among related sets of data.
>
> **Mean, Median, Mode and Range, p. 21**

03-04 Benchmark   F.   *Conduct a simple probability experiment and draw conclusions about the likelihood of possible outcomes.*

Probability / Y2003.CMA.S05.G03-04.BF.L04.I09

> 09. Conduct simple probability experiments and draw conclusions from the results; e.g., rolling number cubes or drawing marbles from a bag.
>
> **An Introduction to Probability, p. 115**

Probability / Y2003.CMA.S05.G03-04.BF.L04.I10

> 10. Represent the likelihood of possible outcomes for chance situations; e.g., probability of selecting a red marble from a bag containing 3 red and 5 white marbles.
>
> **An Introduction to Probability, p. 115**

Probability / Y2003.CMA.S05.G03-04.BF.L04.I11

> 11. Relate the concepts of impossible and certain-to-happen events to the numerical values of 0 (impossible) and 1 (certain).
>
> **An Introduction to Probability, p. 115**

Probability / Y2003.CMA.S05.G03-04.BF.L04.I12

> 12. Place events in order of likelihood and use a diagram or appropriate language to compare the chance of each event occurring; e.g. impossible, unlikely, equal, likely, certain.
>
> **An Introduction to Probability, p. 115**

03-04 Benchmark   G.   *Identify and represent possible outcomes, such as arrangements of a set of up to four members and possible combinations from several sets, each containing 2 or 3 members.*

Probability / Y2003.CMA.S05.G03-04.BG.L04.I13

13. List and count all possible combinations using one member from each of several sets, each containing 2 or 3 members; e.g., the number of possible outfits from 3 shirts, 2 shorts and 2 pair of shoes.

Probability: Native American Game of Sticks, p. 127

Tree Diagrams, p. 118

Grade Five

05-07 Benchmark   A.   *Read, create and use line graphs, histograms, circle graphs, box-and-whisker plots, stem-and-leaf plots, and other representations when appropriate.*

Data Collection / Y2003.CMA.S05.G05-07.BA.L05.I01

01. Read, construct and interpret frequency tables, circle graphs and line graphs.

All About You Survey: Which Graph Is Best?, p. 54

Zodiac Circle Graphs, p. 45

05-07 Benchmark   C.   *Evaluate interpretations and conclusions as additional data are collected, modify conclusions and predictions, and justify new findings.*

Data Collection / Y2003.CMA.S05.G05-07.BC.L05.I05

05. Modify initial conclusions, propose and justify new interpretations and predictions as additional data are collected.

Interpreting Graphs Using CBR and Graphing Calculator, p. 13

05-07 Benchmark   D.   *Compare increasingly complex displays of data, such as multiple sets of data on the same graph.*

Data Collection / Y2003.CMA.S05.G05-07.BD.L05.I03

03. Read and interpret increasingly complex displays of data, such as double bar graphs.

A Variety of Graphs, p. 49

05-07 Benchmark   **E.**   *Collect, organize, display and interpret data for a specific purpose or need.*

Data Collection / Y2003.CMA.S05.G05-07.BE.L05.I02

02. Select and use a graph that is appropriate for the type of data to be displayed; e.g., numerical vs. categorical data, discrete vs. continuous data.

Bar Graphs, p. 41

Line Plots, p. 38

Types of Data: Categorical vs. Measurement and Discrete vs. Continuous, p. 27

A Variety of Graphs, p. 49

Wheel of Fortune: Line Plots, p. 35

Data Collection / Y2003.CMA.S05.G05-07.BE.L05.I04

04. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.

All About You Survey: Which Graph Is Best?, p. 54

Bar Graphs, p. 41

Doing a Data Project, p. 106

Line Plots, p. 38

Taking a Survey, p. 101

A Variety of Graphs, p. 49

Wheel of Fortune: Line Plots, p. 35

05-07 Benchmark   **F.**   *Determine and use the range, mean, median and mode to analyze and compare data, and explain what each indicates about the data.*

Statistical Methods / Y2003.CMA.S05.G05-07.BF.L05.I06

06. Determine and use the range, mean, median and mode, and explain what each does and does not indicate about the set of data.

Doing a Data Project, p. 106

Human Box-and-Whisker Plot, p. 67

Line Plots, p. 38

Mean, Median, Mode and Range, p. 21

Wheel of Fortune: Line Plots, p. 35

05-07 Benchmark H. *Find all possible outcomes of simple experiments or problem situations, using methods such as lists, arrays and tree diagrams.*

Probability / Y2003.CMA.S05.G05-07.BH.L05.I07

07. List and explain all possible outcomes in a given situation.

An Introduction to Probability, p. 115

Tree Diagrams, p. 118

05-07 Benchmark I. *Describe the probability of an event using ratios, including fractional notation.*

Probability / Y2003.CMA.S05.G05-07.BI.L05.I08

08. Identify the probability of events within a simple experiment, such as three chances out of eight.

An Introduction to Probability, p. 115

Tree Diagrams, p. 118

Probability / Y2003.CMA.S05.G05-07.BI.L05.I09

09. Use 0,1 and ratios between 0 and 1 to represent the probability of outcomes for an event, and associate the ratio with the likelihood of the outcome.

