Equivalent Graphs

Date:______________

Subject: Science, math
Grade: 6-8
Time: 30 minutes

Topic: Reading Graphs
Designer: Sara Remsen

Stage 1 – Desired Results

Lesson Overview: The goal of this activity is to focus students on the essential elements of graphs: scales, labels, and titles. We start with graphs with numerical data on both axes but no units on either. Graphs can look different but represent the same datasets; other graphs look alike and represent different datasets. Graphs at the beginning of the activity do not have measurement units, like miles or seconds, on the axes; the variables are referred to as x and y. Student must attend to the mathematical relationships described by the graphs, rather than relying on their prior knowledge of a real situation. The activity concludes with a presentation of real school enrollment data to show two equivalent the usefulness of equivalent graphs. The choice of scale can affect the meaning of a graph. It can be used to highlight different aspects of the data.

Standards Addressed: The Common Core State Standards (CCSS) for mathematics do not directly address graph reading skills as content standards, but rather, embed them as pervasive and flexible skills of mathematical communication and representation in the Standards for Mathematical Practice. Below are excerpts from the Practices that this activity addresses.

CCSS.Math.Practice.MP6	**Attend to precision.** Mathematically proficient students try to communicate precisely to others… They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem…
CCSS.Math.Practice.MP5	**Use appropriate tools strategically.** Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations.
CCSS.Math.Practice.MP2	**Reason abstractly and quantitatively.** Mathematically proficient students make sense of quantities and their relationships in problem situations… Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

Students will be able to:

- Read graph axes and labels
- Match the same dataset with axes of different scales
- Interpret graphs and data despite apparent differences
- Learn how presentation of the data affects the meaning of a graph

Essential Questions:

- How does a graph's appearance change based on the scale of the axes?
- How can you tell a dataset is the same as another dataset if they look different?
- How does the choice of scales affect the meaning of the same data graphed with different scales?

Stage 2 – Lesson Plan

Lesson preparation

- Students should be familiar with plotting points on a graph and with ordered pairs, i.e. (0,0).
- Students should be able to read graph axes and understand x and y variables
- Students should understand that scales on axes are arbitrary and can be changed at will
- No knowledge of slope is necessary

Procedure

1. Students will use computers/tablets for this activity (20-30 minutes)

2. As an extension, you can print out the graphs on the last pages of this lesson plan (pp. 3-7) and give each student one or two of them. These graphs are similar but not identical to the graphs the students saw on the computer activity. You can continue the activity by having students see which of their graphs are the same as other students' and which are different. The questions from the activity are also listed if you want them to answer by hand and turn them in. (10-20 minutes)

   Note: the graphs Random Data 1, 2, 6, and 7 are of the same data; the graphs Random Data 3, 4, 5, and 8 are of different data that are linear functions of the data for the first group, so the graphs look the same.

3. You can also give students some sample data and graph paper and instruct them to make the best graph to represent the data, using what they learned from the activity. They should have to think about their axes and how often they should have tick marks, etc.

Further discussion questions

1. **Which graphs do you think are the easiest to read?**
   Students should observe graphs where the data is centered and takes up most of the space are the easiest to read. It also helps if there are frequent tick marks at easy-to-read intervals (such as 5 and 10), but not so many tick marks that the data are obscured.
2. **Where did you get tripped up when you were trying to identify graphs?**
   Students may say they ignored one axis by mistake or it was confusing because the data had the same shape.
3. **How did this activity change the way you look at graphs?**
   Students should say that they won't get distracted by the shape of the graph, but instead interpret them based on the actual data and the axes.
4. **How are equivalent graphs like an image on two different TV sets? How are they different?**
   If a TV is not calibrated correctly, the image can get stretched or squeezed in the horizontal or vertical direction even if it displays correctly on a different TV. This is very similar to how data can appear differently depending on the axes of the graph. If, for instance, a graph represents a relationship between quantities of the same units using stretched scales can give a false sense of the relationship, and this is a distortion. However, the settings of the TV is not an exact analogy to changing the graph scales. For instance, changing the range of graph axes to display just the graph's data stretches the data, and eliminates some of the representational area of the graph. However, a TV that is stretched always shows all the data in the representational area.

