The learner will understand and use graphs, probability, and data analysis.

4

Notes and textbook references

4.01 Collect, organize, analyze, and display data (including line graphs and bar graphs) to solve problems.

A. When discussing the state symbols, have students brainstorm other possible state favorites. For example, students could design a question, perhaps limiting the choices, and survey 10 people each to choose a "State Dance."

B. Brainstorm types of information the students might want to display on the "We Love Calling North Carolina Home" bulletin board. Decide where to collect the data, how to organize and display the information. (Investigations could involve writing to historic/tourist spots across the state and collecting information about the number of visitors, or surveys about the typical number of miles people drive in a week, or popular eating spots.) You might have the students add an "Investigations" section where they could display their data.

C. Gathering data in a manner which makes the information easy to interpret necessitates asking good questions. Bring sample data displays from newspapers (USA Today is a good resource). What questions did the researchers ask to gather the information for these graphs? Have students brainstorm information they would like to gather and how to write questions that will give them usable data. Be sure to discuss whatever guidelines they suggest. Divide the class into teams; have each team formulate a question and then gather the data based on their questions. For example, students might decide to see whether the most expensive binders are the most durable ones, or are shampoos with conditioners better than plain shampoos?

***Challenge**: Enter data into the data base of a computer, plot both sets of information and graph them.*

Notes and textbook references

D. Conduct a census. Decide on questions to be asked, develop a format, and conduct the survey. Decide how to organize and display information gathered. You may decide to use the Student Census Sheet (see Blackline Master IV - 1).

E. Use the public library to get information on daily temperatures for a period of time during the previous year. From this information, students will predict the range of temperature for the same time period in the current year, then gather data to compare.

F. Place one-half cup warm water from the tap in a glass on a table away from the windows or heat. Measure the temperature and graph. Add one ice cube. Stir to dissolve and record temperature. Add one more ice cube. Again, record the temperature on a graph. Repeat this procedure five more times. What do you notice about the data? Have other students replicate the experiment. Do you see any patterns in the data? Wait 30 minutes and measure temperature again. Repeat at half-hour intervals. Graph data and discuss.

G. How do you spend 24 hours of your day? Have students decide upon categories and create a circle graph showing how they spend their days. All students do not have to use the same categories. Have students use different ways of dividing their circles into 24 parts. For example, some students might begin with a strip of grid paper 24 units long, color the hours by categories, and tape the strip into a circle. Using that ring, the students could then divide a circle they have drawn into the appropriate “pieces of pie”. Or students might collect colored cubes to represent the hours in each category. They could arrange the cubes evenly around a circle they have drawn and use the cubes as a guide to dividing the circle. Another strategy might result in the circle being divided into 8 equal parts. Students could then estimate the division of each of the eight sections into three equal parts to make a circle with 24 equal divisions. (Students who have worked with Logo on the computer may be able to use it to create a circle graph.)

Notes and textbook references

H. Create graphs by grouping North Carolina counties in different ways. For example, cut apart a map and group the counties by area as small, medium, and large. Next, group the counties by size in terms of population. Are the counties in the same groups? Graph them according to beginning letters. (Are there more counties which begin with the letter "A" than any other letter?)

I. Have students practice deciding how to label graphs by having them create bar graphs which need larger numbers. For example, let students choose 5 or 6 large cities in North Carolina. Create a graph showing the populations. Then choose small towns. How would you change the scale to graph their populations?

J. While studying about garbage and recycling, children notice the amount of waste generated in the cafeteria each day. A variety of questions begin to surface such as: What types of waste are there? How much of each? Can it be measured? How? How often should we measure it to get an idea of the average amount of waste generated each day? How can we help make less waste? The class considers how it can find answers to these questions, designs a way to obtain the data, and finds answers to their questions.

K. Which is the quicker-picker-upper? Using several different brands of paper towel, an eyedropper and water, determine the absorbency of the various brands of paper toweling. Put one sheet of each brand of towel on a dry surface. Place two drops of water on each towel and observe the results. Measure, using a centimeter ruler and graph paper the approximate size of the absorbing (wet) surface.* Record results. Add one drop to each spot and record the change in the size of the wet area until each towel stops absorbing. How many drops could each brand absorb? Who is the winner? *A transparency of centimeter grid paper (Blackline Master I - 25) can be helpful.

L. Presented with a display of data from your local newspaper , students generate questions which can be answered from the display and discuss a second way the same information can be communicated.

Notes and textbook references

M. Display monthly student attendance data in a variety of ways. Have students discuss the advantages and disadvantages of each method.

N. Record and display the weather at the beginning of class and at the end of the day in a variety of formats. After two weeks compare the results and discuss the advantages and disadvantages of each method.

O. Collect classroom data related to time spent on different activities (i.e. sleep, homework, play, school, TV, meals, etc.) Display information in pie charts, and bar graph form. Discuss best method for display of data. Why is it best?

P. After collecting, organizing, and analyzing data on the favorite sport in their school, fourth-graders are asked to interpret their findings. Why do you suppose basketball (or whatever) was chosen as the favorite sport? How close were the other sports? What if we collected data on the same question from a school in another state or country? Do you think students there would answer similarly? Why?

