Chapter 9
Evaluating Outcomes

Abstract The final step in the problem-solving process is to evaluate the effectiveness of the intervention. One way to make data more easily interpretable is to display it visually. By graphing data both providers and caregivers are able to see changes in the behavior measured and decisions about interventions can be made. Graphs can be created through drawing by hand or using computer programs, such as Microsoft Excel.

Keywords Baseline data • Intervention data • *X*-axis • *Y*-axis • Phase change line • Continuing an intervention • Modifying an intervention • Discontinuing an intervention

Once progress monitoring data has been collected for a minimum of three different points, this data should be plotted on a graph. Visual displays provide a simple way to quickly interpret progress monitoring data and determine whether or not an intervention has been effective. Graphs require little time to create once you understand the basic components. Graphs can be created by hand or through computer programs such as Microsoft Excel. In the following sections, both graphing methods will be described.

Important Graphing Terms

- *Baseline Data*: Baseline data refers to the data collected about a behavior prior to intervention. When one looks at data of a behavior before and after intervention implementation, they are able to infer about the intervention's impact. (A in graph below)
- *Intervention Data*: Intervention data refers to the data collected after an intervention has been put into place. Intervention data allows one to see if the behavior has changed after intervention implementation. (B in graph below)

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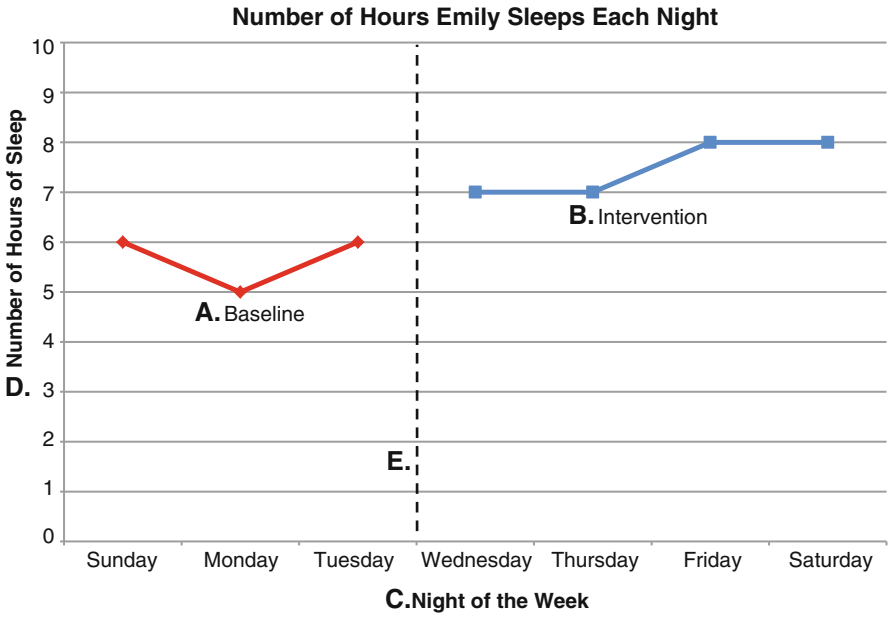
- *X-Axis*: The horizontal axis of the graph represents the time the data was collected. This axis could be divided into minutes, hours, days, weeks, and so on. For example, if the number of hours a child sleeps each night were being measured, the *X*-Axis would represent night of the week. (C in graph)
- *Y-Axis*: The vertical axis of the graph represents the instances of a behavior. This axis could be divided into number of times the behavior occurs, number of minutes, and so forth. For example, if one was measuring the number of hours a child sleeps each night, the *Y*-Axis would represent number of hours of sleep. (D in graph)
- *Phase Change Line*: A vertical, dashed line that separates baseline data from Intervention data. (E in graph below)

See the graph below for an illustration of the graphing terms.



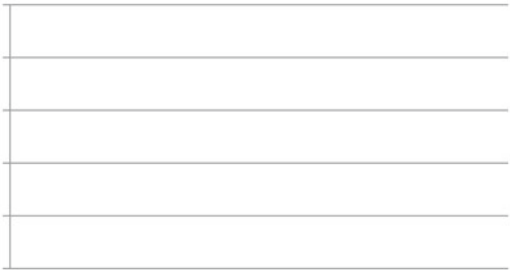
Directions for Graphing by Hand

Emily's parents began implementing an intervention to increase the amount of food Emily consumes. To evaluate the effectiveness of their intervention, Emily's parents have counted the number of bites of food Emily eats each night at dinner for the past week.

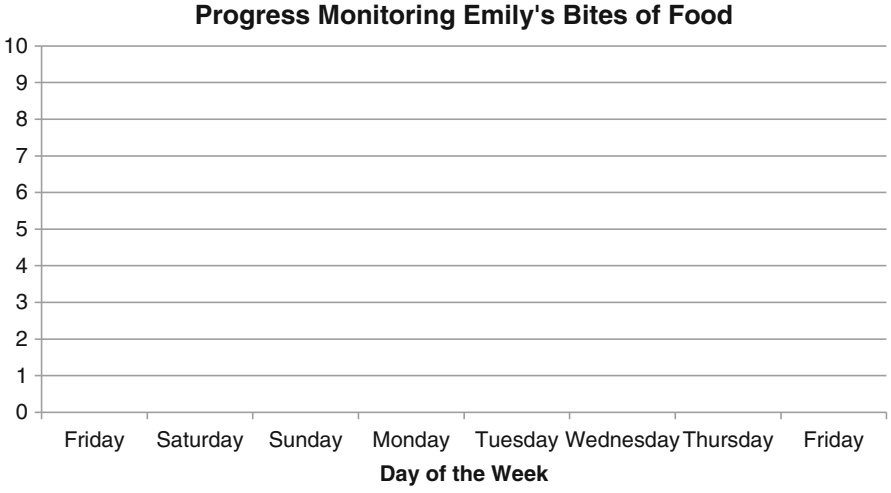
This included 3 days before they actually implemented the intervention (the baseline) and 5 points once they started implementing the intervention (progress monitoring). The next step is to graph this data.

Baseline data			Intervention data				
Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
4	4	4	4	7	6	8	9

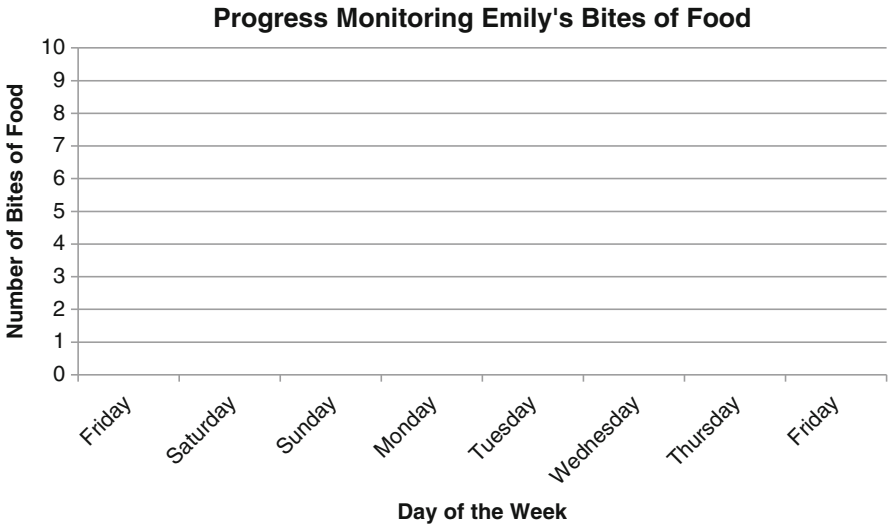
Step 1: See Appendix D. This is the type of graph on which data can be plotted.



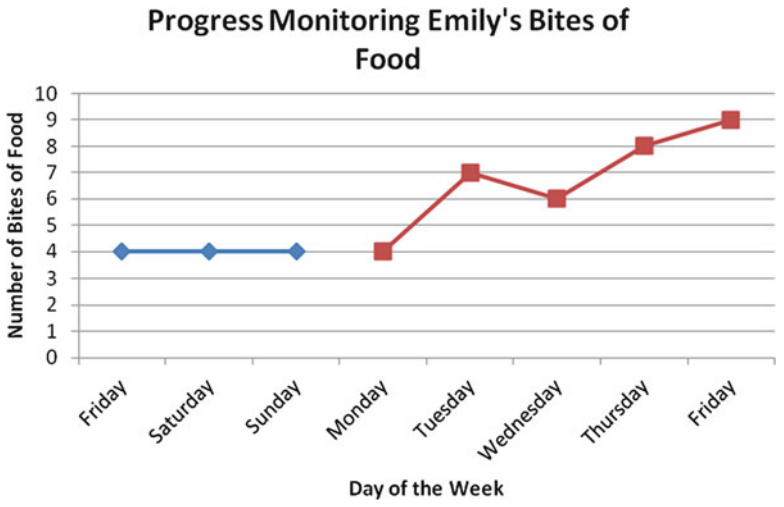
Step 2: Label the horizontal *X*-axis with the days of the week.