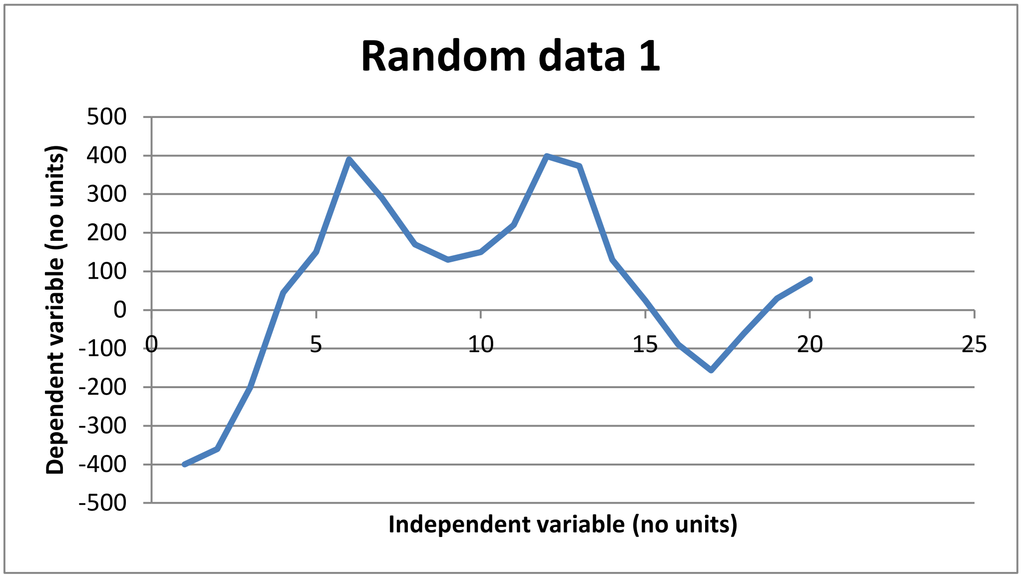
Resource Graphs and Questions

Name: _____________ Date: _________

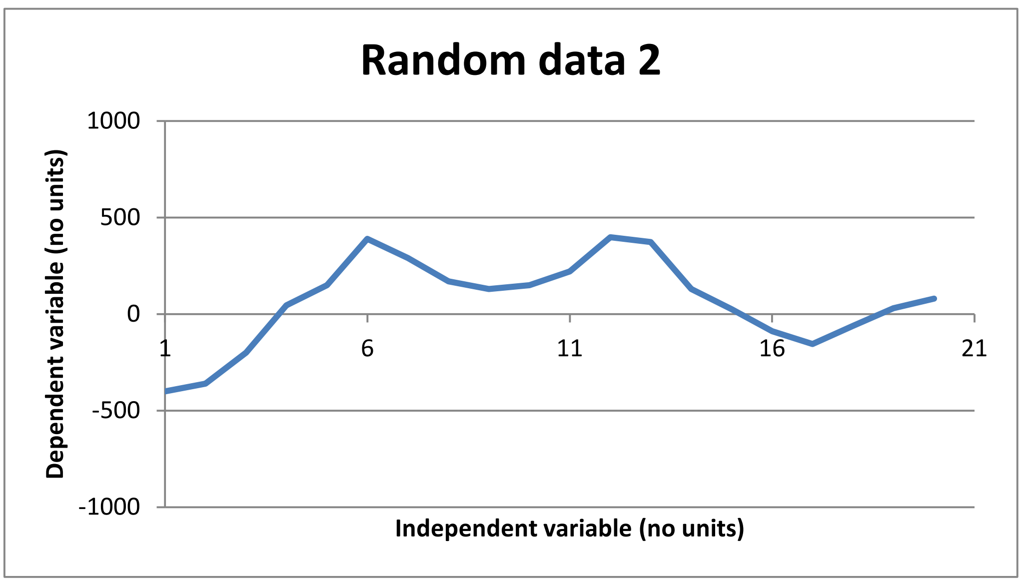
1. What was the number of your graph?