Q. A local video store loads a gumball machine with 100 multi-colored gumballs. The white ones have the word winner printed on them. If a customer pays 25¢ for a gumball and receives a free rental (usually $2.00) when he is a winner, how many gumballs should be white if the store owner wants to make a profit? Why?

R. In playing the **Wheel Of Fortune Game** contestants have to guess letters from a mystery word or phrase. Have students design a strategy for which letters should be selected first. A possible pre-activity might be to tabulate the occurrence of letters in a 50 word passage. Which letters most frequently occur? Which vowels? Which consonants?

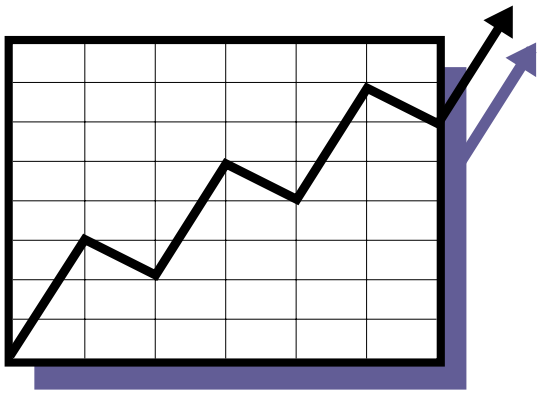
Notes and textbook references

S. Have students list all information they can learn from a specific chart or graph. Have them design questions to ask one another.

T. Use the following sources for line graphs you provide for your students: Guinness Book of World Records, North Carolina Almanac, local newspapers, ingredient labels on cereal boxes, soup cans, and so on. Give students a graph. Ask them to list the things they know based on the data. What might they conjecture?

U. A line graph (broken -line graph) is used to display continuous data and/or to show a trend. Points are plotted within perpendicular axes (see Blackline Masters IV - 2 through IV - 8) to represent change over time or a linear functional relationship. The labeled axes intersect at a common point, usually zero. The units of division on each axis are evenly spaced, and the graphed points are connected by line segments. When students keep a record over time of their height, weight, savings, attendance, local daily temperature, etc. line graphs are appropriate.

Multiple line graphs are used to compare two or more sets of data, for example, to compare the heights or weights of two students over a period of time, the growth of two plants from seed to mature height.



Notes and textbook references

The discussion on graphs should be helpful in providing students with a variety of graphing experiences.

V. Have students keep an hour by hour log for a 24 hour period. Ask the class to determine categories for these data (sleep, school, eating, play, and so on). Students need to round their categories to the nearest half hour or hour (nearest half hour is more precise, but may be very difficult for some students). Have each child construct a circle graph. (See pages 124 -129, a section about creating graphs.) Use these graphs to create a bulletin board and have students write about their day.

W. Have students watch television for specific hours and specific stations. Graph the number of commercials per hour. Compare Saturday mornings from 10-11 AM with Tuesday evenings from 6-7 PM or Friday nights from 8-9 PM.

X. Additional opportunities for charting and graphing data might come from organizing collections of various kinds. Bags of bean mix, candy hearts, M&M's™, colored paper clips, etc. could be sorted and organized by color or type. This information could then be used to construct a chart or graph showing the number of each color, etc. Have students summarize results. Students might be asked to bring in their own collections for sorting.

4.02 Describe the distribution of data using median, range, and mode.

Notes and textbook references

A. Measure intake of air capacity. First, exhale all air, then inhale air to fill lungs. Blow into a balloon and measure the circumference. Repeat this five times, measuring the balloon each time. Find your median and range. Compare with other students in classroom. Find the median, mode, and range of the class data.

B. Find the median height of the students in your class. Then find the median height of the players of your favorite basketball team. Use the median to compare your class to your favorite team. Why would the median be a good way to compare the groups? How do the results of your investigation differ if you determine the mode in each of these situations? Do you think the mode would be a more informative comparison?

C. Conduct a timed run for each student. (Use fitness testing information.) Find the range, median, and mode for the class. Extension: Collect the same information from students in younger and older classes and compare the data.

D. Have students gather absentee information by grade level for a week. Determine range, median, and mode for each grade for each day and each grade level for the week. Analyze and compare the information. Repeat the activity several other weeks. Are the numbers similar? If they are very different, what statements might you make?

E. Given a graph of climate data, such as the temperatures of several North Carolina cities (graphs can be found in textbooks), have students determine the range, median and mode of the temperatures.

Notes and textbook references

F. Have pairs of students cover a sheet of paper with a pattern block design. They should cover the entire surface. (Some edges may show.) Create six different graphs showing the number of each kind of pattern block used by the class. Using the graphs, discuss the range, median, and mode for each piece.
Extension: Suppose you and your partner were responsible for putting together pattern block sets. Each set is to have 100 pieces. How many of each piece would you put in the set? With your partner, decide on the composition of the sets and prepare a brief presentation to convince your classmates that your set would be the best one.

G. Divide the class into 10 groups. Give each group a list of the names of 10 different North Carolina counties. Students count the number of letters in each county's name, and then record each individual total on a post-it note or paper square with the name of the county. Next, create a bar graph by taping the names and numbers in the appropriate column. Determine range, median, and mode for these data.

