

# Statistics Activities for Developmental Mathematics Classes

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## Stem-and-Leaf Diagrams Using Dates on Coins

One way of organizing data is to make a *stem-and-leaf display*. Here's an example. Have students take one or two pennies (or coin of your choice) out of their pockets and look at the dates. Record the dates on the board. For example, looking at the change in my pockets today I find these dates on coins:

1967 1990 1992 1989 1982 1989 1972 1998 1978 1993 1982  
1992 1989 1995 1995 1996 1994 1993 1983 1998 1987

We can organize the data showing the various decades or class intervals (the “stems”), with just the last digit (the “leaves”) of the year on the right side. After that you can write the frequency to make other kinds of graphs.

Stem	Leaf	Frequency
196	7	1
197	2 8	2
198	9 2 9 2 9 3 7	7
199	0 2 8 3 2 5 5 6 4 3 8	11

If we wanted smaller class intervals, say of 5 years, we could write the years ending in 0-4 with a stem ending in, say, ■ and the years ending in 5-9 with a stem ending in □:

Stem	Leaf	Frequency
196□	7	1
197■	2	1
197□	8	1
198■	2 2 3	3
198□	9 9 9 7	4
199■	0 2 3 2 4 3	6
199□	8 5 5 6 8	5

One nice thing about stem-and-leaf displays is that they look like text versions of histograms. Another advantage is that they preserve values of the original data, unlike making tally marks.

## Using Lines to Make Predictions

Percent of World's Population That Is Urban, 1950-95

Year	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995*
Share%	29.3	31.4	34.2	35.5	36.6	37.7	39.4	41.2	43.1	45.2

\*preliminary estimate

Source: NEA graphic, *Johnson City Press*, July 21, 1996

1. Use the urban-world-population data in the table to plot the points on a graph. Note: The relationship appears to be roughly linear.
2. Use your piece of uncooked spaghetti to find what appears to be the best-fit line that goes through or near the most points.
3. Find two points on the line and compute the slope of the line. For calculation purposes, you may wish to use a baseline year of 0 rather than 1950. Then 1960 would be 10, and so on. If so, remember to take this adjustment into consideration when answering questions 4-7.
4. Use the slope and a point to write the equation of your line. Write the equation in slope-intercept form.
5. Check how well your model fits the data by “predicting” the urban percent in those years that you did not use in questions 2 and 3.
6. Use your equation to predict the percent of world population that will be urban in the years 2000 and 2005.
7. If your model continues to be accurate, in approximately what year will the world's population be 50 percent urban?
8. Is it reasonable to use your model to estimate a time when no population was urban (0%) or when the entire population (100%) will be urban? Explain your answer.

## Answer Key to Urban Population Worksheet:

1-2. Answers will vary; see example at right (generated by a Quattro Pro spreadsheet).

3. Answers will vary. As an example, using the points (1950,29.3) and (1990,43.1) give a slope of 0.345.

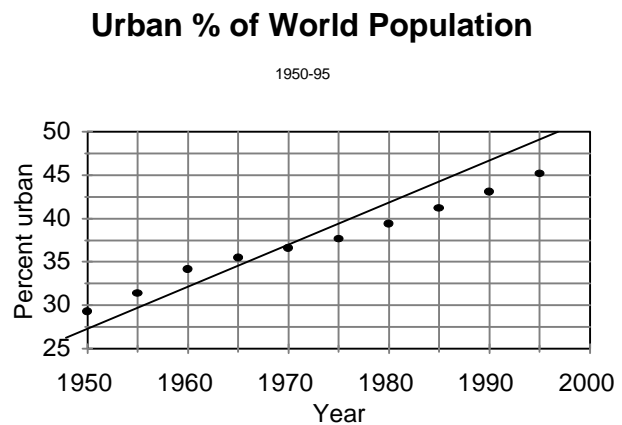
4. Answers will vary. The equation of the regression line using a statistical calculator is approximately  $y = .33x + 29.92$  (using 0 for 1950). Using the points (25,37.7) and (40,43.1) gives an equation of  $y = .36x + 28.7$ .