2. Which graphs (by number) were equivalent to your graph?

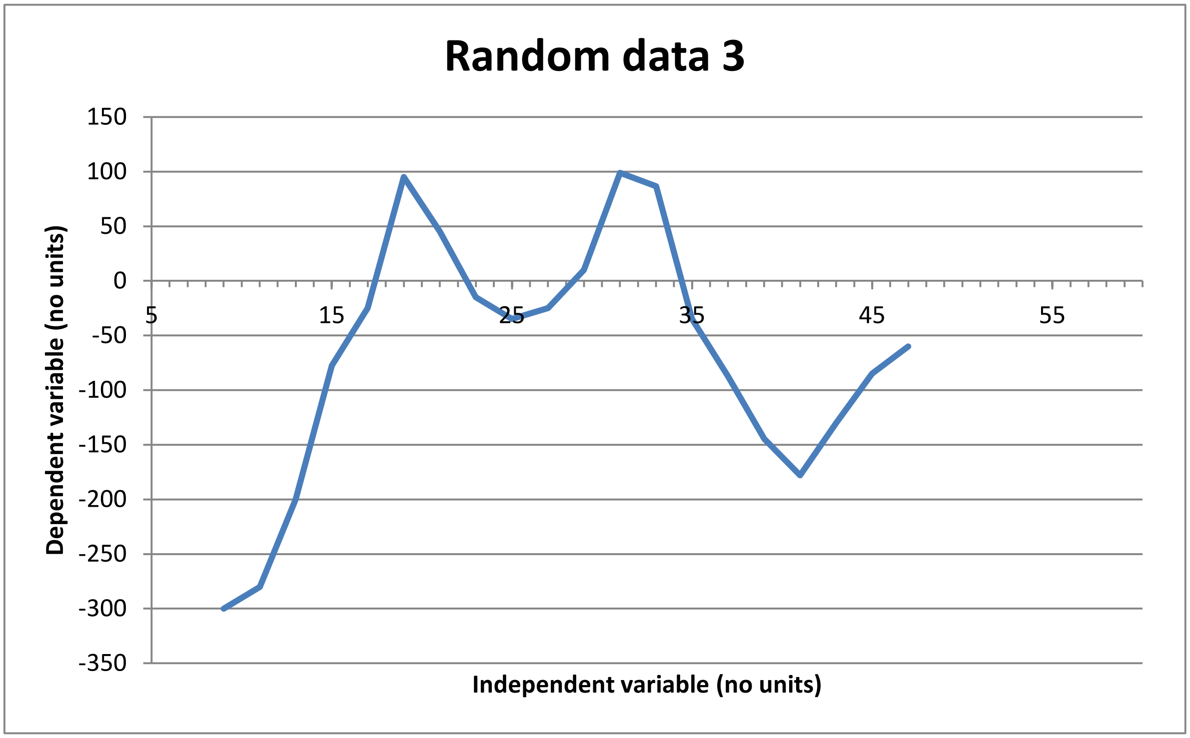
3. How did you know?

