Discovering Math: Using and Collecting Data
Teacher’s Guide

Grade Level: 3-5  Curriculum Focus: Mathematics  Lesson Duration: Four class periods

Program Description
Discovering Math: Using and Collecting Data — From data points and determining spread to creating and reading graphs and charts, introduce elementary students to more advanced concepts of statistics and data analysis.

Lesson Plan

Student Objectives

- Use data to represent specific pieces of information about real-world objects or activities.
- Use a number line to identify and demonstrate extremes, where the points pile up, and where the gaps are.
- Demonstrate the ability to collect, organize, and display data in number lines, bar graphs, pie charts, and line graphs.
- Explain that data come in many forms and that collecting, organizing, and displaying data can be done in many ways.
- Demonstrate how a sample predicts the characteristics of a large set and explain the effects of sample size.

Materials

- Discovering Math: Using and Collecting Data video
- Calculator
- Tape measure
- Height of Students Data Chart (see below)
- Examples of bar graph, line graph, and circle graph
- Bar Graph Data Chart (see below)
- Graph paper
- Computer with internet access
Procedures

1. Discuss how data was displayed on number lines in the video segment about horse heights. Recall that wider intervals yield less precise graphic representations, but make it easier to identify larger patterns within the data. Tell students they will be collecting data and displaying it on a number line plot.

Note: This activity works best with at least 20 or more students. If the class is smaller than that, try combining data from two classes.

- Distribute a copy of Height of Students Data Chart to each student. Have students work with a partner to find their height in inches using a tape measure. When all students have measured and recorded their height, ask each to share their height with the class. Students should record the height data on their charts.

- Once data is collected, have students set up number line on paper using a ruler. Use the following intervals.
  
  - 40”–42”
  - 43”–45”
  - 46”–48”
  - 49”–51”
  - 52”–54”
  - 55”–57”
  - 58”–60”
  - 61”–63”

- Have students record each height over the correct interval on the number line.

- When number line plot is complete ask students to write three factual statements about the pattern on data on the plot. They should share and explain their statements, referring to the number line plot in their explanations.
  
  - Extension: Have students increase interval spans and re-plot the data. Ask them to explain the benefits of altering the intervals.

2. Display the words mean, median, range, and mode. Discuss the meaning of each word, having students share their thoughts and ideas.

  - mean: the average value of a data set
  - median: the middle number in a data set
range: the difference between the greatest number and the least number in a set of data
mode: the number found most often in a set of data

Display a sample set of numbers and model how to calculate the mean, median, range, and mode of the data set.

- Have students list the data from their Height of Student Data Chart from least to greatest. Then calculate the mean, median, range, and mode of the data set.
- Discuss the process they used to find the mean, median, range, and mode of the data set. Have them share their thoughts and ideas on why the information is important and how it can be used to summarize the number line plot.
- Have students summarize the number line plot in writing. They should include a statement about the mean, median, range, and mode of the data set in their summary.

3. Display examples of a bar graph, line graph, and circle graph. Ask students to compare the graphs and share their thoughts on the use of each type.

   - Bar graphs are used to compare data.
   - Line graphs are used to show change over time.
   - Circle graphs are used to show parts of a whole.

Tell students they will be collecting, organizing, and displaying data in bar graphs, line graphs, and circle graphs.

- Distribute a copy of the Bar Graph Data Chart to each student. Survey the class and have students share and record their favorite type of book.
- Review the important parts of a bar graph: title, labels on each axis, and an appropriate scale.
- Have students set up bar graph to display the data they collected on their Bar Graph Data Chart. They should use graph paper to create their bar graph.
- Ask students to write three summary statements about the data in the bar graph. They can write statements comparing pieces of the data, identifying the least liked and most liked type of book, etc.
- Have students share and explain their summary statements with the class.

4. Display a sample line graph and review its format and uses. Tell students they will create a line graph to display and compare the average monthly temperatures in their city or town (or another area determined by the teacher if their town is not listed). Assign each student a partner. Have each pair go to [www.weatherbase.com](http://www.weatherbase.com) and following the links to their city or town.