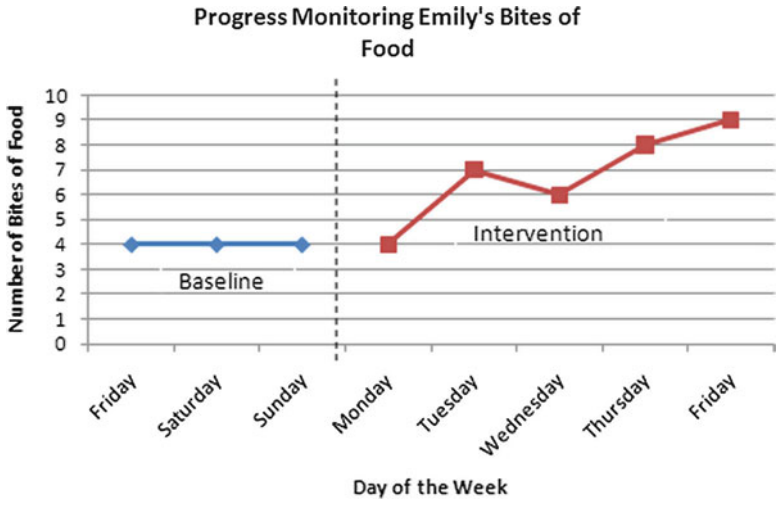
Step 3: Label the vertical *Y*-axis with the behavior and ensure that the scale is appropriate for that behavior (e.g., consider whether or not the scale begins at zero and goes up to or beyond the maximum number of behaviors expected).



Step 4: Plot the data provided above. Be sure not to connect Baseline and Intervention data.



Step 5: Draw a vertical, dotted line between the Baseline and Intervention data to separate them. Then label each.



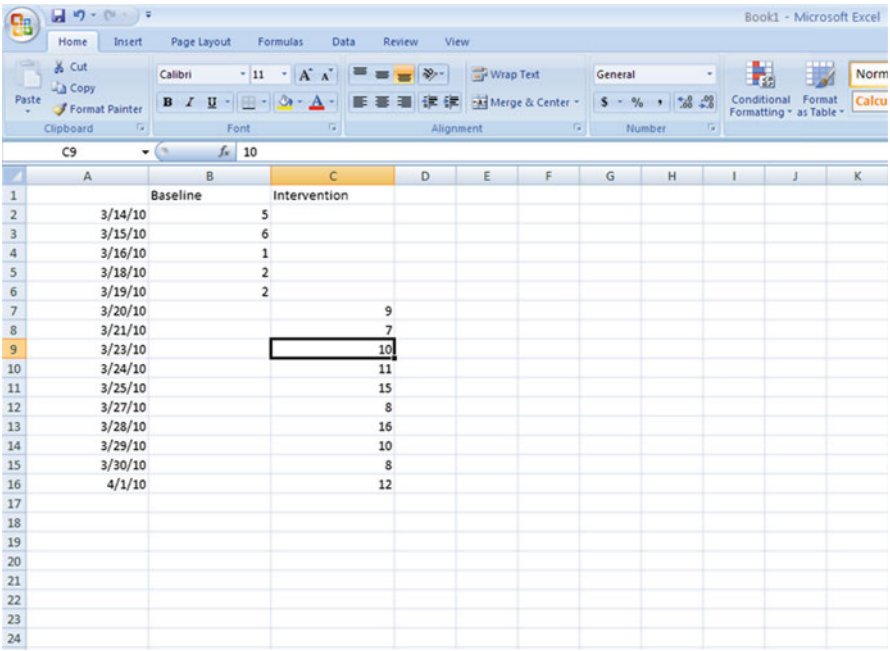
All finished! Now you have a graph of your data.

Computer Graphing

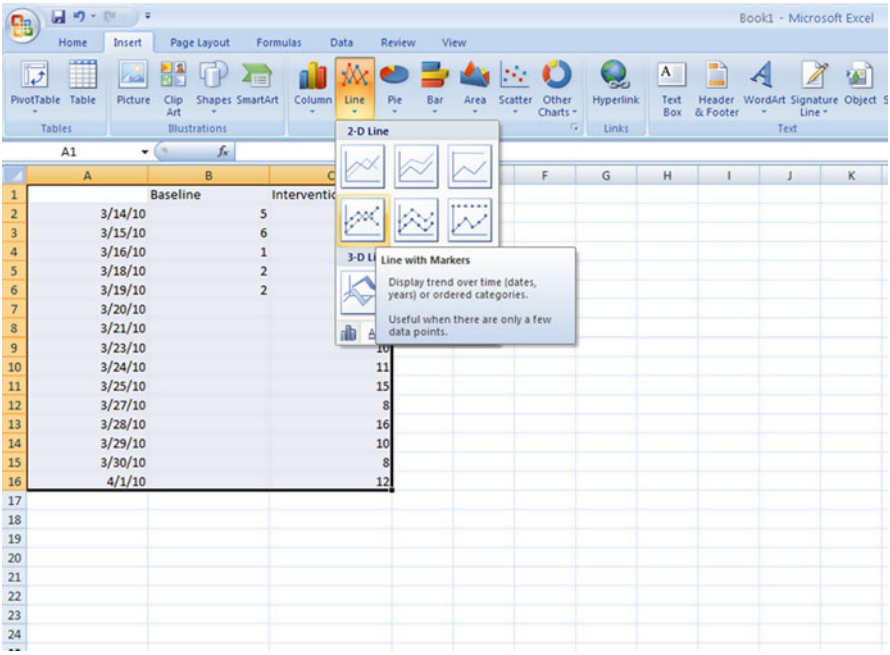
Microsoft Excel is one example of a computer program that makes graphing easy and produces professional-looking graphs. Some people may initially find Excel to be overwhelming, but once you get the hang of it, graphing with Excel is much easier (and more professional looking) than graphing by hand. Included in this text are instructions for graphing with Excel 2007 and Excel 2011.

Graphing with Excel 2007

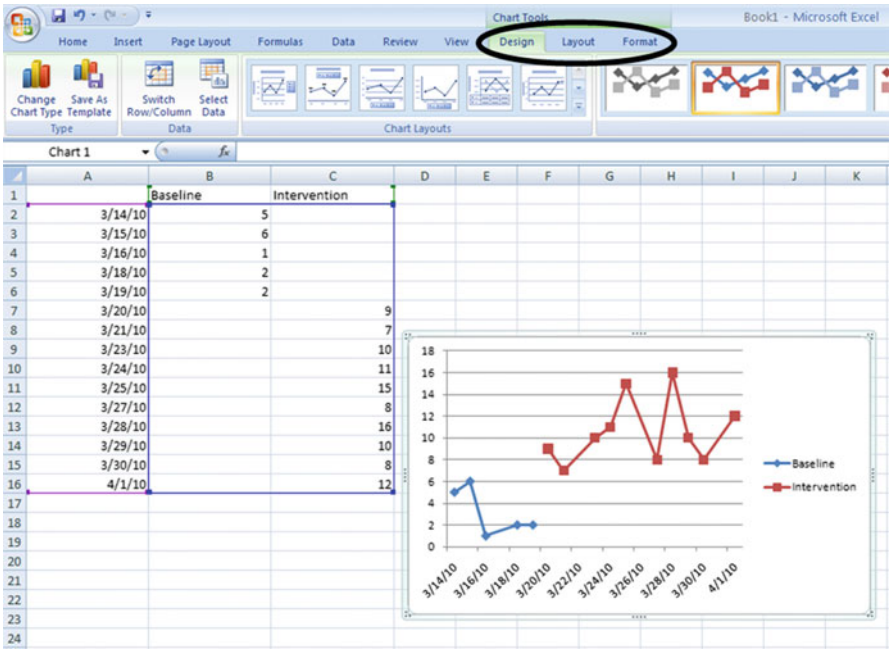
1. Enter your data in columns as shown below. In column A, enter when the data was collected. This will be your *X*-Axis. In Column B, enter your baseline data for the days you collected it. In Column C, enter your intervention data.