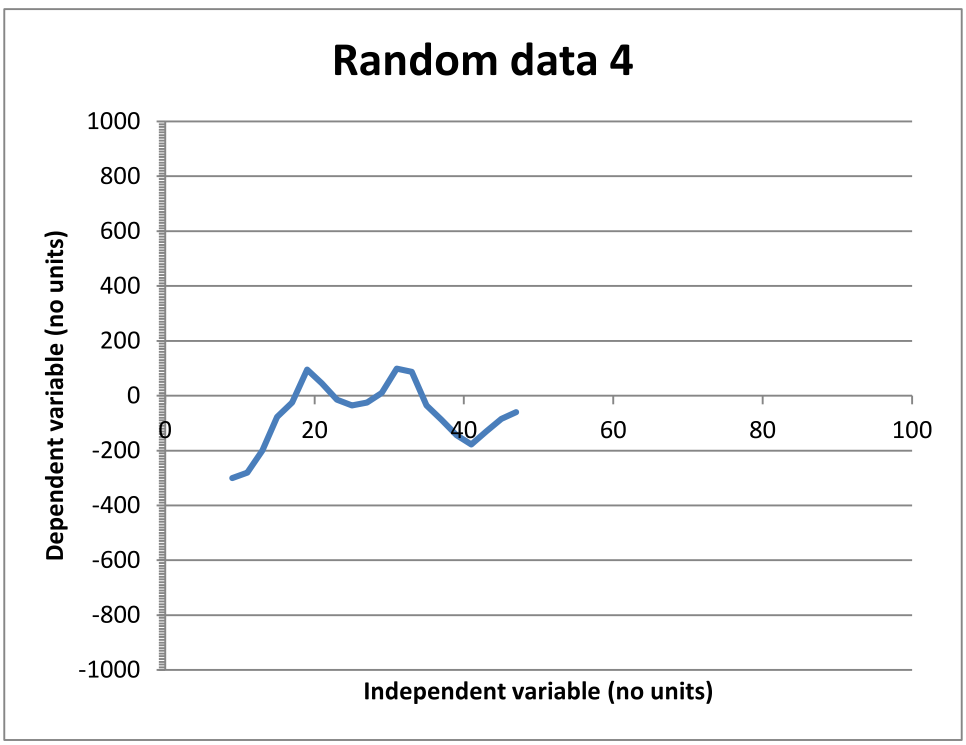


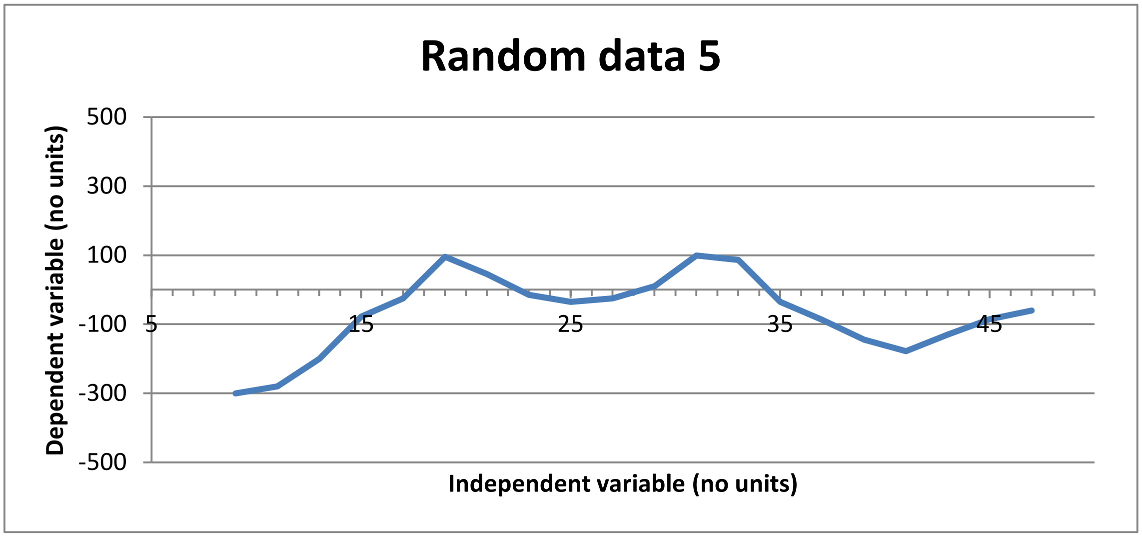
Random data 1
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
5
10
15
20
25
Dependent variable (no units)
Independent variable (no units)