- Distribute a copy of the Line Graph Data Chart to each pair. Have them record the average monthly temperature for their chosen area on the chart.
- Review the important parts of a line graph: title, labels on each axis, and an appropriate scale.
• Have each student graph the average monthly temperature data in a line graph.
• Ask each student to write three summary statements about the data in the line graph. They can write statements comparing pieces of data, identifying the lowest or highest monthly temperature, etc.
• Have students share and explain their summary statements with the class.

5. Display a sample circle graph and review its format and uses. Remind students that each part of the circle graph represents part of the whole. Tell students they will create a circle graph to display a given data set. Distribute a copy of the Circle Graph Data Chart to each student and explain the scenario:

A class raised $100 in various fundraisers.

The data chart represents how much money was raised by each fundraising activity.

The students will display the data in a circle graph.

• Discuss the data and ask questions about the whole or parts of the whole.
  o How much money did the students raise in all?
  o What part of the whole did they raise selling cookies?
  o What part of the whole did they raise selling candles?

• Distribute a copy of the Circle Graph Template each student. Ask them to create a circle graph to display the fundraiser data. Remind students that the circle should be divided to represent the appropriate part of the whole for each activity.

• Have students write three summary statements about the data in the circle graph. They can write statements comparing pieces of data, identifying the activity that raised the most or least amount of money, etc.

• Have student share and explain their summary statements with the class.

6. Ask students to look at the data they collected about favorite book types on the Bar Graph Data Chart. Based on their data, ask them to predict the favorite book types of all third, fourth, or fifth grade students. Ask how they made their predictions. Discuss the affects of sample size on data.

If possible, allow students to survey other classes and organize and display the new data in a bar graph.

• Have students compare the class data to the larger sample size data. Ask them how the new data can help give a more complete picture of favorite book types of third, fourth, or fifth grade students.

• Emphasize the importance of sample size and how it affects the data. When collecting data on a large population a larger sample size is needed to get more reliable information.
Assessment

Use the following three-point rubric to evaluate students’ work during this lesson.

- **3 points**: Students were highly engaged in class discussions; produced complete charts, graphs, and summaries, including all the requested information; clearly demonstrated the ability to collect, organize, and display data in number line plots, bar graphs, line graphs, and circle graphs; and clearly demonstrated an understanding of the effects of sample size.

- **2 points**: Students participated in class discussions; produced adequate charts, graphs, and summaries, including most of the requested information; satisfactorily demonstrated the ability to collect, organize, and display data in number line plots, bar graphs, line graphs, and circle graphs; and satisfactorily demonstrated an understanding of the effects of sample size.

- **1 point**: Students participated minimally in class discussions; created incomplete charts, graphs, and summaries, including little or none of the requested information; did not demonstrate the ability to collect, organize, and display data in number line plots, bar graphs, line graphs, and circle graphs; and did not demonstrate an understanding of the effects of sample size.

Vocabulary

**bar graph**
*Definition*: a graph that uses bars to show and compare data
*Context*: The students created a bar graph to display and compare the data collected on the number of books each person read over the summer.

**circle graph**
*Definition*: a graph in the shape of a circle that is divided into areas proportional to percentages of the whole
*Context*: Each section of the circle graph represents the part of the class that has brown, blonde, black or red hair.

**line graph**
*Definition*: a graph that uses a line to show how data changes over time
*Context*: Each point on the line graph represents the average monthly temperature so the data can be easily displayed and compared.

**mean**
*Definition*: the average of a data set
*Context*: The students found the mean of the data set 3, 6, 1, 3, 2 by finding the sum of the numbers and dividing by 5. The mean of the data set is 3.
median

Definition: the middle number in a data set

Context: The students found the median of the data set 3, 6, 1, 3, 2 by listing the numbers from least to greatest and identifying the middle number. The median of the data is 3.

mode

Definition: the number found most often in a data set

Context: The students found the mode of the data set 3, 6, 1, 3, 2 by identifying the number found most often in the data set. The mode of the data set is 3.

number line plot

Definition: a tool used to organize and display data; a number line labeled in intervals with marks above each interval to represent a set of data

Context: The students created a number line plot to display the data they collected on the height of the students in the class.

range

Definition: the difference between the greatest and the least number in a data set

Context: The students found the range of the data set 3, 6, 1, 3, 2 by finding the difference between the greatest and least number in the data set. The range of the data set is 5.

sample

Definition: a sub-group of a population used to collect data on the whole population

Context: The researchers used a sample of 100 third grade students to learn about how third graders spend their time after school.