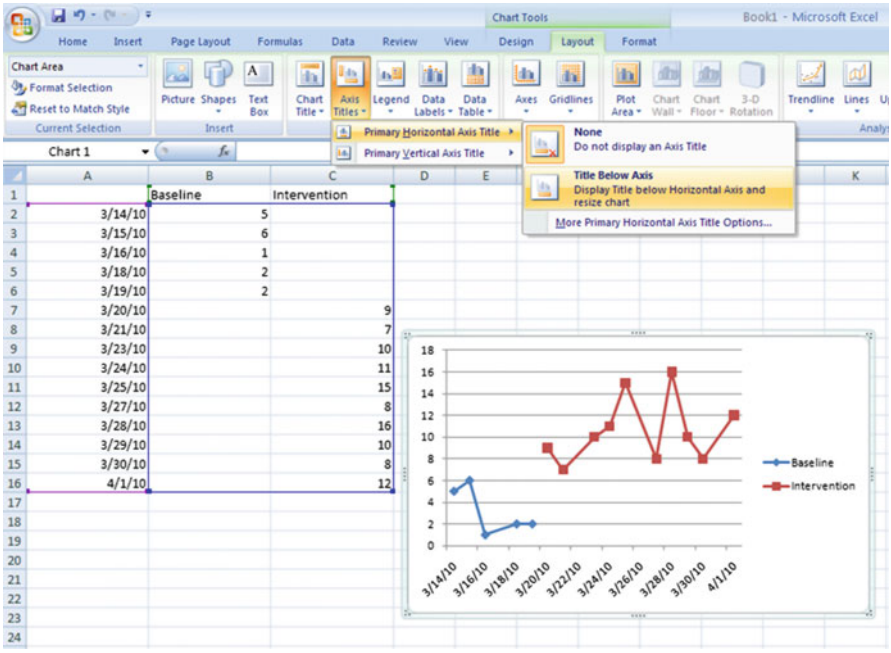
2. Highlight the data by left-clicking on the top left cell, and dragging down and to the right, until all the data are highlighted. Click on the Insert tab, and then click on "Line" in the Charts subsection. Select the "Line with markers" option, which is the first option in the second row.



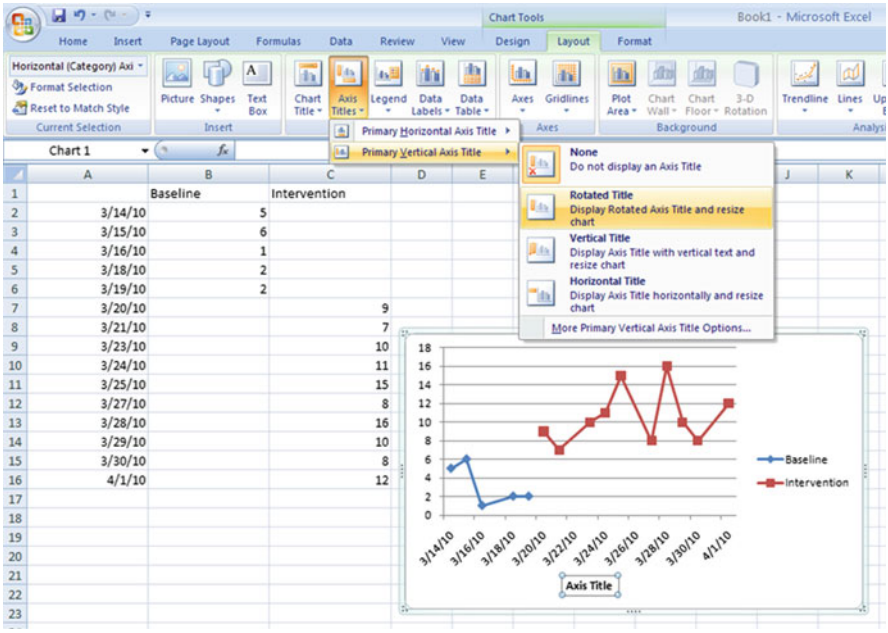
3. You should now have a graph that looks like this one. You will notice a new trio of tabs that appears at the top of the window on the right, colored light green and categorized as Chart Tools, which we will use to modify your graph.



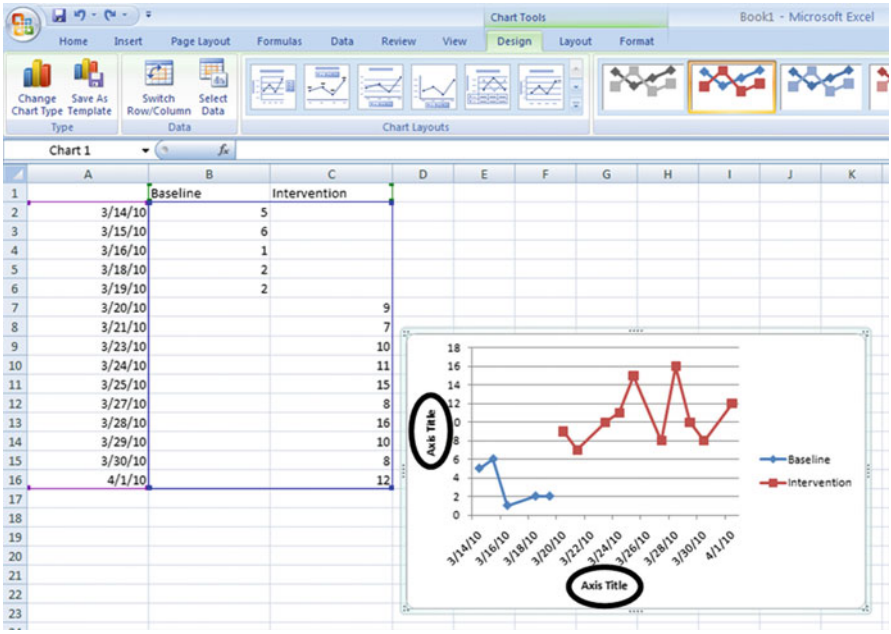
4. Now let's format the axes titles. We will do the *X*-axis title first. Select the "Layout" tab (in Chart Tools) and click the "Axis Titles" submenu. Select "Title Below Axis" for the *X*-axis title.



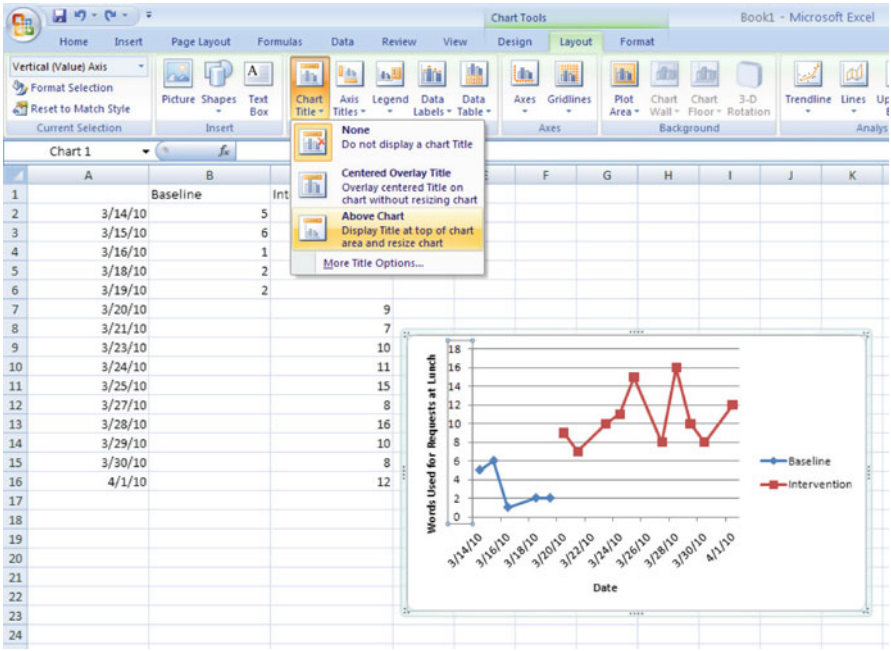
5. Now let's format the *Y*-axis title. Select the *Y*-axis from the same "Axis Title" submenu, then click "Rotated Title" to display your title along the *Y*-axis line. This function will put the *Y*-axis title along the vertical bar of the graph.



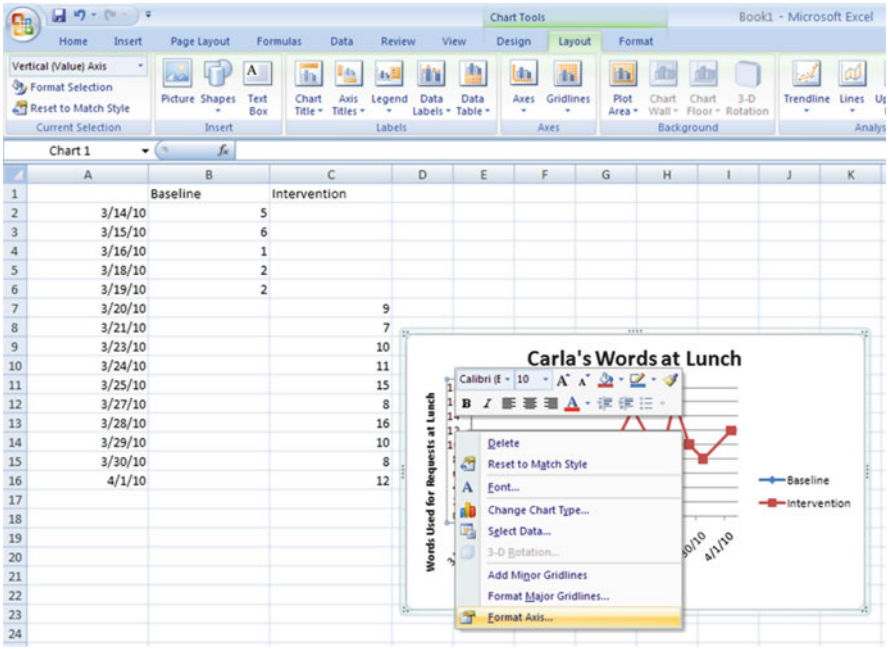
6. Click on the "Axis Title" boxes to enter the desired titles for the *X* and *Y* axes.