An Introduction to Probability, p. 115

Tree Diagrams, p. 118

05-07 Benchmark J. *Compare experimental and theoretical results for a variety of simple experiments.*

Probability / Y2003.CMA.S05.G05-07.BJ.L05.I10

10. Compare what should happen (theoretical/expected results) with what did happen (experimental/actual results) in a simple experiment.

Experimental vs. Theoretical Probability: The Checkout Game, p. 131

Probability: Native American Stick Game, p. 127

05-07 Benchmark K. *Make and justify predictions based on experimental and theoretical probabilities.*

Probability / Y2003.CMA.S05.G05-07.BK.L05.I11

11. Make predictions based on experimental and theoretical probabilities.

Experimental vs. Theoretical Probability: The Checkout Game, p. 131

Probability: Native American Stick Game, p. 127

Grade Six

05-07 Benchmark   **E.**   *Collect, organize, display and interpret data for a specific purpose or need.*

Data Collection / Y2003.CMA.S05.G05-07.BE.L06.I02

            02.   Select, create and use graphical representations that are appropriate for the type of data collected.

                All About You Survey: Which Graph Is Best?, p. 54

                Bar Graphs, p. 41

                Doing a Data Project, p. 106

                Grades: Making a Histogram, p. 43

                Human Box-and-Whisker Plots, p. 67

                Line Plots, p. 38

                A Variety of Graphs, p. 49

                Wheel of Fortune: Line Plots, p. 35

                Zodiac Circle Graphs, p. 45

05-07 Benchmark   **F.**   *Determine and use the range, mean, median and mode to analyze and compare data, and explain what each indicates about the data.*

Statistical Methods / Y2003.CMA.S05.G05-07.BF.L06.I04

            04.   Understand the different information provided by measures of center (mean, mode and median) and measures of spread (range).

                Doing a Data Project, p. 106

                Human Box-and-Whisker Plots, p. 67

                Line Plots, p. 38

                Mean, Median, Mode and Range, p. 21

                Wheel of Fortune: Line Plots, p. 35

05-07 Benchmark   **G.**   *Evaluate conjectures and predictions based upon data presented in tables and graphs, and identify misuses of statistical data and displays.*

Statistical Methods / Y2003.CMA.S05.G05-07.BG.L06.I06

            06.   Make logical inferences from statistical data.

                Bar Graphs, p. 41

                Doing a Data Project, p. 106

                Line Plots, p. 38

                Labeling Graphs, p. 9

                The Need to Use a Random Sample, p. 94

                Wheel of Fortune: Line Plots, p. 35

| *05-07 Benchmark* | K. | *Make and justify predictions based on experimental and theoretical probabilities.* |

Probability / Y2003.CMA.S05.G05-07.BK.L06.I07

07. Design an experiment to test a theoretical probability and explain how the results may vary.

Experimental vs. Theoretical Probability: The Checkout Game, p. 131

Grade Seven

| *05-07 Benchmark* | A. | *Read, create and use line graphs, histograms, circle graphs, box-and-whisker plots, stem-and-leaf plots, and other representations when appropriate.* |

Data Collection / Y2003.CMA.S05.G05-07.BA.L07.I01

01. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate.

All About You Survey: Which Graph Is Best?, p. 54

Box-and-Whisker Plots, p. 70

Human Box-and-Whisker Plots, p. 67

Mean, Median, Mode and Range, p. 21

Scatter Plots and Median Fit Lines, p. 87

Stem-and-Leaf Plot, p. 63

A Variety of Graphs, p. 49

| *05-07 Benchmark* | B. | *Interpret data by looking for patterns and relationships, draw and justify conclusions, and answer related questions.* |

Statistical Methods / Y2003.CMA.S05.G05-07.BB.L07.I04

04. Construct opposing arguments based on analysis of the same data, using different graphical representations.

All About You Survey: Which Graph Is Best?, p. 54

Doing a Data Project, p. 106

05-07 Benchmark   D.   *Compare increasingly complex displays of data, such as multiple sets of data on the same graph.*

Statistical Methods / Y2003.CMA.S05.G05-07.BD.L07.I05

05.   Compare data from two or more samples to determine how sample selection can influence results.

Doing a Data Project, p. 106

Learning About Sampling, p. 97

05-07 Benchmark   E.   *Collect, organize, display and interpret data for a specific purpose or need.*

Data Collection / Y2003.CMA.S05.G05-07.BE.L07.I02

02.   Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.

Doing a Data Project, p. 106

Grades: Making a Histogram, p. 43

Zodiac Circle Graphs, p. 45

05-07 Benchmark   F.   *Determine and use the range, mean, median and mode to analyze and compare data, and explain what each indicates about the data.*

Statistical Methods / Y2003.CMA.S05.G05-07.BF.L07.I03

03.   Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion or exclusion of outliers affects those measures.

Box-and-Whisker Plots, p. 70

Doing a Data Project, p. 106

Human Box-and-Whisker Plot, p. 67

Mean, Median, Mode and Range, p. 21

05-07 Benchmark   G.   *Evaluate conjectures and predictions based upon data presented in tables and graphs, and identify misuses of statistical data and displays.*

Data Collection / Y2003.CMA.S05.G05-07.BG.L07.I02

02.   Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.