Academic Standards

Mid-continent Research for Education and Learning (McREL)

McREL’s Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following benchmarks:

- Understands that data represent specific pieces of information
- Understands that spreading data out on a number line helps to see what the extremes are, where the data points pile up, and where the gaps are
- Understands that a summary of data should include where the middle is and how much spread there is around it
- Organizes and displays data in simple bar graphs, pie charts, and line graphs
- Reads and interprets simple bar graphs, pie charts, and line graphs
- Understands that data come in many different forms and that collecting, organizing, and displaying data can be done in many ways
- Understands the basic concept of a sample
National Council of Teachers of Mathematics (NCTM)
The National Council of Teachers of Mathematics (NCTM) has developed national standards to provide guidelines for teaching mathematics. To view the standards online, go to http://standards.nctm.org.

This lesson plan addresses the following standards:

- Represent data using tables and graphs such as line plots, bar graphs, and line graphs
- Describe the shape and important features of a set of data and compare related data sets, with an emphasis on how the data are distributed
- Use measures of center, focusing on the median, and understand what each does and does not indicate about the data set
- Compare different representations of the same data and evaluate how well each representation shows important aspects of the data
- Design investigations to address a question and consider how data-collection methods affect the nature of the data set

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html

DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How to Use the DVD

The DVD starting screen has the following options:

Play Video — This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index — Here the video is divided into chapters indicated by title. Each chapter is then divided into four sections indicated by video thumbnail icons; brief descriptions are noted for each section. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.
Quiz—Each chapter has four interactive quiz questions correlated to each of the chapter’s four sections.

Standards Link—Selecting this option displays a single screen that lists the national academic standards the video addresses.

Teacher Resources—This screen gives the technical support number and Web site address.

Video Index

I. Data as Information (7 min.)

Data as Information: Introduction
Data is defined as information gathered for a purpose—to aid decision-making and problem solving. Data can be qualitative or quantitative.

Example 1: Qualitative Data
Qualitative data gives information about qualities—color, size, or shape. It can be used right away to make decisions. Examples of qualitative data are explained.

Example 2: Qualitative and Quantitative Data
Farmers gather qualitative and quantitative data on crops. Qualitative data pertains to soil type and nutrients. Quantitative data pertains to the number of sunny or rainy days and the crops’ weight.

Example 3: Automated Data Recording
Weather forecasters use land stations, ocean stations, and satellites to gather data about the weather. They use the quantitative data to predict weather and upcoming storms.

II. Data Distribution (7 min.)

Data Distribution: Introduction
Plotting data is a useful way to organize and understand information. It is important to understand the data when making decisions.

Example 1: Number Line Plots
Data can be represented on a number line. Placing one dot for each piece of data on the number line provides a useful visual representation. A number line is modeled.

Example 2: Stacking Data in Line Plots
Stacking data on a number line is a useful way to organize and represent information. By stacking data, more can be plotted, extremes can be identified, and substantial gaps can be found.

Example 3: Line Plots with Wider Bins
Increasing the intervals on the line plot makes data more usable. Although the data isn’t as exact, it is easy to identify patterns and broader groups of information. Broadening the intervals is modeled.
III. Summarizing Data (8 min.)

Summarizing Data: Introduction
Summarizing and comparing data is important. Median is the middle number in a data set, mode is the number occurring most often, and range is the difference between the greatest and least number in the data.

Example 1: Center and Spread
Summarizing and comparing data by finding the median, mode, and range is modeled and explained. The importance of summarizing data is reiterated.

Example 2: Calculating the Mean
Calculating the mean is explained and modeled. The mean is the average value of a data set. In swimming, the mean is calculated by dividing the total score by the number of scores.

Example 3: Mean, Median, Range and Overall Distribution
A rider’s scores are used to find the mean, median, and range. Normal distribution is described; in large sets of data, there are fewer low and high numbers as you move away from the center value.

IV. Graphing Data (8 min.)

Graphing Data: Introduction
Graphing finance data helps achieve a saving’s goal.