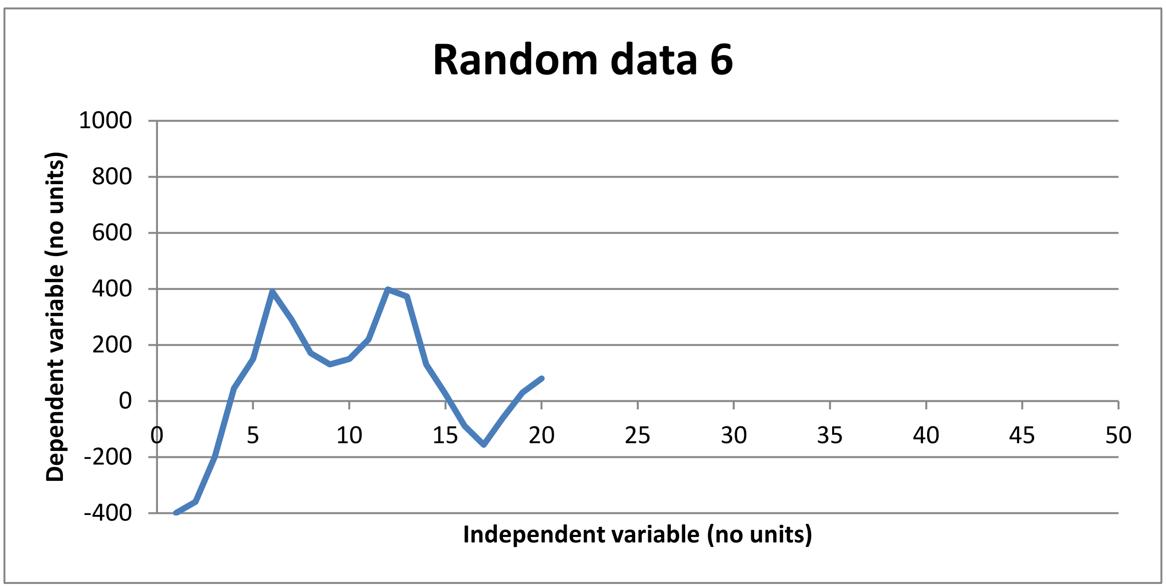


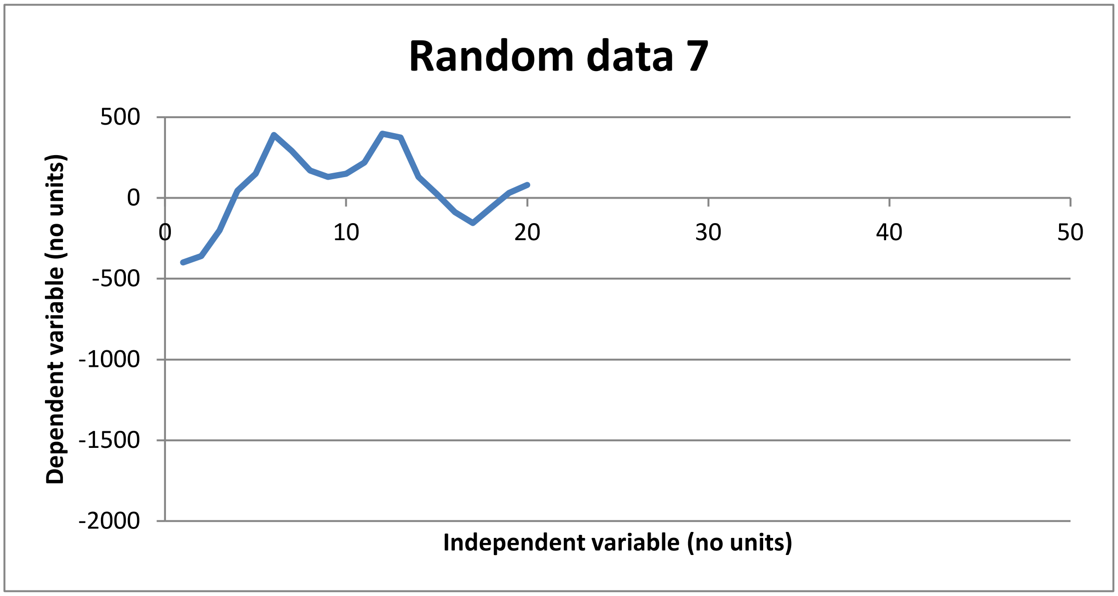
Random data 2
1000
500
0
-500
-1000
1
6
11
16
21
Dependent variable (no units)
Independent variable (no units)


