



the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Lines and Bars – Graphing Exercise

Grade Level	Middle School	Subject	Science
Objective(s): TSW determine the graph type to represent real world data collected and recorded at the CEED building to understand how to analyze and interpret graphical information.		SOL Addressed: 6.1 g) data are collected, recorded, analyzed, and reported using metric measurements and tools; h) data are analyzed and communicated through graphical representation; L.S. 1 h) data are organized, communicated through graphical representation, interpreted, and used to make predictions; LS 1 i) patterns are identified in data and are interpreted and evaluated PS 1 i) frequency distributions, scatterplots, line plots, and histograms are constructed and interpreted PS 1 j) valid conclusions are made after analyzing data Next Generation Science Standards: MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	
Materials Needed Per Class of 30 and Prior Knowledge	internet computer access to the CEED dashboard for data graph paper pencil ruler		
Ways to differentiate this lesson plan	<ul style="list-style-type: none"> • EXTENSION for Higher Level Learner or students in Algebra I. Students can determine the slope and equation of their line of best fit for their line graphs. 		

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Instructional Activities

<p style="text-align: center;">Introduction/ Anticipatory Set</p>	<p>Anticipatory Set: The teacher will show various types of graphs (bar graphs, histograms and line graphs) and ask students to identify each type and to explain the differences to assess prior knowledge.</p> <p>What is the difference between a bar graph compared to a histogram? When should information be displayed in a bar graph or line graph?</p>	<p>Introduction: In this activity, the teacher will model as each student works individually to create both a bar graph and a histogram.</p>
<p style="text-align: center;">Guided Practice</p>	<p>The teacher will model the creation of a bar graph, histogram and line graph from data collected by the class. Data will be collected and recorded into data tables created by the students on their answer sheets, and the teacher will guide the students through the proper creation of each type of graph. Special focus will be placed on identifying the x and y axis, the independent and dependent variables, determining data range and proper scales and labeling axes with units and a descriptive title.</p>	
<p style="text-align: center;">Independent Practice</p>	<p>The students will investigate various data that is collected at the CEED website and Weatherbug station. The students will then determine data to download into a data table to create both a bar graph and a line graph. The students will independently create their graphs and will be assessed on proper graph usage, labeling, scaling and identification of variables.</p>	
<p style="text-align: center;">Closure (Summary of Lesson)</p>	<p>Student should answer conclusion questions. Students can share their graphs with the class to discuss and determine any potential relationships between their independent and dependent variables.</p>	

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Instructional Activities

CEED Building Application/ Sensor Data	CEED sensor data using the data query feature of the dashboard.
Assessment	Proper graphing technique and graph interpretation will be assessed.

Teacher Notes

Part One: Bar Graphs

What is the difference between a bar graph compared to a histogram?

A bar graph the bars have spaces between them and each bar is labeled with a category. Histogram bars have a number scale at their based that is a portion of the number line and have no spaced between them. Bar graphs and histograms are used to show the frequency of data of a particular type.

In this activity, the teacher will model as each student works individually to create both a bar graph and a histogram.

Bar Graph: Collect class data on the number of boys and girls in the classroom. Let the students determine what information should go on the x axis and the information on the y axis. Lead the class in a discussion on the scale of the y axis. The scale represents the range of frequency values shown on the graph. Visually show students how to properly create a scale using an overhead projector, whiteboard or interactive board. Students should write down the **range** of data, count the squares on the graph paper and determine the appropriate spacing. Students should be encouraged to use at least 3/4th of the available space for their graph.

Students will now determine how to label the graph with the **graph title, axes labels and units**, (if required) and **keys**.

Histogram:

Collect information on birthdates of students across a range by season.

December 21 – March 20 Winter

March 21 – June 20 Spring

June 21 – September 20 Summer
September 21 – December 20 Autumn

Create a histogram where the bars are touching for each range of dates. Students will need to create a proper scale on both axis for this graph.

Graph Analysis:

Key terms - **Interpolate** – identify specific areas between points
Extrapolate – identify areas beyond the data points.

For bar graphs and histograms, it is challenging to identify specific interpolation points on the graph, but estimates for comparison purposes are very easy. Extrapolation is almost impossible on bar graphs as well since we are not necessarily observing trends.

