Not Just Your Favorite Graphs: Representing Data with Bar Graphs		
Description	**Instructor Notes**	**Slides/Handouts/Files**

Explore data representation with bar graphs on the TI-73 Explorer using categorical and numerical data. Distinguish between appropriate and inappropriate representations for data based on essential features of bar graphs. Explain how conventions in constructing bar graphs may be manipulated to highlight certain features of the data while obscuring other features of the data. Determine which statistics (range, mode, median, mean) may be appropriately applied to describing data represented in bar graphs.
 	
Key Questions to Explore:
1. What are essential features of bar graphs?
2. What conventions help to make sense of data in bar graphs?
	1. Noticing features of bar graphs:
	  a. Show four different bar graphs (i.e., case value plots and frequency bar graphs using categorical and numerical data).
	  b. Have students examine these bar graphs to identify similarities and differences.
	  c. The focus of this discussion should reflect the features of bar graphs (e.g., bars are used to represent the data, each bar represents a case or a category of something, the length of each bar tells how much or how many of something, bars are equal width); and features of the data (e.g., cases with case values, categories with frequencies, if it matters that bars could be arranged in a different order)
	2. Collect data from students (e.g., number of letters in first name; birthday month; height in centimeters; estimated number of minutes used on cell phone today). Be sure to ask at least two survey questions to collect some data that is categorical and some data that is numerical. One way to collect data is for each student to have a separate sticky note for each survey question. Each student writes her/his answer to each question on a separate sticky note.
	3. Organize the data from the class. Gather the sticky notes from each student according to each question and sort the responses for each question, or have students post their sticky notes with responses for one of the questions on the wall/board for the class to sort. Decide what information indicates the cases or categories, and what information indicates the case values for each case or frequencies for each category.
	4. Have students enter the data in lists on the TI-73 Explorer. Please note that the TI-73 Explorer is limited to 7 bars for any one bar graph. Data may need to be grouped to accommodate data from the whole class
		• Sample Bar Graphs to Compare – may be used to compare similarities and differences in the first step of this activity.
		• Conventions for Bar Graphs – may be used by the instructor as background information on key ideas for data analysis with bar graphs.
		• Descriptive Statistics and Bar Graphs – may be used by the instructor as background information on key ideas for using statistics appropriately with bar graphs.
		• Student Sheet – Not Just Your Favorite Graphs: Representing Data with Bar Graphs
		• Instructions for entering data in lists on TI-73 Explorer (See the manual for the TI-73

3. What conventions of bar graphs are not necessary to make sense of the data?
4. When is it appropriate to use a bar graph to display data?
5. What does the TI-73 Explorer assume about the data for making a bar graph?
6. What does the TI-73 Explorer allow (correct and incorrect), and what do you need to know to set up a meaningful plot for a bar graph?

(frequency bar graphs), or select data from 7 students (case value plots). For example, the TI-73 will allow up to 7 cases for a case value plot, or up to 7 categories for a frequency bar graph. Numerical data such as the height of students in centimeters may be grouped into 7 or fewer categories (e.g., 120-129 cm, 130-139 cm, 140-149 cm, etc.). In this case, the numerical data for students' heights is treated as discrete categories, rather than a continuous measure. When grouping data into categories, please note that each category must be distinct (discrete) from other categories for a bar graph. If numerical data is used and the data is considered as continuous, then a histogram would be more appropriate.

5. Set up the following plots:
   a. case value plot with categorical data
   b. case value plot with numerical data
   c. frequency bar graph with categorical data
   d. frequency bar graph with numerical data
6. Discuss each plot for conventions used in displaying data with bar graphs (what each bar represents, what the length of each bar represents, equal width bars, equal spacing between bars, order of the bars).
7. Discuss how the TI-73 Explorer deals with each convention, implicitly or explicitly. Discuss the implications for manipulating the data by manipulating the conventions (change the plot to switch the meaning of the bars and bar lengths; change the order of the bars; when the TI-73 Explorer shows an error message for the plot and how that relates to the data and setting up the plot for a bar graph). Analyze and interpret the data represented in each bar graph.
8. Calculate the descriptive statistics for each bar graph (range, mode, median, mean).
9. Discuss which statistics make sense for the data represented and which statistics do not make sense for the data represented in a bar graph. Have students explain how the statistics describe the data represented.

with Graph Explorer Software, Chapter 5: Lists)
- Instructions for setting up plots for bar graphs on TI-73 Explorer (See the manual for the TI-73 with Graph Explorer Software, Chapter 6: Statistical Plots)

Participant Discussion Questions and Sample Responses

1. *Examine these bar graphs.* **[Examples are provided in the *Sample Bar Graphs to Compare* document.]**