H. Students in North Carolina report that they spend less time doing homework and more time watching TV than students in most other states, according to the National Assessment of Educational Progress (NAEP). Ask students what they think about this. How might they go about gathering some information to either support or refute this statement? Will students keep specific records over a period of time, estimate, gather specific data from a set night? An important part of gathering data is making decisions like this and recognizing how the manner in which you gather data may influence the outcome. Stem and leaf plots may be helpful in looking at the data, or your students may decide that they find other ways to organize more meaningful. As students are gathering and representing these data, explain how to find the *range*, the difference between the largest and smallest number for a set of data, the *median*, the middle number when data are arranged in numerical order, and the *mode*, the value occurring most often in a set of data. Have students explore how these "measures of central tendency" help describe a set of data. What other questions do the data generate?

I. Continue to explore median and mode using data sets such as: a list of temperatures at 10 a.m. for two weeks, lists of test scores, student heights, timed runs, pulse rates, name lengths, etc. Ask students, "If given the choice, would you rather have your grades based on median or mode when using test scores? Explain your choice."

J. Have students use connecting cube towers to show number of members in their household. Group students according to size of towers and determine the mode. After arranging the student groups from least to greatest, determine the range and the median.

Notes and textbook references

Notes and textbook references

4.03 Solve problems by comparing two sets of related data.

A. Have students collect and graph data for the monthly average rainfall in the year 2004. Then have students collect and graph data (using the same type of graph that was used for the 2004 data) for the monthly average rainfall for the year 2005. Have them compare the two sets of data. Questions to pose: What do you notice? Are there any patterns? Can you predict the amount of rainfall for next month?

B. Allow students to work in groups to conduct surveys of students in different grades to hours of television watched per night. For instance, one group could survey a set number of third graders, while the other group surveys the same number of fifth graders. Have the class graph the data. Have small groups of students work together to write their conclusions about the data. Then share as a class.

Extension: Either activity above could also be used with a variety of other data. For example, number of siblings per student in two different classrooms, heights of boys/girls in third grade compared to fourth grade.

C. Create a class bulletin board for collecting, comparing, and displaying data. This board could hold spelling or math test scores (without student names) comparing one set of test scores to another. Mix it up by using bar graphs one week, line graphs another, etc. Have students discuss their findings.

D. Use the newspaper as a resource. Have students use the weather charts from major cities to make posters and compare weather data. This data could be compared from one week to another or from one region of North Carolina to another. Have students discuss their comparisons.

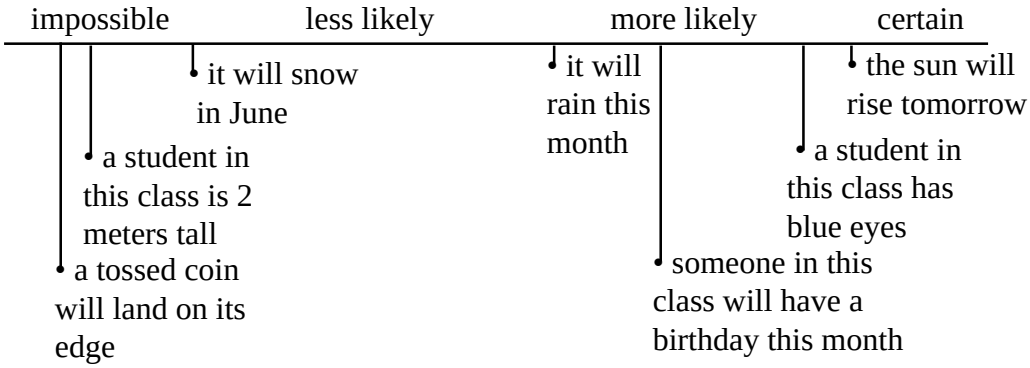
E. Compare the house numbers of two fourth grade classes to each other. Have students in one class write their house numbers on one color index card. The students in the other fourth grade should write their house numbers on a different color card. Decide how to display the data. A Venn diagram could be used to compare how many students live in an odd numbered house to those who live in a house with a number that is a multiple of five. Have students discuss the findings of their data.

Notes and textbook references

Notes and textbook references

4.04 Design experiments and list all possible outcomes and probabilities for an event.

A. Students can list a variety of events in their experience that may or may not occur. A poster or chart can be created to sort the events according to certain, more or less likely and impossible. Deciding where to place an event and the rationale for its placement helps students consider factors for chance events.



Read Do You Wanna Bet? by Jean Cushman. Donny and Brian discover that you are likely to predict an outcome if you know something about probability. Each of the eight chapters has investigations for the class to try.

B. Put ten colored markers or snap cubes in a glass or transparent container. Two should be of color A and eight of color B. Ask students about the probability - more or less likely of drawing, without looking, a marker of color A, of color B. What happens if there are three of color A and seven of color B? four and six? five and five? Have students explain and justify their responses.

C. Give each student a circle divided into eighths. See Blackline Master IV - 9. Ask the students to color their circles using three colors. Ask the students to record the probability of each color by counting it as a fraction. Using the circles, make a spinner, spin 20 times and record the results. On the back of their circles, ask the class to make a new circle using four colors, coloring one-fourth of each circle one color. Have each student (using a pencil and paper clip) spin the spinner 20 times. Compile the results and compare them to the expected results.