5. Answers will vary.

6. Using the regression line derived from a statistical calculator, the population in 2000 could be 46.42% urban and in 2005 could be 48.07%. Using the sample equation in #4 yields 46.7% and 48.5%, respectively.

7. Again from the calculated regression line, the world's population may be 50% urban in 2010.

8. No. This model only applies well to the latter half of the 20th century. The regression line "predicts" 0% urban population in 1860 or thereabouts, but we know there were cities then. Likewise, it is unreasonable to assume that everyone will live in cities in the future, since farmers will always be needed, even in 2160.



## Setup for a spreadsheet:

Put the information in a spreadsheet. Quattro Pro can make a scatter diagram if you highlight the information and tell it to make a broken line graph. When you've created the graph, edit it. Right click on the line and choose Line Series from the box that pops up. On the Line Settings tab, choose the rectangle with no line on it. You can draw in your own line with the tool on the bar that looks like a diagonal line. Just click the square, then click where you want the line to start, keep holding the button down, move the mouse where you want the line to end, and release the mouse button. By right clicking on that line you can change its properties as well. (That's how the graph on this page was constructed.)

This activity, in a slightly different form, was one I wrote that appears in *Mathematics Teacher*, September, 1997, in the "Media Clips" column.

## Scatter Plots: Absences and Grades

Below are the number of absences and final semester grades from part of an intermediate algebra class a few years ago. The class met 28 times on Tuesdays and Thursdays. A grade below 70 was considered failing.

Absences	2	2	8	0	2	15	3	2	18	2	1	1
Grade	70	84	64	100	78	9	91	72	8	78	99	87

Make a scatter diagram showing this information.

1. Draw what appears to be the best fitting line through the points.
2. Pick two points on your line. (They don't have to be points you plotted.) Find the slope of the line. Write it first as a fraction and then as a decimal rounded to the nearest hundredth.
3. Now use the slope you computed and use the point-slope form to get an equation for this line.
4. Find the  $x$ - and  $y$ -intercepts for this equation. What do they mean?
5. What kind of relationship does there appear to be between absences and grades?
6. What does the slope represent in this case?
7. Use your equation to predict the grade for a person with 5 absences. Do you think this is a good prediction? Why or why not?

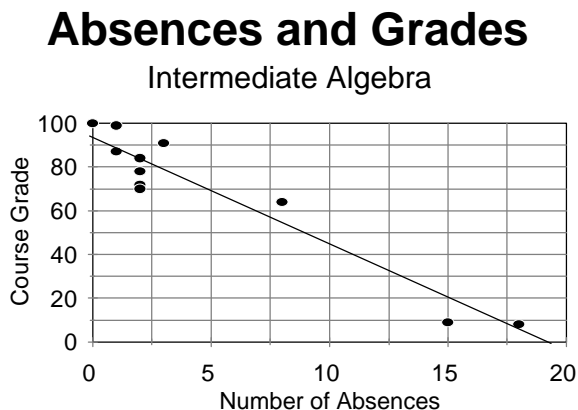
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### Comments

From a statistical calculator, the regression line equation is  $y = 93.24 - 4.98x$ . The correlation coefficient was computed to be about -0.95.

Using this equation, a person with five absences would have a predicted grade of about 68.

Chart generated in Quattro Pro:



Original idea came from Jim A. Ham's home page at Delta College in Michigan, found at <http://www.delta.edu/~jaham/absence.txt>. I used information from my own classes and different questions. Ham has a number of interesting ideas and links, including several more activities blending algebra and statistics, on his home page at <http://www.delta.edu/~jaham>; you might want to check it out!

## Edible Data

**Objective:** At the conclusion of this activity, the student should be able to construct bar graphs and circle graphs (pie charts).