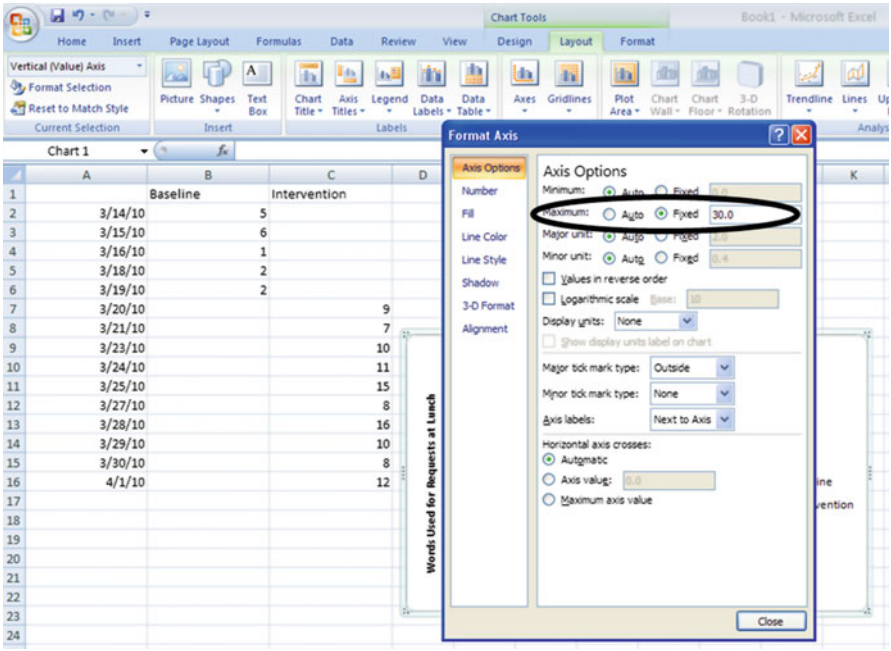
7. The final label on the graph will be the title. Under the "Layout" tab (within Chart Tools), select "Chart Title" and select the placement of the Title for the graph. The title can then be filled in by clicking on the Chart Title box in the graph.



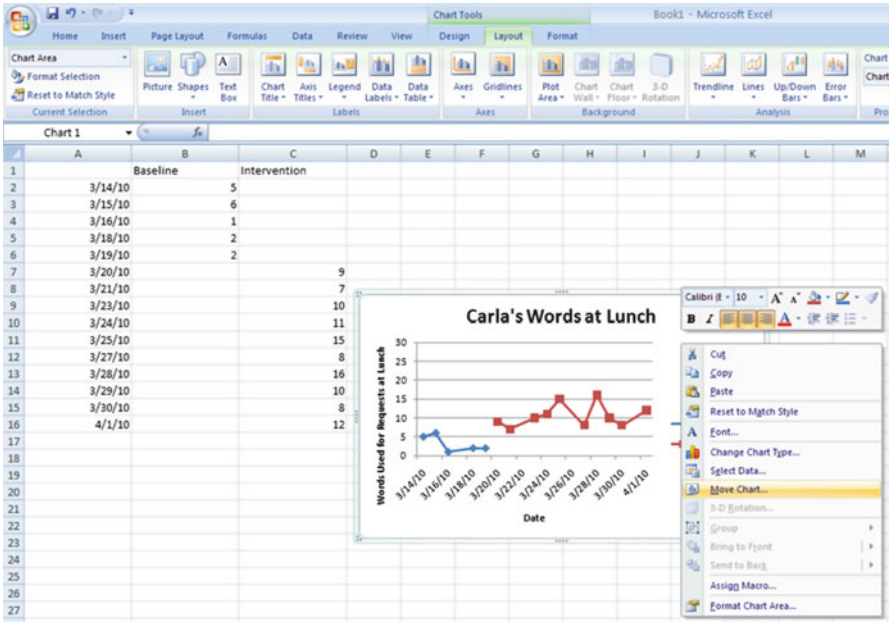
8. Notice that the maximum *Y*-axis value is 18. However, if our goal or aim will exceed 18, we need to extend the scale. We can do this by right-clicking on the *Y*-axis itself. This will bring up a menu with the option "Format Axis."



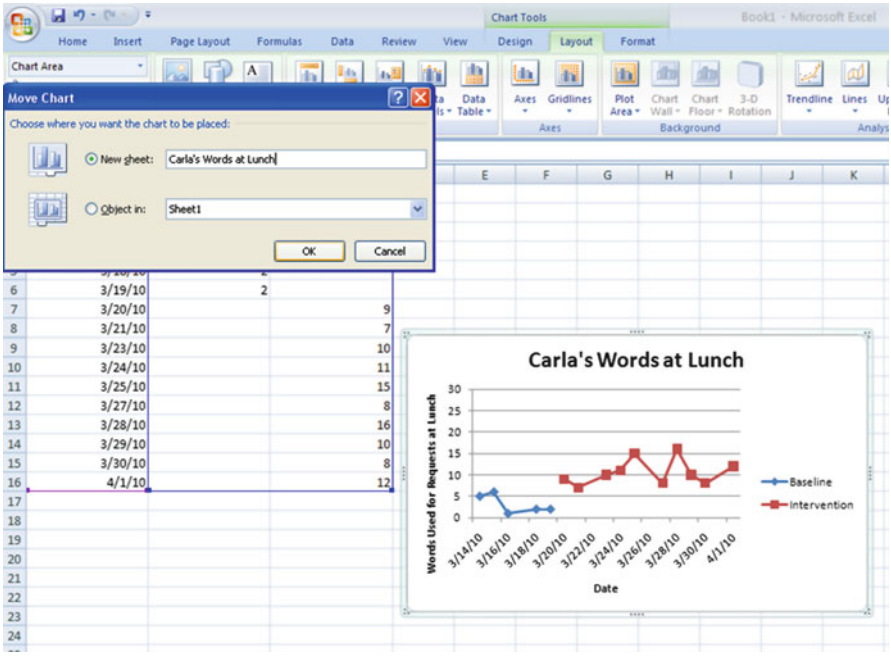
9. In the “Format Axis” toolbox, change Maximum from “Auto” to “Fixed” and make the maximum value 30.0. Click “Close.”



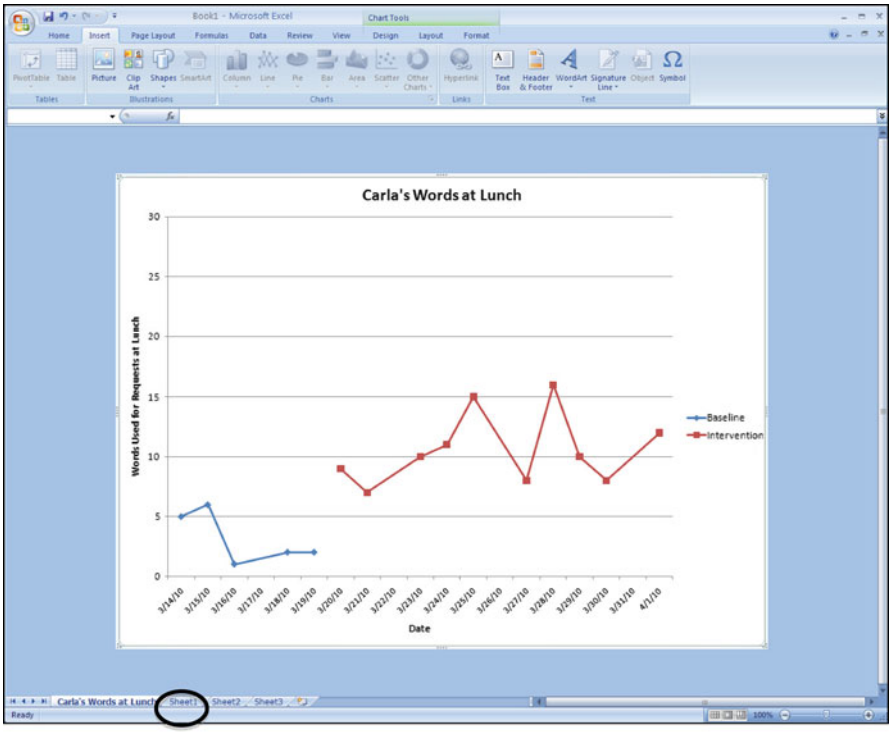
10. Now, right-click within the graph sub-window, but OUTSIDE of the data point area. This will bring up a slightly different window, within which you will see the option “Move Chart.”