Notes and textbook references

D. Display spinners with a variety of sectors. Ask students to choose between or among them as to the one most (least) favorable in a game or contest. See Blackline Masters IV - 9 and IV - 10.

E. Use the graphs made in 4.02 and 4.03 to write and discuss statements about the relative likelihood of additional data gathered and where they would be placed on the existing graph or chart. Example: If one student were chosen from the favorite sports survey is it more or less likely she/he would choose soccer?

F. How often does the number 1 come up when a number cube (die) is rolled? Compare data when a student rolls 10 times, when 6 students roll 10 times, and when everyone in class rolls 10 times. Which set gives probability closest to $\frac{1}{6}$?

G. Place 2 red cubes, 2 yellow cubes, and 2 brown cubes in a paper bag. Draw, without looking, one cube from the bag 12 times. (Be sure to place the cube back into the bag after every draw.) Record results. Compare results when four students' draws are combined; 8 students' draws are combined; and the entire class.

H. Place six plastic colored eggs in a large brown bag. Have students draw eggs out of bag one at a time and record result (do this a total of 20 times). Be sure to put the egg back into the bag after each draw. Next, place students in groups of five to six and repeat the above procedure. Be sure to record results. As a whole class, examine data collected. Predict what the results might be as the sample size increases. For example, "What do you think the results would be if each fifth grade class were involved?" Compile the report data. Make an "official" presentation with charts and overheads to another class, principal, etc.

Notes and textbook references

I. Give each pair of students a deck of cards. Discuss:

1. How many cards are in the deck?
2. How many red? black?
3. How many spades? hearts? clubs? diamonds?

Ask each pair of students to draw 10 cards randomly. Choose a classification (i.e., color or suit or value) and predict what the cards might be before looking at the cards. Keep a record of the cards drawn. Repeat the activity ten times, returning cards to the deck after each draw. Have the students share the results with the class.

J. Ask each pair of students to roll two dice twenty times. Record sum of each roll. Organize these data. (Before beginning the rest of the activity, have students predict in writing what they think the most popular sum will be.) Combine the findings with the class. Are the results of 20 trials similar to those of the entire class? Discuss why some sums appear more often. Make generalizations.

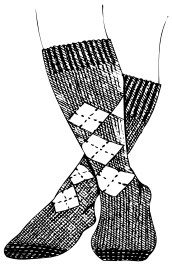
K. What is the probability of getting a sum of 3 with three spins in the **Tricky Three** probability game? Make a copy of the blackline master "Tricky Threes" for each pair of students. For each turn, players spin 3 times. Players record all 3 spins and find the sum. After 12 rounds, the player with the most sums of 3 is the winner. After playing the game, have students explore possible ways to get a sum of 3 with the spinner on their recording sheet. Suggest that they use a tree diagram to list all of the possible combinations of spinning the sum of three. See Blackline Master IV - 11.

L. Given two pennies, have students decide whether a game would be fair if 1 point was awarded to player A for double heads, 1 point to player B for double tails, and 1 point to player C for pennies which do not match. Have students toss the coins 20 times each. Record how coins land and the points earned by each player. Write an explanation, using the data collected, to explain whether or not this was a fair game.

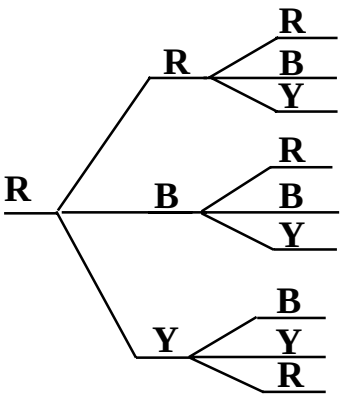
Extension: How could a penny toss game such as this one be modified to be a fair game?

Notes and textbook references

M. Put three socks in a bag, two of same color (brown), one different (blue). Ask: What is the probability of pulling a brown sock from the bag? a blue sock? What is the probability of pulling a same color pair from the bag? Use different numbers and colors of socks for new problems.



N. Begin with sets of three objects such as three colored cubes. Model all the possible ways to sequence these three objects. For example, a red (R), blue (B), and yellow (Y) could be sequenced in the following ways: RBY, RYB, BRY, BYR, YRB, YBR. This is a good time to begin modeling the use of tree diagrams. There are three possible choices for the first cube: R, B, or Y. Once the first cube is chosen, then there are two possible choices for the second cube, and one possible choice for the third cube. This creates a tree diagram like the one to the left.



The above illustrates one-third of a tree diagram which would also include two additional sections having blue and then yellow in the first position.

Gradually increase the number of objects to be sequenced. After students have had many opportunities to sequence and list concrete objects, move on to numbers and letters. For example, how many different three-digit numbers can be written using the digits 2, 3, and 4? Or how many ways can the letters *c, a, n* be arranged? Be sure to have students actually list the possibilities and not just report an answer to "How many?"