Example 1: Bar Graphs
A bar graph compares the different amounts of money earned in three jobs. Creating a bar graph is explained and modeled.

Example 2: Circle Graphs
Circle graphs show the parts of a whole and the relationship between each part. Creating a circle graph to show how much time was spent on three jobs is explained and modeled.

Example 3: Line Graphs
A line graph shows change over time. Creating a line graph to show how much money was earned over three weeks is explained and modeled.

V. Reading Graphs (8 min.)

Reading Graphs: Introduction
Graphs can be used to see trends and patterns in data. Line graphs, bar graphs, and circle graphs are used for different purposes.

Example 1: Bar Graphs
Bar graphs compare amounts in different situations. A bar graph is used to compare the types of pets that live in U.S. households.
Example 2: Line Graphs
Line graphs show change over time by charting one quantity in relation to another quantity. The quantities are called variables. A line graph is used to track the number of people who exercise regularly.

Example 3: Circle Graphs
Circle graphs show parts of a whole and how the proportions of something make up the whole. A circle graph is used to show how many collectors in a group collect specific items.

VI. Collecting and Handling Data (9 min.)

Collecting and Handling Data: Introduction
Data is information collected for a purpose. The way data is collected, organized, and displayed depends upon the purpose. Data can be used to solve problems and make decisions.

Example 1: Gathering Numerical Data
The purpose for collecting data will govern the data collected, the way it is collected, how it is analyzed, and the results of the collection.

Example 2: Organizing Data
Data can be organized by writing a list, making a graph, creating a chart, or in any other way that makes the data useful and meets the purpose for which it was collected.

Example 3: Displaying Data
The purpose for collecting data determines the way it is displayed. Use a bar graph to compare, a line graph to show change over time, or a circle graph to show parts of a whole.

VII. Sample Size (8 min.)

Sample Size: Introduction
Samples are used to collect data on populations. A sample is a sub-group of a population. The larger the sample size, the more data that can be collected.

Example 1: Sample Size from a Limited Population
Looking at one member of a population will not give enough information about the whole population. A larger sample size is more effective for collecting data on a whole population.

Example 2: Sample Size from a Larger Population
When collecting data on a population, the larger the sample size, the more likely it will represent the whole group and the proportions and distribution of characteristics within the group.

Example 3: Reliability Based on Sample Size
When collecting data on a very large population, a large sample size is necessary to get reliable information on the specific characteristics and composition of the population.
Quiz

I. Data as Information

1. Sal is gathering information to learn about average temperatures in his town. The information he is gathering is called _____.
   A. data
   B. quality
   C. quantity
   D. weather
   
   Answer: A

2. Farmer Jones is gathering data on his crops. Which data should he collect if he wants qualitative data?
   A. the weight of the crops
   B. the inches of rain the crops received
   C. the number of sunny days in the summer
   D. the type of nutrients added to the soil

   Answer: D

3. Farmer Smith is gathering data on his crops. Which data should he collect if he wants quantitative data?
   A. the type of soil used on the farm
   B. the different colors on the leaves
   C. the amount of rain the crops received
   D. the type of nutrients added to the soil

   Answer: C

4. Which data would not be useful to weather forecasters when predicting the weather?
   A. rainfall
   B. wind speed
   C. air temperature
   D. day of the week

   Answer: D
II. Data Distribution

Valerie collected data to find out how many books her classmates read over the summer. Each x on the stacked number line represents one person.

1. How many students read eight books over the summer?
   A. 2
   B. 4
   C. 8
   D. 10

   Answer: B

2. How many books did the largest number of classmates read over the summer?
   A. 4
   B. 5
   C. 7
   D. 10

   Answer: B

3. Valerie decides to broaden the intervals on her line plot. She makes the intervals 1–5 and 6–10. How many Xs should Valerie place above the 6–10 interval?
   A. 13
   B. 15
   C. 16
   D. 22

   Answer: B
III. Summarizing Data

1. What is the mode of the data? 5, 5, 6, 6, 6, 7, 9, 10, 11, 11, 13
   A. 5
   B. 6
   C. 11
   D. 13

   Answer: B

2. What is the range of the data? 5, 5, 6, 6, 6, 7, 9, 10, 11, 11, 13
   A. 5
   B. 7
   C. 8
   D. 13

   Answer: C

3. Jack was in a diving competition. His scores were 7, 8, 7, 9, 6, and 5. What is the mean of Jack’s scores?
   A. 5
   B. 6
   C. 7
   D. 9