Random data 3
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
5
15
25
35
45
55
Dependent variable (no units)
Independent variable (no units)

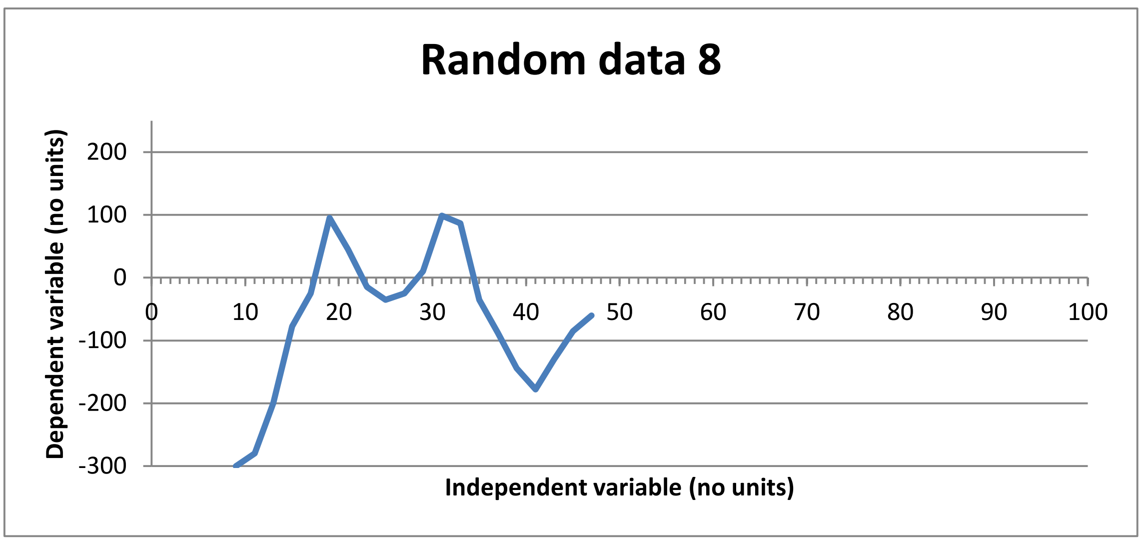

Random data 4
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
0
20
40
60
80
100
Dependent variable (no units)
Independent variable (no units)


Random data 5
500
300
100
-100
-300
-500
5
15
25
35
45
Dependent variable (no units)
Independent variable (no units)


Random data 6
1000
800
600
400
200
0
-200
-400
0
5
10
15
20
25
30
35
40
45
50
Dependent variable (no units)
Independent variable (no units)



Random data 7
Dependent variable (no units)
500
0
-500
-1000
-1500
-2000
0
10
20
30
40
50
Independent variable (no units)



Random data 8
Dependent variable (no units)
200
100
0
-100
-200
-300
0
10
20
30
40
50
60
70
80
90
100
Independent variable (no units)