O. Give each student a circle divided into eighths. (See Blackline Master IV - 9.) Ask the students to color their circles using three colors. Ask the students to record the probability of each color by writing it as a fraction. That is, if three parts are colored red then record:

$$\textbf{RED} \qquad \frac{3}{8} \left(\frac{\textbf{Favorable Outcomes}}{\textbf{Possible Outcomes}} \right)$$

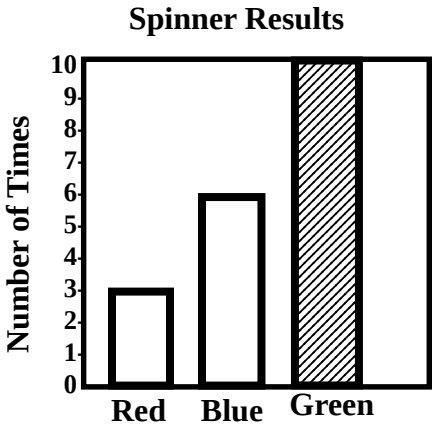
Share the circles among the class members. Compare circles and make generalizations about the probabilities if a given circle were used as a spinner. Discuss which circles are "fair" and which are "unfair" if they were used in a game. Can an eight-part spinner that is colored with 3 different colors be fair? What could be modified to make it a fair spinner?

Notes and textbook references

P. Refer to activity 4.04 J. Use the data collected to determine all of the possible outcomes of the sum of the dice. Write the probabilities in fraction form.

Q. Fill several sandwich bags with different combinations of two or three colors of cubes. Have different students explain to the class what the probability of drawing a certain color would be and how they know.

R. A student spun a spinner and recorded the data on this graph.



Using the graph on the right, answer the following questions:

1. Can we determine the total number of times that this student spun the spinner? Why or why not?
2. In fraction form, express the number of times that the spinner landed on blue ... on red ... on green.
3. In fraction form, express total of times the spinner landed on blue and green.
4. What do you think this spinner looked like? Why?

Notes and textbook references

S. You are opening a pizza parlor. If you have cheese, peppers, sausage and mushrooms as the toppings how many different kinds of pizza can you offer your customers? If you add olives to the list , how many more can you advertise? What are the chances that you will have an order for a cheese and mushroom pizza? How about a three-topping pizza?

T. Students discuss the probability that a particular number will come up when a die is thrown, and predict how many times that number will appear if the die is rolled 50 times. They then toss a die 50 times and compare the results with their predictions.

U. Record the temperature for a month. Use fractional representations to describe the probability of several ranges of temperatures.

V. Was there a **Big-Bang** inning in last night's Braves game? Have students collect several days' box scores from the sports pages in the newspaper. It has been said that in over 60% of all ball games the winning team scores more runs in one inning (a **Big-Bang** inning!) than the losers score in all nine innings. Is this true in the games you observed? Collect data to prove or disprove this theory.

W. Suppose a family has four children. What are the possible birth orders? What are the chances that a girl will be the oldest? If there are three or five children, what is the probability that a boy will be the middle child? Explore the probabilities of the families in your class.

Notes and textbook references

Some thoughts on graphing . . .

We live in an information age. Rapidly expanding bodies of knowledge combined with increased uses of technology clearly indicate that we as adults and the children currently enrolled in elementary grades will need to be able to evaluate and use vast amounts of data in personal and job-related decisions.

Skills in gathering, organizing, displaying, and interpreting data are important for students within all content areas. Graphing activities incorporate knowledge and skills from a variety of mathematical topics and integrate geometric ideas with computational skills, and classification tasks with numeration understandings.

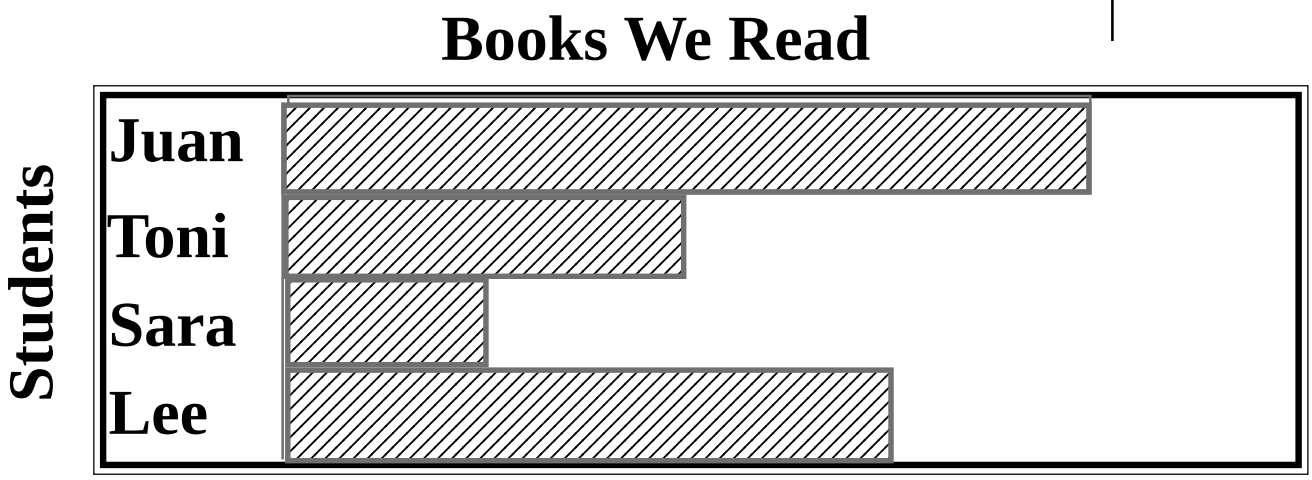
Graphs provide a means of communicating and classifying data. They allow for the comparison of data and display mathematical relationships that often cannot easily be recognized in numerical form. The traditional forms of graphs are picture graphs, bar graphs, line graphs, and circle graphs. New plotting techniques include line plots, stem-and-leaf plots, and box plots.