### Materials/Additional sources:

- For each group of approximately four students, a small bag of M&Ms, Gummi Bears, jelly beans, Reese's pieces, or any other snack-type food that comes with several different colors in each bag (but not too many, as it slows the process down).
- (optional) napkins, paper towels, pie pans, margarine containers, or other item to help keep the candy from rolling off in the floor and make counting easier
- Protractors (supplied by teacher or student, at teacher's discretion), at least one per group
- Straightedges
- Calculators, at least one per group (usually supplied by students)
- (optional) Sheets with circles already drawn with the center marked. The instructor may even wish to have circles with sectors already marked off in increments of  $5^\circ$  or  $10^\circ$ .
- (optional) Computers with graphing software and printer and/or floppy disks
- (optional) Colored markers, pencils, or crayons. It's interesting that college students, when given a chance, may want to color their graphs, especially if it's at a stressful time of the semester!

### Activities

Have students work in groups of approximately four. Give each group a small package of M&Ms, Reese's pieces, Fun Fruits, or other type of multicolored candy. You may also want to give each group something to place the candy pieces on or in (such as a margarine container) if the desks are tilted. You may need to guide the students through the process step by step as they go along, depending on their backgrounds.

Instructions for each group:

Before opening the package, the group should predict how many pieces are in the package and how many of each color might be found when opened. Then open the package and sort the pieces by color or other appropriate category. Do not eat the data yet!

Record the number of pieces of each category that are in the bag in a frequency table. Be sure to note the total number of pieces.

Make a bar graph to represent this information.

Compute the percentage of the total each color represents, and then translate that into degrees of a circle. Use this information to construct a circle graph.

Consolidate information from all groups and record this on the board/overhead. See how closely each groups' findings match the aggregate.

Discussion questions to consider: Which color appeared most frequently? least frequently? Is this true overall, or just in some packages? If you opened another package, what distribution of colors would you expect?

Save the information collected to use again later in discussing mean, median, mode, and probability. Then (and only then) may the students eat their data! Continue with the lessons for the rest of this objective.

**Extension:** In the lesson on measures of central tendency and variability, use the aggregate data collected in this activity to compute the mean, median, mode, and standard deviation of the frequencies of the various categories.

**Interesting Tidbits:** Here are the official percentages of M&Ms in each kind of bag as given by M&M/Mars Consumer Affairs. (Source: *Chance*, vol. 9, no. 4, 1996, p. 22)

Variety	Brown	Yellow	Red	Orange	Green	Blue	Pink	White	Purple
Plain	30%	20%	20%	10%	10%	10%			
Peanut	20%	20%	20%	10%	10%	20%			
Almond	20%	20%	20%		20%	20%			
Peanut Butter	20%	20%	20%		20%	20%			
Easter		20%			20%	20%	20%		20%
Valentine's			40%				40%	20%	

Note: The Easter colors are pastels, so they're not the same as the regular colors.

# More Ideas for Statistical Activities

## Reaction Times

**Materials:** Meter sticks or yardsticks, calculators (likely student supplied). Optional: Computer with statistical package or spreadsheet.

**Activity:** Have students work in pairs or threes. One student holds a meter stick vertically (with low end of the measuring scale at the bottom) right above the other student's hand. On cue, the student drops the meter stick (or yardstick) and the other student grips it as soon as possible. Record the number of centimeters (or inches) it took for the student to catch the meter stick (yardstick). Students switch jobs and repeat the procedure. Have each student get several trials and record each trial. Then consolidate the information for the class as a whole.

Have students compute the mean, median, mode, and range, first for themselves, then for their pair or group, then for the class as a whole. Discuss what might be an appropriate type of graph for this activity. Try constructing graphs on graph paper or spreadsheets. You might even introduce the concept of standard deviation here, perhaps showing how to use the statistical functions of the calculator or spreadsheet (Quattro Pro uses  $@STD(\text{range})$ , for example).

## How Do Your Feet Measure Up to Your Height?

Here's another one for making scatter plots. If you wanted to get really brave, you could introduce a correlation coefficient to see how closely height and shoe size are related.

Have each student relate his/her height and shoe size. The height may be done in inches or converted to centimeters. Alternatively, heights could actually be measured in centimeters in class, and it might be interesting to find the lengths of students' feet in centimeters. In case someone has feet of significantly different size, take the mean of the two sizes. Optionally, students may want to plot shoe size versus height on graph paper. Note: It is probably a good idea to have separate graphs for men and women, since their sizes are computed slightly differently.