Part 2. Line Graphs

While bar graphs and histograms are used to compare facts and categories, line graphs are used to determine the relationship between two factors or variables and identify trends. Using the following data table, students will be follow along independently with the teacher modeling the proper scaling, labeling and plotting of a line graph.

Data Collection: Height and arm span. The teacher will set up a large sheet of paper on the wall previously marked with a scale. This can also be done simply using an overhead projector shining on the student to determine height and arm span from fingertip to fingertip. Students will create a data table.

Students should be asked if they can identify the x and y axes labels and units. These should be labeled on the graph.

Ask students about the terms independent and dependent variable. Where are these placed on a graph? Students should label their graph with the terms *independent* until the x- axis and *dependent* on the y axis.

Student should now identify any additional missing labels (title). The title should be description of the type of information to be conveyed from the activity, not simply the title of the lab or renaming the axes.

The teacher should lead the students to determine the range of data points for each axis (which will involve analyzing the data table carefully as it is not likely listed in increasing or decreasing order). The scale for each axis will be determine by counting the number of squares available on the graph paper. Each data point should be plotted.

Finally, a trend line should be determined. If a trend is visible (generally increasing), the line should be drawn using a straight edge to create a line of best fit, not connect the dots with the data point. Remind students that if more than one set of data points were to be plotted, a key would need to be added to the graph. Students could offer suggestions of additional measurements that could be made.

Line graph interpretation:

Emphasize that graphs can be used to determine relationships and trends as well as interpolation and extrapolation of data.

To demonstrate **interpolation** try to find a value that should lie between two actual data points on the graph. To demonstrate **extrapolation** of data find a value that lies on the line before or beyond the actual data points.

Since this example will generally generate a straight line, some students may be asked to write the equation for the straight line in a slope-intercept form ($y = mx + b$) where m is the slope of the line (rise/run or $\Delta y / \Delta x$) and b is the point at which the line crosses the y axis. The line of best fit may need to be extended to determine the y -intercept.

Part III. Student Determined Graph Types

The students will now have access to the CEED Dashboard with sensor data and weather bug data. Allow students to explore the site to discover all of the types of data that is collected at the CEED building. The students will then be tasked with creating two graphs. One must be a line graph that has an independent and dependent variable. The other will be a bar graph or histogram that displays categories of information. The students will use the query feature to download at least ten data coordinates for their line graph and at least two categories for their bar graph or histogram.

The students will copy or print the data into data tables and then create one graph each of the data. The graphs will be graded for identification of the correct graph type, identification of axis and labels, title, keys if necessary, units and proper scaling of the data. If a trend is identified for the line graph, the students should draw a line of best fit, not connect the dots.

Conclusion Questions:

Bar Graph/Histogram

1. Using the bar graph and histogram, if a new student is added to the class tomorrow can you make any predictions about their gender or birthdate?
2. What type of data is best represented by a bar graph?
3. Why do you think it is important to determine a scale for your graph?

Line Graph

4. What type of data is best represented by a line graph?
5. What is the independent variable in the line graph data collected in class?

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6. Where are independent variables placed on a graph?
7. Determine the likely arm span of a student who is 10 cm taller than the tallest student in your class?
8. Determine the likely height of a student who has an arm small 3 cm smaller than the smallest arm span in your class.

CEED Website Data Query:

The CEED is a center for students to actually and virtually explore ways to save and produce energy. The center also has a Weatherbug station that collects weather information. Take some time exploring the various dashboards at the center and the information being collected by the center. Then use the query function to download data for your two graphs.

INSERT DIRECTIONS TO USE DATA QUERY OF CEED BUILDING.

What data did you decide to obtain to display in a bar graph? Explain why you chose this data and how it fits into a bar graph format.

What data did you decide to obtain to display in your line graph? Explain why you chose this data and how it fits into a line graph format.

Determine at least one value that you could **interpolate** on your graph and how that could be important for a scientist studying information collected at the CEED.

Determine at least one value that you could **extrapolate** on your graph and how that information could be important for a scientist studying information collected at the CEED.

Name _____

Date _____

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