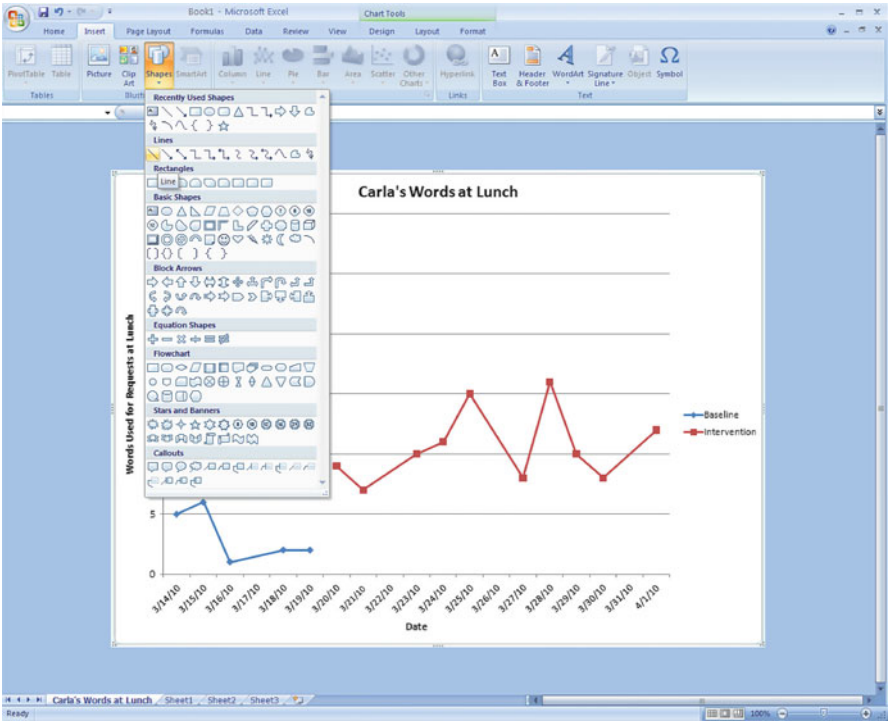
11. In the “Move Chart” window, select the option “New sheet” and type the title of your graph. Now click OK.



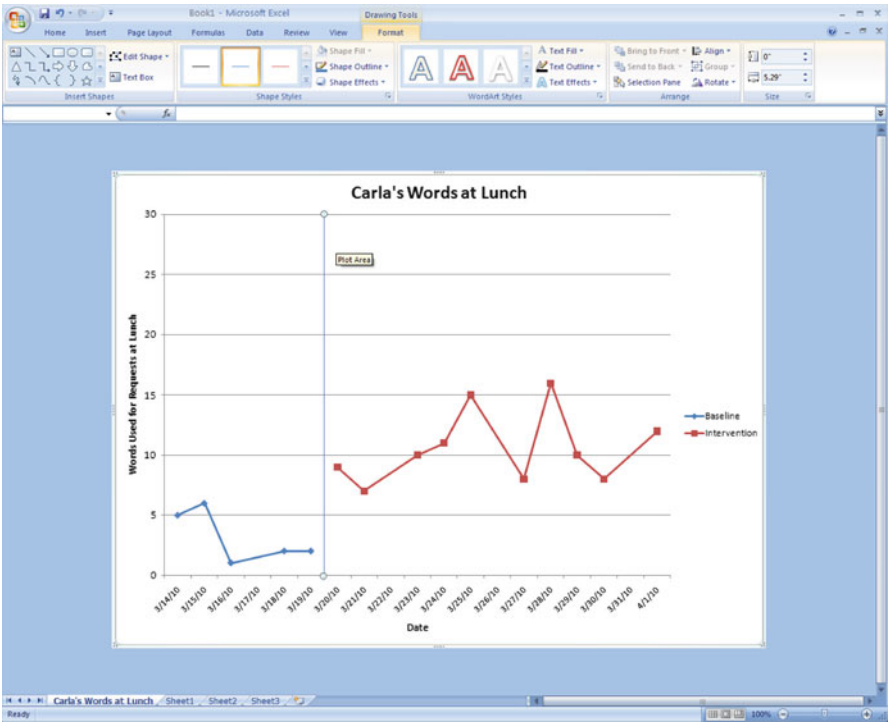
12. Your graph should now look like the one below. You can access the data you typed in before by clicking on "Sheet 1" at the bottom left of the Excel window.



13. Now we are going to add the phase change line to separate the Baseline from the Intervention data. Under the Insert tab, select Shapes, and pick the first line shown under the Lines submenu.

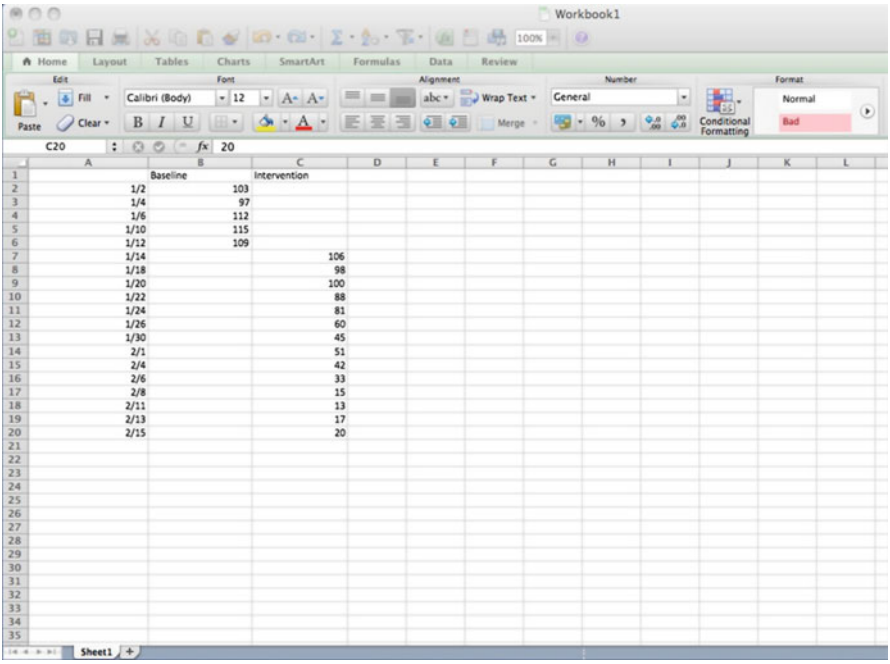


14. You will notice that your pointer has changed into a small cross-hair. Move this new pointer to a point that is between the Baseline and Intervention data. Now, hold down the Shift key on your keyboard, then left-click and drag the pointer vertically downward to the *X*-axis. Release the mouse button and *then* the SHIFT key. (Holding the Shift key keeps the line straight.)