After making a scatter diagram, have the students predict, for example, the height of a woman who wears a size 5 shoe.

For a dramatic flair, make up a story about footprints being found in the mud or snow. Detectives have determined the size of the shoe. What was the probable height of the suspect?

## Making Graphs with Quattro Pro

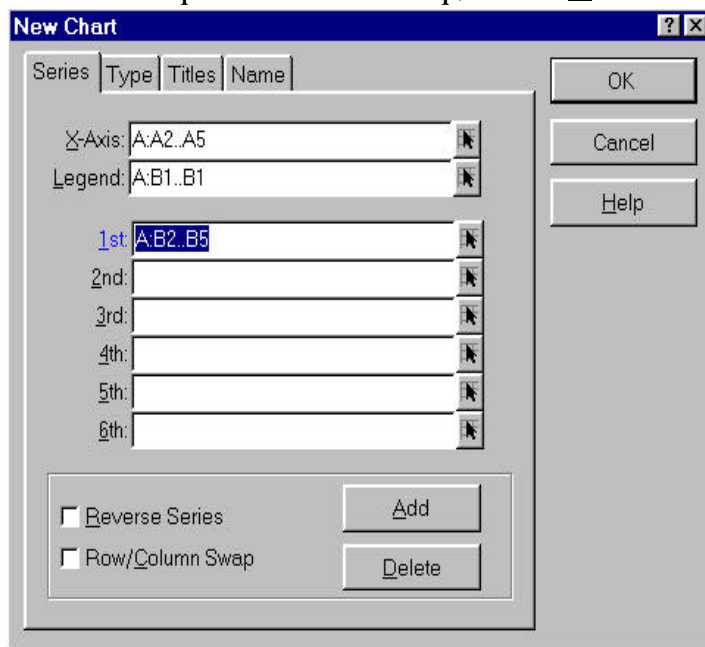
*(Note: These instructions are for Quattro Pro v. 7, included with the Word Perfect 7 Suite. They have also been tested for Version 6. I haven't bought Version 8 yet, so I can't promise they'll work exactly the same. Similar instructions should hold for other spreadsheet programs with graphing capabilities.)*

First, enter the information you want into a spreadsheet. For the example with the coins, here's a table we might enter:

	A	B
1	Decade	Frequency
2	1960s	1
3	1970s	2
4	1980s	7
5	1990s	11

Now use the mouse to highlight this part of the spreadsheet. (Bring the mouse to one corner of the spreadsheet, press the left button down and hold, move it to the opposite corner, and release. The boxes should appear in inverse video.)


From the Graphics menu at the top, choose New Chart. . . . A new pane pops up.



### Bar Graphs

To make a bar graph, everything should be fine on the Series tab, but here's a note on the settings. The X-Axis refers to the *x*-axis if you're doing a line or bar graph, or the categories used for a circle graph. The Legend refers to what will be seen as a label on the *x*-axis. Then 1st is your *y*-axis. If you do want to change the cells used for creating your graph, you can either manually type in the addresses of the cells (note: the A: means the top layer of the spreadsheet), or you can click on the arrow in the box to the right and highlight the cells you want to use and press Enter.

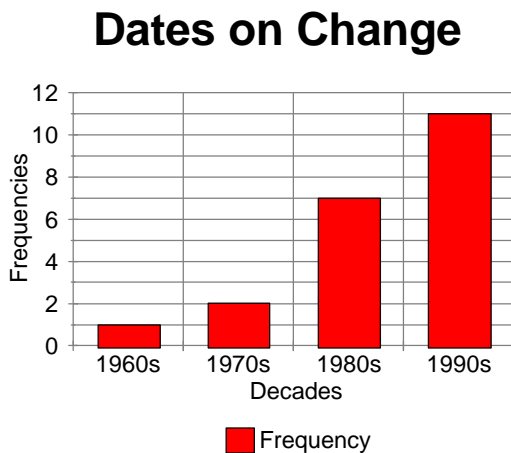
Now you'll want to choose the type of graph you want. Click on the Type tab in this pane. You'll get a pull-down menu at the top to choose Area/Line, Bar, Stacked Bar, Pie, Specialty, or Text. Let's start with a simple bar graph, which would be appropriate for our data. Click on the down-arrow and choose Bar. You'll see several styles of bar graphs to choose from. Let's choose the first one on

the first row (  ) for now for a traditional vertical bar graph.