The following discussion is paraphrased and condensed by permission from the National Council of Teachers of Mathematics from *Developing Graph Comprehension*, pages 1-9. Information on newer techniques is for the teacher's benefit, since most applications of these techniques are more appropriate for upper elementary and middle grades rather than third grade.

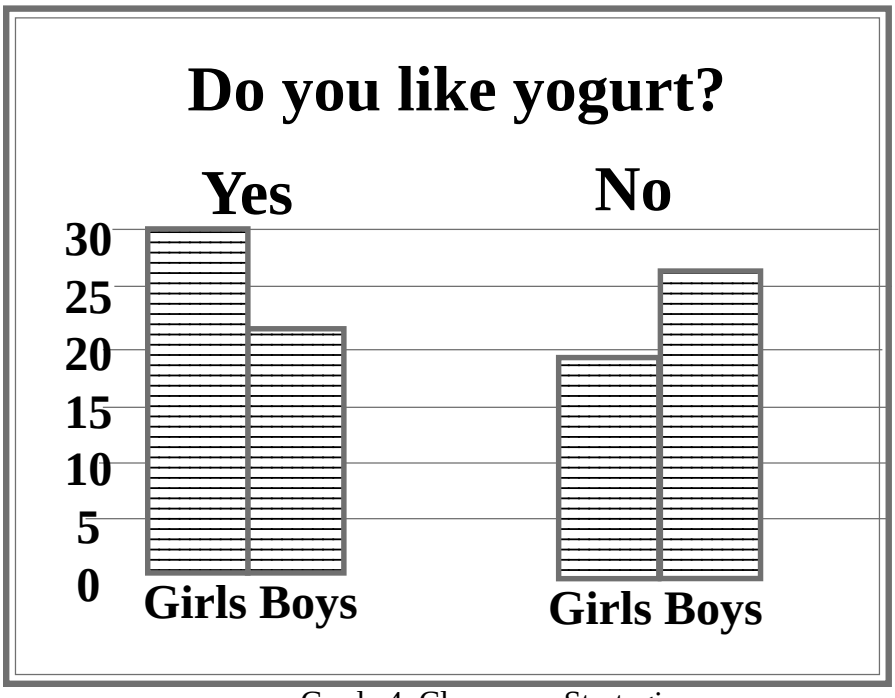
Traditional Graph Forms

Notes and textbook references

Bar graphs. Used horizontally or vertically, bar graphs (also called bar charts) compare discrete quantities expressed by rectangular bars of uniform width. The heights (or lengths) are proportional to the quantities they represent. The bars are constructed within perpendicular axes that intersect at a common reference point, usually zero. The axes are labeled.