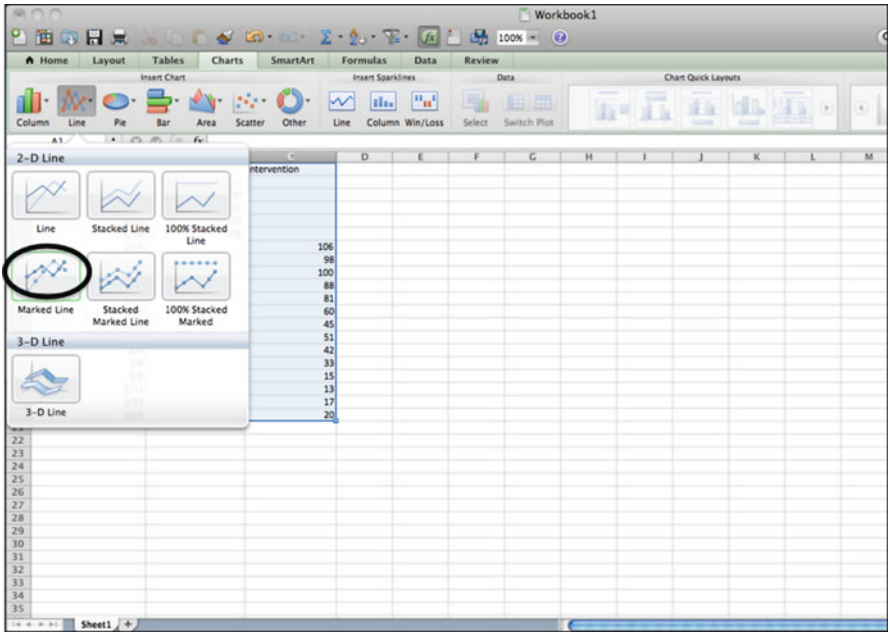


Graphing with Excel 2011

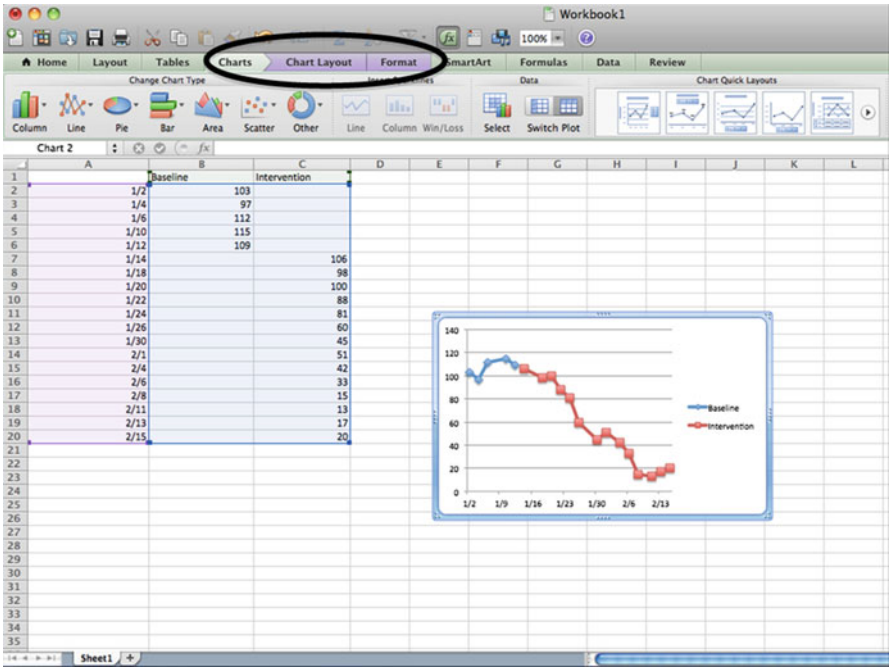
1. Enter your data in columns as shown below. In column A, enter when the data was collected. This will be the *X*-axis. In column B, enter your baseline data for the days you collected it. In column C, enter the data collected while the intervention was in place.



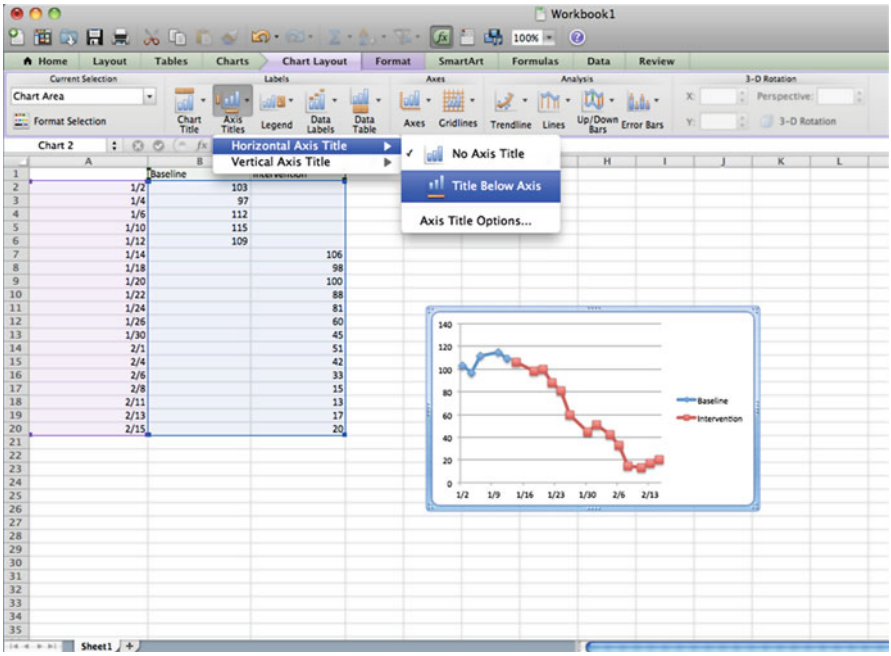
2. Highlight all the information by clicking on the top left cell and holding the mouse while dragging to the bottom right. Make sure all the data are highlighted. Then click on the "Charts" tab at the top and select "Line." The preferred form of Line graph to use is the "Marked Line."



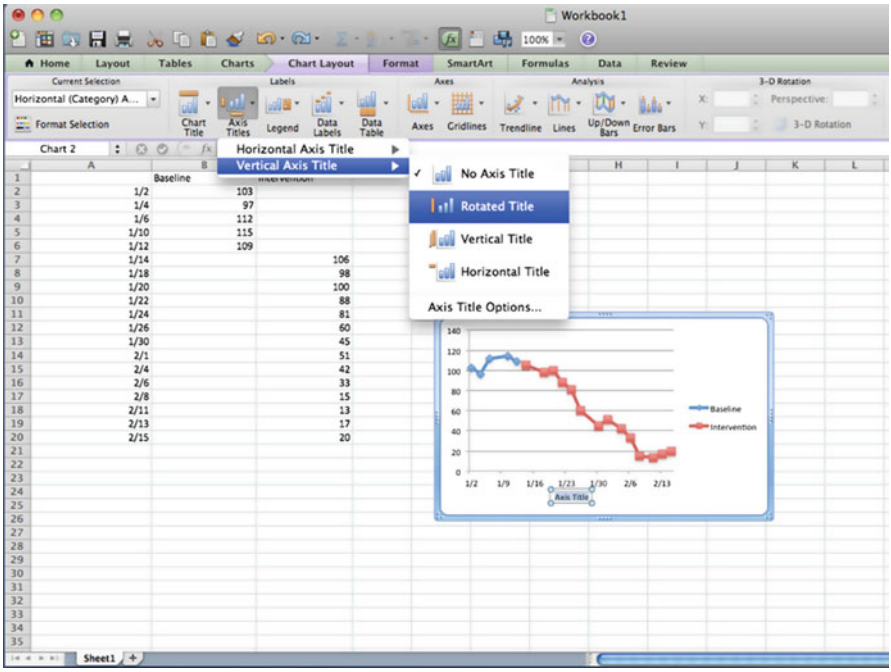
3. Excel will generate a graph to the right of your data. There are also two new tabs: “Chart Layout” and “Format” which contain many functions to changes your graph.



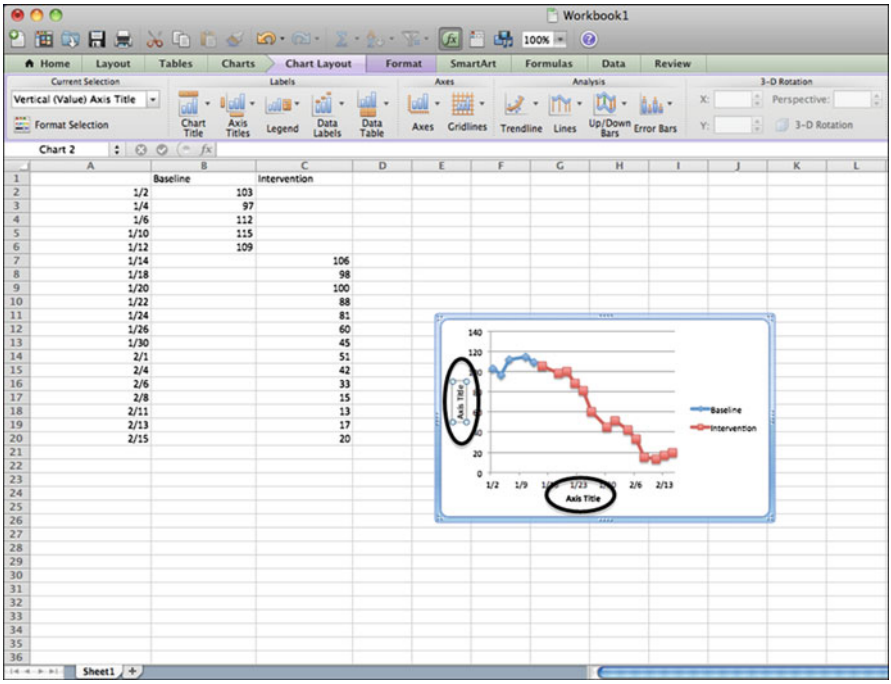
4. The next step is to label your graph so other people can understand what the data represent. First click on the "Chart Layout" tab and then on "Axis Titles." Select the "Horizontal Axis" option and then "Title Below Axis." This will make a text box appear that will allow you to label the graph with the word "Date" in Step 6.