Doing a Data Project, p. 106

Grades: Making a Histogram, p. 43

Statistical Methods / Y2003.CMA.S05.G05-07.BG.L07.I06

06. Identify misuses of statistical data in articles, advertisements, and other media.

Misleading Graphs, p. 17

05-07 Benchmark   I.   *Describe the probability of an event using ratios, including fractional notation.*

Probability / Y2003.CMA.S05.G05-07.BI.L07.I07

07. Compute probabilities of compound events; e.g., multiple coin tosses or multiple rolls of number cubes, using such methods as organized lists, tree diagrams and area models.

Area Models or Geometric Probability, p. 138

Multiplying the Probability, p. 123

Probability: Native American Stick Game, p. 127

Tree Diagrams, p. 118

05-07 Benchmark   K.   *Make and justify predictions based on experimental and theoretical probabilities.*

Probability / Y2003.CMA.S05.G05-07.BK.L07.I08

08. Make predictions based on theoretical probabilities, design and conduct an experiment to test the predictions, compare actual results to predicted results, and explain differences.

Experimental vs. Theoretical Probability:
The Checkout Game, p. 131

An Introduction to Probability, p. 115

Grade Eight

08-10 Benchmark   A.   *Create, interpret and use graphical displays and statistical measures to describe data; e.g., box-and-whisker plots, histograms, scatter plots, measures of center and variability.*

Data Collection / Y2003.CMA.S05.G08-10.BA.L08.I01

01. Use, create and interpret scatter plots and other types of graphs as appropriate.

Doing a Data Project, p. 106

Monopoly Madness, p. 87

Scatter Plots and Median Fit Lines, p. 77

08-10 Benchmark **B.** *Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an identified purpose.*

Data Collection /Y2003.CMA.S05.G08-10.BB.L08.I02

02. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an identified purpose; e.g., line graph for change over time, circle graph for part-to-whole comparison, scatter plot for relationship between two variants.

All About You Survey: Which Graph Is Best?, p. 54

Doing a Data Project, p. 106

Data Collection / Y2003.CMA.S05.G08-10.BB.L08.I03

03. Differentiate between discrete and continuous data and appropriate ways to represent each.

Doing a Data Project, p. 106

Types of Data: Categorical vs. Measurement and Discrete vs. Continuous, p. 27

08-10 Benchmark **C.** *Compare the characteristics of the mean, median and mode for a given set of data, and explain which measure of center best represents the data.*

Statistical Methods / Y2003.CMA.S05.G08-10.BC.L08.I05

05. Explain the mean's sensitivity to extremes and its use in comparison with the median and mode

Scatter Plots and Median Fit Line, p. 77

08-10 Benchmark **D.** *Find, use and interpret measures of center and spread, such as mean and quartiles, and use those measures to compare and draw conclusions about sets of data.*

Statistical Methods / Y2003.CMA.S05.G08-10.BD.L08.I04

04. Compare two sets of data using measures of center (mean, mode, median) and measures of spread (range, quartiles, interquartile range, percentiles).

Mean, Median, Mode and Range, p. 21

Statistical Methods / Y2003.CMA.S05.G08-10.BE.L08.I08

08. Describe how the relative size of a sample compared to the target population affects the validity of predictions.

Doing a Data Project, p. 106

Learning About Sampling, p. 97

The Need to Use a Random Sample, p. 94

08-10 Benchmark   *F.   Construct convincing arguments based on analysis of data and interpretation of graphs.*

Statistical Methods / Y2003.CMA.S05.G08-10.BF.L08.I06

06. Make conjectures about possible relationship in a scatter plot and approximate line of best fit.

Doing a Data Project, p. 106

Interpreting Graphs Using CBR and Graphing Calculator, p. 13

Monopoly Madness, p. 87

Scatter Plots and Median Fit Line, p. 77

Statistical Methods / Y2003.CMA.S05.G08-10.BF.L08.I09

09. Construct convincing arguments based on analysis of data and interpretation of graphs.

Doing a Data Project, p. 106

Interpreting Graphs Using CBR and Graphing Calculator, p. 13

Monopoly Madness, p. 87

The Need to Use a Random Sample, p. 94

08-10 Benchmark   *H.   Use counting techniques, such as permutations and combinations, to determine the total number of options and possible outcomes.*

Probability / Y2003.CMA.S05.G08-10.BH.L08.I10

10. Calculate the number of possible outcomes for a situation, recognizing and accounting for when items may occur more than once or when order is important.

Experimental vs. Theoretical Probability:
The Checkout Game, p. 131

08-10 Benchmark   *J.   Compute probabilities of compound events, independent events, and simple dependent events.*

Probability /Y2003.CMA.S05.G08-10.BJ.L08.I11

11. Demonstrate an understanding that the probability of either of two disjoint events occurring can be found by adding the probabilities for each and that the probability of one independent event following another can be found by multiplying the probabilities.

Multiplying the Probability, p. 123

Tree Diagrams, p. 118

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