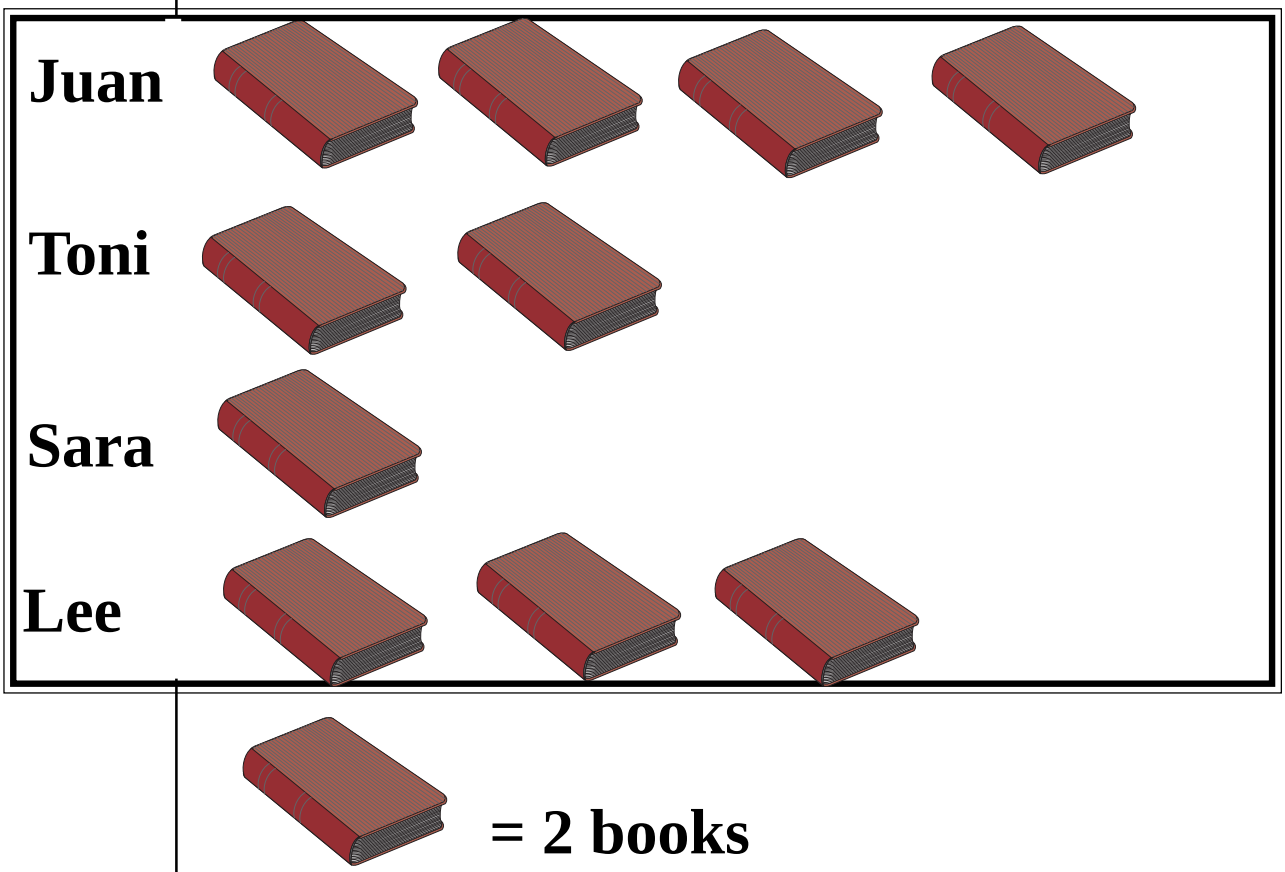


Multiple or double bar graphs are used to compare discrete stratified date (i.e., data collected from particular groups). For example, when asking children to vote for their favorite pets, colors, or favorite games to play, organize the results according to boys' responses and girls' responses.



Notes and textbook references

Books We Read



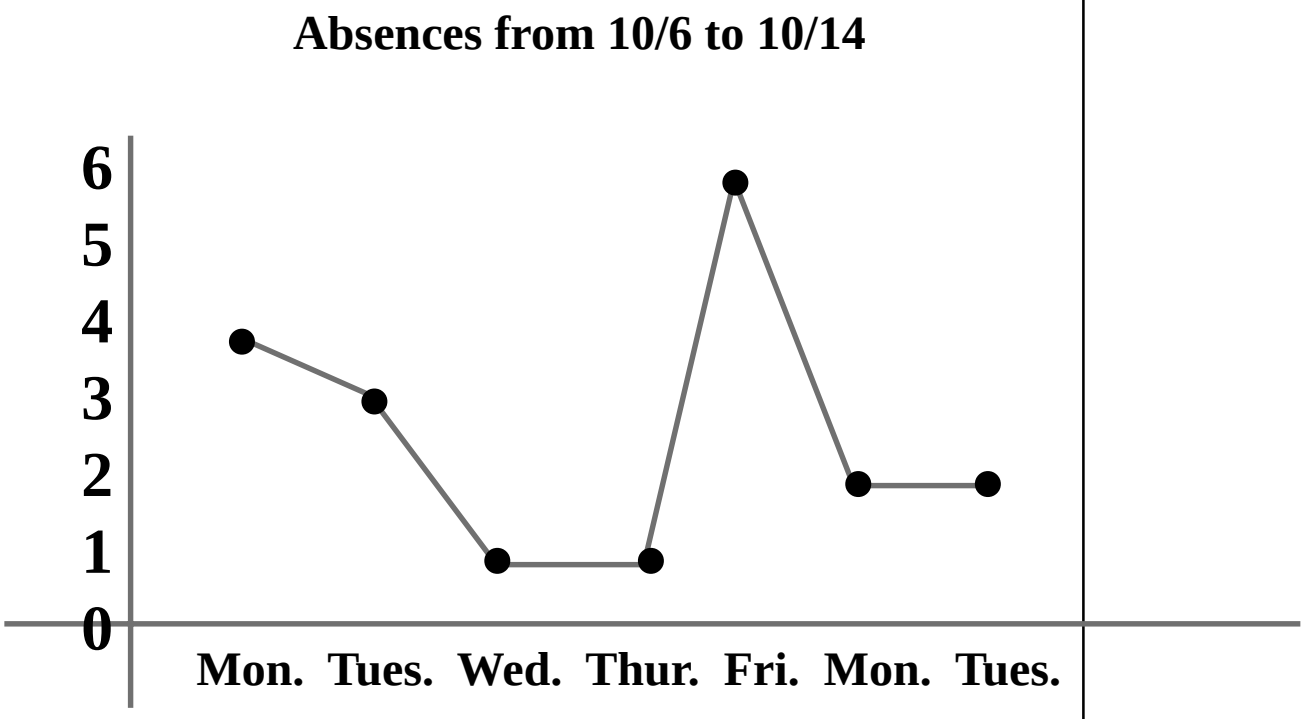
Picture graphs. Picture graphs (pictographs) use the pictures to depict quantities of objects or people with respect to labeled axes. They are used when the data are discrete (i.e., noncontinuous). The symbols (ideographs) need to be the same size and shape. These symbols may represent real objects (e.g., a stick figure to represent a person or a carton to represent milk drunk by students) or they may take the form of something more abstract (e.g., a triangle or square).