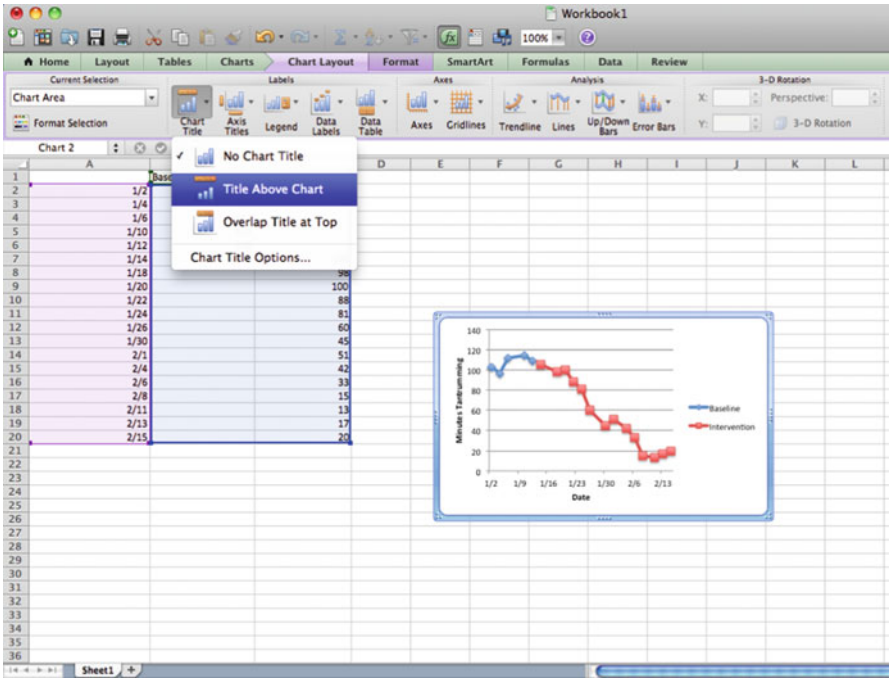
5. Next is the *Y*-axis title. Click "Axis Titles" again but select "Vertical Axis Title" and then select "Rotated Title." A second text box will appear along your *Y*-axis. You will fill this in on the next step.



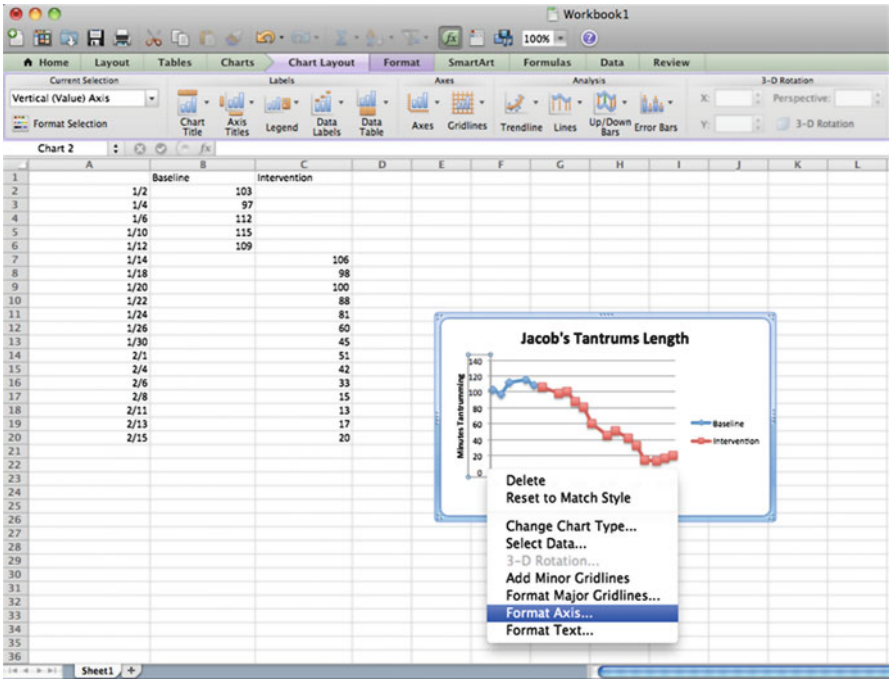
6. Click on both "Axis Title" boxes and enter the desired titles for the *X* and *Y* axes. For this graph, the *X*-axis will get the word "Date" and the *Y*-axis will be labeled with "Minutes Tantrumming."



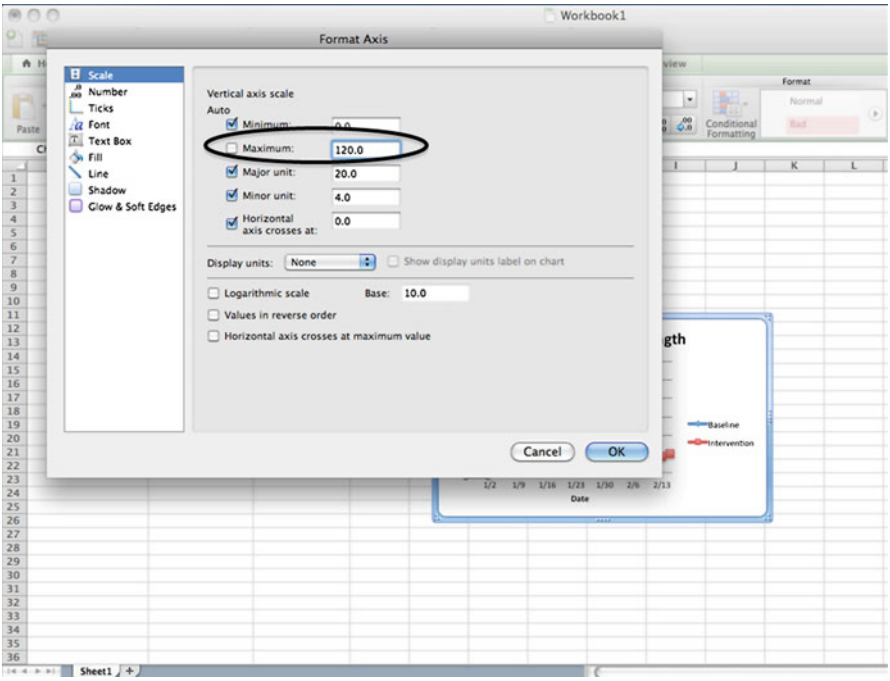
7. The final label on the graph will be the title. Under the "Chart Layout" tab, select "Chart Title" and then click on "Title Above Chart." This will create the final text box or you to type in the title for this graph. In the example below, the graph will be called "Jacob's Tantrums Length."



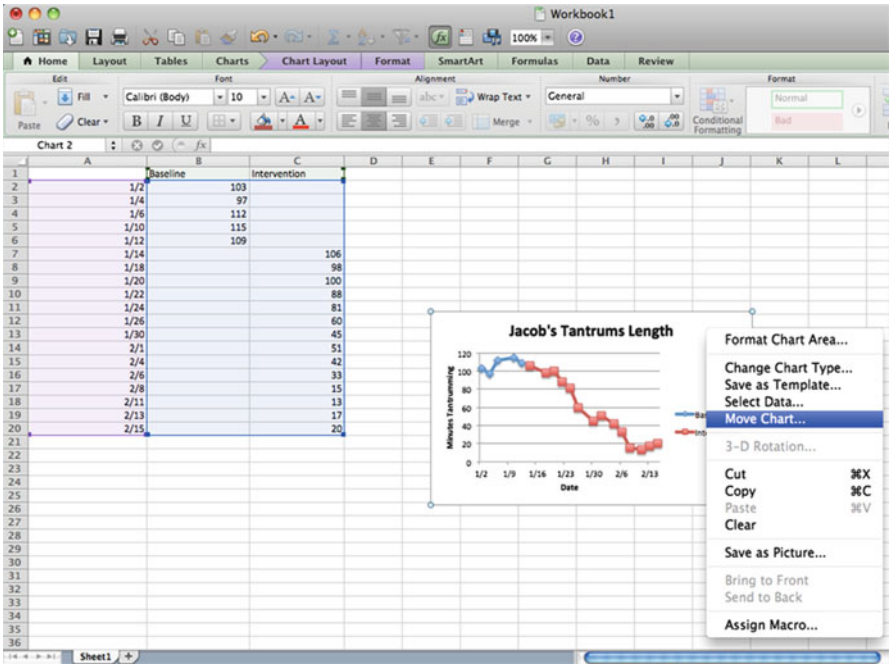
8. Notice that the *Y*-axis goes up to 140 min, but our highest value is 115. To make the graph fit the data better, the *Y*-axis has to be rescaled. To do this, right click when the mouse is over the *Y*-axis. Mac users can hold the "control" button and click the mouse to do this. In the pop-up box that appears, select "Format Axis."