   Answer: C

4. Julie recorded how long a rider could stay on a bucking bronco. The rider’s scores were 3, 4, 5, 7, 8, and 8. What is the median of the data?
   A. 5
   B. 6
   C. 7
   D. 8

   Answer: B
IV. Graphing Data

1. Which activity takes up the greatest amount of Tara’s time?
   A. sports
   B. reading
   C. computer
   D. homework

   *Answer: A*

2. Bruce created a circle graph to compare the amount of time he spends doing chores each month. According to the circle graph, which chore takes the least amount of Bruce’s time each month?
   A. washing dishes
   B. taking out trash
   C. washing windows
   D. cleaning bedroom

   *Answer: B*

3. Margaret created a line graph to show how much money she made each week in February. How much money did she make in Week 3?
   A. $20
   B. $35
   C. $50
   D. $55

   *Answer: A*
V. Reading Graphs

1. Which type of graph is best for comparing different amounts?
   A. bar graph
   B. line graph
   C. circle graph
   D. number graph
   
   Answer: A

2. Which type of graph is best for showing change over time?
   A. bar graph
   B. line graph
   C. circle graph
   D. number graph
   
   Answer: B

3. Which type of graph is best for showing parts of a whole and how the proportions of something make up the whole?
   A. bar graph
   B. line graph
   C. circle graph
   D. number graph
   
   Answer: C

VI. Collecting and Handling Data

1. John wants to collect data to determine the fastest route from his house to Paula’s house. He travels several routes on his bike. What data does he need to determine the fastest route?
   A. the names of the roads he took
   B. what kind of bike he was riding
   C. the time it took to travel each route
   D. the distance from his house to Paula’s house
   
   Answer: C

2. Sally collected data on the time it took five people to clean their rooms.
   
   Gail........3 minutes 25 seconds
   Kim.........9 minutes 42 seconds
   Ron.........7 minutes 32 seconds
   David......4 minutes 35 seconds
   Lena.......8 minutes 48 seconds
Sally wants to organize the data in a list. She wants to put the name of the person who took the longest amount of time to clean a room first on the list. Which name should Sally put first on the list?
A. Ron
B. Kim
C. Gail
D. Lena

*Answer: B*

3. Addison wanted to understand how he spends his time every day. He records how long he spends doing different activities throughout the day. If Addison wants to represent how long he spent doing each activity in relation to the whole day and the other activities, how should he display the data?
A. in a bar graph
B. in a line graph
C. in a circle graph
D. on a number line

*Answer: C*

VII. Sample Size

1. A subgroup of a population that is used to study the characteristics and proportions among the whole population is called a _____.
A. sample
B. subpopulation
C. small population
D. population group

*Answer: A*

2. Which statement about collecting data on a population is correct?
A. The larger the sample size, the less data can be gathered.
B. The larger the sample size, the more data can be gathered.
C. The smaller the sample size, the more data can be gathered.
D. The amount of data gathered does not depend upon the sample size.

*Answer: B*

3. A scientist is studying the range in lengths of earthworms. There are a thousand worms in the population being studied. What sample size should the scientist use?
A. 10 worms
B. 25 worms
C. 50 worms
D. 100 worms

*Answer: D*
### Height of Students Data Chart

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<th>Name</th>
<th>Height</th>
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### Height of Students Data Chart

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## Bar Graph Data Chart

<table>
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<th>Type of Book</th>
<th>Number of Students</th>
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<tr>
<td>Mystery</td>
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### Line Graph Data Chart

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<td>November</td>
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<td>December</td>
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### Circle Graph Data Chart

Money Raised for Ms. Smith’s Class

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<thead>
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<th>Activity</th>
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<td>Cookie Sale</td>
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<td>Penny Collection</td>
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<td>Car Wash</td>
<td>$40</td>
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<tr>
<td>Donations</td>
<td>$5</td>
</tr>
<tr>
<td>Candle Sale</td>
<td>$20</td>
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Circle Graph Template