In picture graphs without a legend, the ideograph and the item it represents are in a one-to-one correspondence. When a legend is used, the ratio of each ideograph to the number of objects it represents must be taken into consideration when interpreting the graph. Fractional parts of ideographs (e.g., one-half of a picture) may cause some difficulties for children. Data presented in picture graphs are usually appropriate for bar graphs. Converting picture graphs to bar graphs is one way to help children move from semiconcrete representations of data to more abstract forms.

Line graphs. A line graph (broken-line graph) is used to compare continuous data. Points are plotted within perpendicular axes to represent change over a period of time or any linear functional relationship. The labeled axes intersect at a common point, usually zero. The units of division on each axis are equally spaced, and the graphed points are connected by straight or broken lines. When children keep a record over a period of time of their own height or weight, of the daily average temperature, and so on, line graphs are appropriate displays.

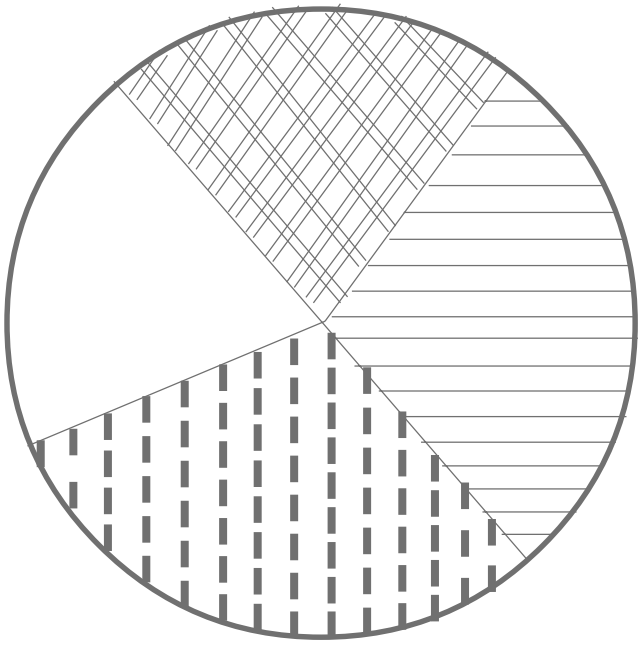
Multiple line graphs are used to compare two or more sets of continuous data: for example, to compare the heights or weights of two children over a period of time (e.g., four months or one year), or the heights of two (or more) plants over a period of time (e.g., one to two months after planting seeds).

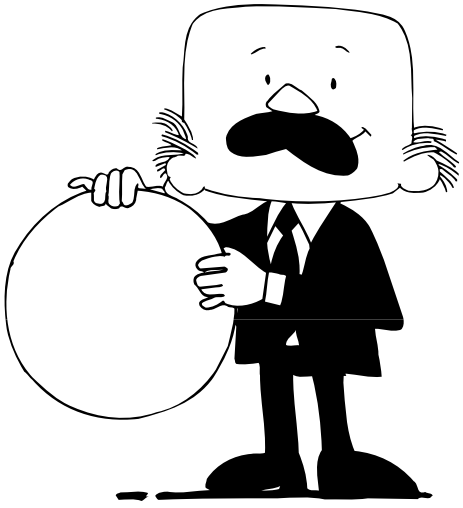
Notes and textbook references



Notes and textbook references

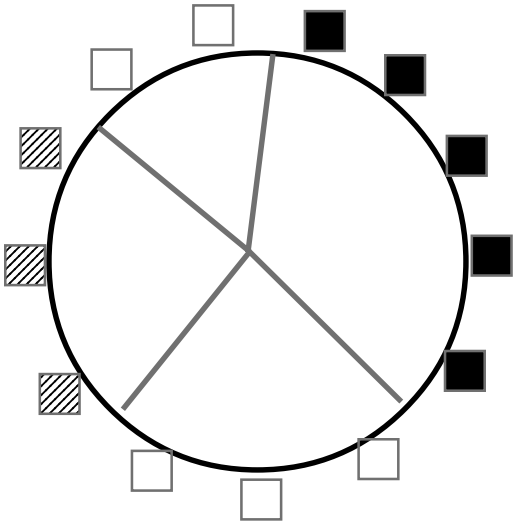
Circle graphs. The area of the circle graph (pie graph, pie chart, area graph) is divided into sections by lines emanating from the center of the circle. Circle graphs are appropriate when children have an understanding of fractions; they provide children with a means of displaying the relationship of parts to whole.

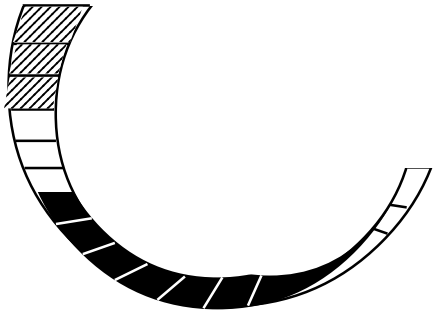




Children may create circle graphs informally before they are able to measure angles and figure proportions. For example, counters representing the total units are evenly spaced around the circle. When the divisions occur, a radius is drawn to divide the circle into appropriate parts. A second informal method is to mark units on a strip and then loop to form a circle, drawing radii as appropriate.

Notes and textbook references





Notes and textbook references