Now we'll set up our titles and labels. Click on the tab marked "Titles." The Main Title is the large title you want above the entire graph. The Subtitle is just underneath. Then you can choose titles (labels) for your X-axis and the y-axis, which here is the Y1-axis. (The Y2 axis isn't needed here. We can type in a main title of something like "Dates on Change." Our X-axis could be labeled "Decades" and the Y-axis "Frequencies."

The Name tab allows you to name the graph you're creating. Once you've named it, it appears under the Window menu at the top of the screen when you pull it down.

Once all of that is done, click on OK. Now you have your first graph! It should look something like this:



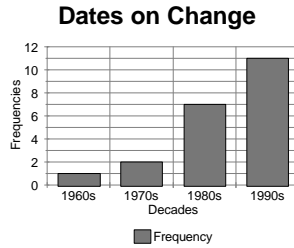
But how can you print it? One of the things you'll probably want to do is to import your graph into a word processing document. For example, I sometimes create a graph that I put in a test and ask questions about.

Click on the boxed X on the *second* (usually gray) line at the top right corner of the screen. Now go to the Graphics menu on the top of the screen, and choose Inset Chart.... Select the chart you just created. Your mouse cursor will change to an icon that looks like a graph. Click in an empty area of the spreadsheet. While there are still the little black squares at the corners of the image, either press Control-C, click on the copy icon at the top, or choose

Copy from the Edit menu. Then switch to your word processing program (e.g. Word Perfect), and press Control-V, select Paste from the Edit menu, or click on the Paste icon. You may have to move your mouse pointer over the chart, right-click, choose Position, and choose to anchor the graphic to the paragraph or a character, then move it where you want it. Otherwise it often gets stuck somewhere on a page where you didn't intend to put it.

You may be saying, "This is great, but even if my printer can print in color, my copier doesn't!" In Quattro Pro you can change the colors of the bars. Go back to the spreadsheet. Under the Graphics menu, choose Edit Chart. . . . Choose the graph you just made. Now right-click your mouse over one of the bars and choose Bar Series Properties... from the pop-up menu. Click on the tab marked Fill Settings. Click on the box marked Pattern Color and click on the black or one of the gray squares. If you don't want a solid bar, you can pick a pattern for the bars instead by clicking on one of the boxes underneath. (By the way, to make a histogram, you can go to another tab marked Bar Options and change the Bar Width Percentage to 100% by sliding the slider or clicking on the numbers and deleting and changing them.) Play around with the other settings and see what they do. Click on OK when you're done and paste it onto the spreadsheet as before. Here's an example of our

graph being changed, in reduced form:



## Circle (Pie) Graphs

Now let's make a circle graph. Here's a different spreadsheet showing how many hours of television 100 students in some classes last spring claimed they watched on average each week:

	A	B
1	Hours	People
2	0-9	5
3	10-19	53
4	20-29	26
5	30-39	13
6	>40	3

Note: To get "0-9" (and other similar classes) instead of the value zero *minus* nine, begin the cell with a double quotation mark: "0-9. It won't appear on the spreadsheet, but it forces the spreadsheet to treat "0-9" as a label rather than subtraction.

Again we'll highlight this information, go to Graphics, choose New Chart..., and on the Type tab, choose Pie from the pull-down menu. We can get some fancy ones, but this one will be plain. Go through the same approximate steps as outlined above to make a bar graph. To get something we can photocopy, you can click on the pull-down bar marked "Default▼" and select "Black and White Patterns." If you don't like the patterns the computer chooses, you can right-click on any segment, choose Pie Chart Properties, and click on a different pattern, finishing by clicking OK. I haven't figured out how to change the percentages to be formatted any way except in hundredths. You can change any of the fonts by pulling down on the font menu while you're viewing the chart. Here's our result:

### Weekly TV Hours Watched