- *What do the bars represent?* **[Each bar represents a category or case.]**
- *What do the lengths of the bars represent?* **[The length of a bar represents the frequency of each category or value of each case.]**
- *What does each bar graph show about the data?* **[List statements that can be concluded about the data represented in each bar graph. For example: 15 people surveyed own basic calculators; Ann owns 3 more calculators than Bob; more than half the people surveyed own 2 or 3 calculators.]**
- *What features of the data are highlighted or shown in the bar graph?* **[It is typically easy to see how many or how much of each category or case; it is relatively easy to compare the quantities of each category or case.]**
- *What features of the data are not shown or hidden in the bar graph?* **[What portion of all the data represented is a certain kind of category or case; what is average or typical about the set of data; when representing numerical data (such as how many people own a certain number of calculators) the categories are numbers and the frequencies are numbers, which can cause some confusion for keeping track of what the numbers mean.]**
- *Are the bars arranged in any kind of order? Why or why not? Would it matter if the bars were arranged in a different order?* **[Examples from the *Conventions for Bar Graphs document include* bar graphs with bars arranged by height (least frequent to most frequent); bars arranged by the number of calculators owned; categories arranged alphabetically; categories arranged by level of sophistication (e.g., kind of calculator owned is basic, fraction, scientific, or graphing).]**
- *How are these bar graphs similar, and how are they different, from each other?* **[All use bars to compare data; some are frequency bar graphs and others are case value plots; all have equal width bars and equally spaced bars; some arrange the bars in a particular order; the bars may be arranged in any order for all of the example graphs without changing the meaning of the data.]**
- *Which bar graphs show the value or how much of something?* **[For example: How many calculators does each person own?]**
- *Which bar graphs show the frequency or how many of something?* **[For example: How many people own each kind of calculator?]**
- *Which bar graphs represent categorical data?* **[For example: What kind of calculator do you own?]**
- *Which bar graphs represent numerical data?***[For example: How many calculators do you own?]**

2. *Collecting data: sample survey questions are listed below, or you may design your own survey questions. Be sure to include at least one survey question that results in categorical data and at least one survey question that results in numerical data.*

- *How many letters are in your first name?*
- *What month of the year were you born?*
- *What is your height in centimeters?*
- *What kind of calculator do you own (choose from basic, fraction, scientific, graphing)?*
- *About how many minutes will you use on your cell phone today?*
- *How did you come to school today (walk, ride bicycle, bus, car, other transport)?*

3. *Organizing the data collected by students:*
- *How can we sort this data to make sense of it?*
- *What kind of data was collected for this survey question (e.g., cases and case values or categories and frequencies of each category)?*
- *What information indicates the cases/categories?*
- *What information indicates the case values/frequencies?*
- *How many cases/categories are represented by sorting the data in this way? If we are limited to 7 bars (cases or categories) in our bar graph, how can we sort the data?*
4. *Enter data in lists on the TI-73 Explorer.*
5. *Set up the plots for bar graphs of the data.*
6. *Examine the bar graphs of the data on the TI-73 Explorer.*
- *What do the bars represent?*
- *What do the lengths of each bar represent?*
- *Are the bars in any kind of order? Why or why not?*
- *Explain how it would change the visual effect of the bar graph for analyzing or interpreting the data if the bars were rearranged in a different order than what is currently displayed.*
7. *Bar graphs have several conventions (features that are agreed upon by mathematicians and statisticians) for what the bars represent, what the lengths of each bar represent, the width of the bars, the spacing of the bars, and the ordering of the bars. Answer the questions below by using the TI-73 Explorer to manipulate the data for your bar graphs in the following ways, and compare the new bar graphs with the original bar graph:*
   a) Switch the order of the bars by changing the order of the data in the lists. Be sure to keep related data values together (e.g., switching the order of the categories requires also switching the frequencies for each category in the same way).
   b) Switch the category list with the data list for one of your bar graphs. What happens? If you get an error message, what does it indicate? Explain. Try switching the lists for a different set of data. If you do not get an error message, explain how this new bar graph is similar and different from the original bar graph. What do the bars represent now? What does the length of each bar represent now? What does this new bar graph show about the data? What is not as obvious about the data from this display of the data?
- *Why are certain conventions helpful when displaying data in bar graphs?*
- *What conventions about bar graphs does the TI-73 Explorer automatically use to display the data?*
- *Which conventions of bar graphs does the TI-73 Explorer allow to be manipulated?*
8. *Use the conventions for bar graphs and set up the plots on the TI-73 Explorer to represent your data. You should have at least one case value plot, and one frequency bar graph. (Note: if you manipulated the data by switching data lists and ordering data, be sure to switch it back so that the conventions for bar graphs are evident). Calculate the descriptive statistics of range, mode, median, and mean for the data represented in each bar graph.*

9. *Consider the statistics you calculated and the related bar graph:*
   - *Which statistics make sense to calculate for this set of data? Explain.*
   - *Which statistics can be calculated but have no meaning for this set of data? Explain.*
   - *What statistics cannot be calculated for this set of data? Why?*

Questions for prospective and practicing teachers

based on the National Council of Teachers of Mathematics Content and Process Standards for Grades 6-8

Data Analysis and Probability

- *Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them*

  What topics or information might be interesting to your students for designing questions to collect data?

  How might you support students to develop and refine their own questions to pursue for collecting data?

  What methods will students use to collect and organize the data?

  - *select, create, and use appropriate graphical representations of data*

    How might you support students' thinking so that they are able to determine what are appropriate graphical representations of the data they collected?

    What role will technology have in the creation of representations of data collected (e.g., graphing hand-held; spreadsheet software; etc.)?

    How might students use graphical representations to analyze the data collected?

- *Select and use appropriate statistical methods to analyze data*

  How might you support students in determining which statistics are meaningful for analyzing the data they collected?

  What methods of calculating appropriate statistics are meaningful to your students?

  - *find, use, and interpret measures of center and spread*

    What tools or materials might be helpful for students when finding appropriate statistics for data collected?

    How might you support students' interpretation of the statistics used to describe the data they collected?

    How might graphical representation of the data help students to make sense of the statistics that describe the data?

Representation

- *Create and use representations to organize, record, and communicate mathematical ideas*

   What will students need to know to use technology appropriately in creating meaningful representations of the data they collected?

   How might students use appropriate graphical representations to communicate analysis of the data to answer the original question posed for collecting the data?