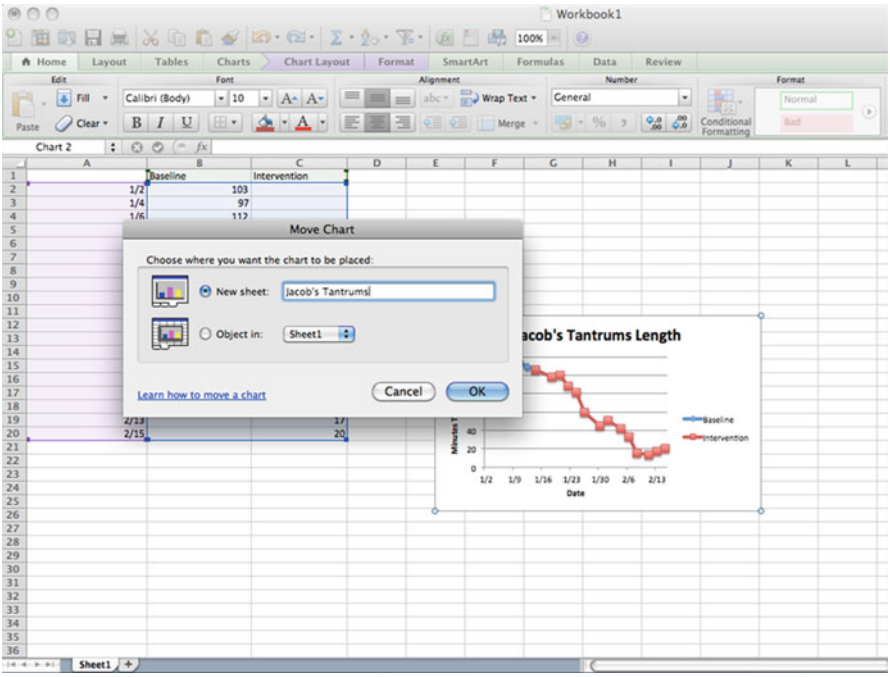
9. In the Format Axis box that pops up, select "Scale" and then change the "Maximum" to reflect the value you want for the top portion of the *Y*-axis. Then select "OK." For this graph, the maximum value will be 120.



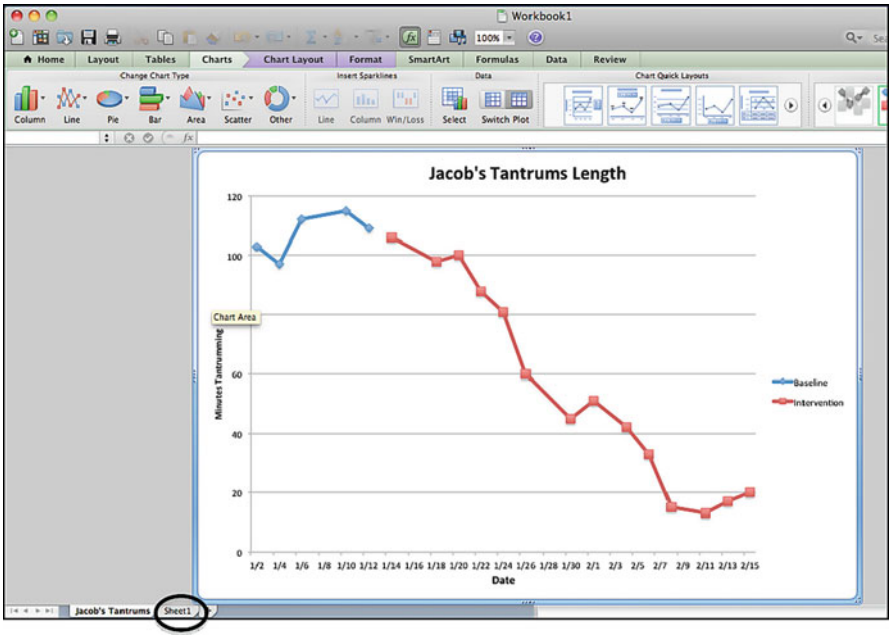
10. Now the graph will be moved so that it can be examined in more detail. To do this, right click on any area outside of the graph lines. A good place is the white space over the "Baseline" word in the Legend. Clicking here will bring up a new menu window where you can select "Move Chart."



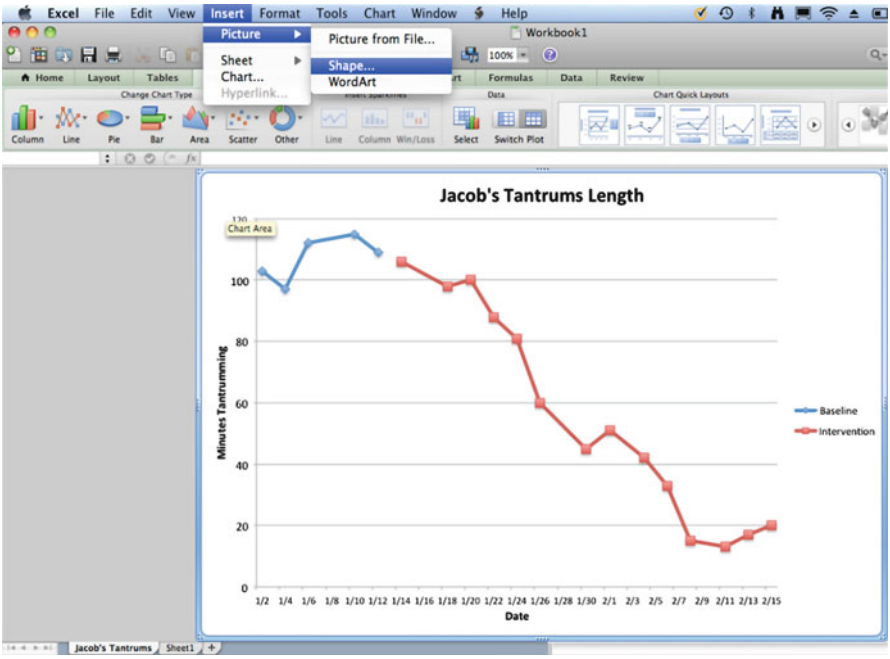
11. Clicking on “Move Chart” opens a new box. Select “New sheet” and then type in the name of your graph. Then click “OK.”



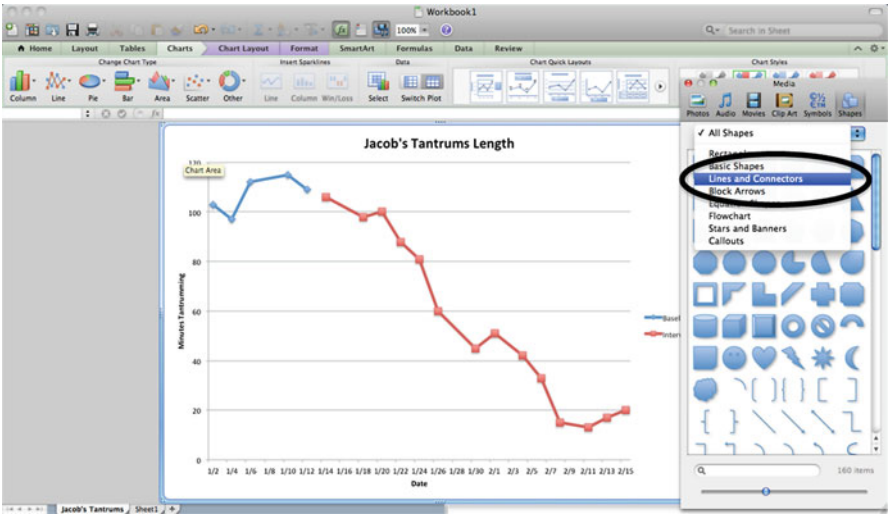
12. You will get a graph on a new sheet. It should look like the one below. You can access the data you typed in before by clicking on "Sheet 1" at the bottom left of the Excel window.



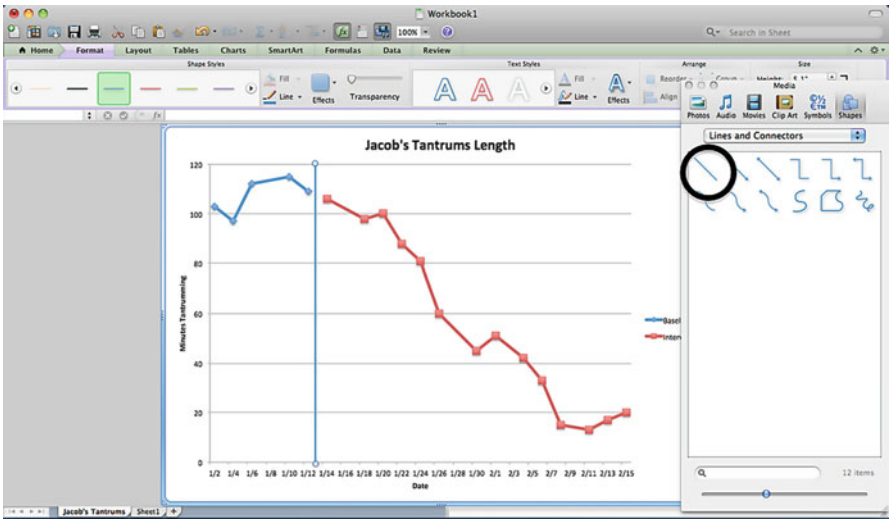
13. The last element to add is the phase change line to separate the Baseline and Intervention phases. At the top of the screen, select "Insert" (between View and Format) and highlight the word "Picture." In the new menu that opened, click on "Shape." This will open a new window with options for shapes.



14. In the new window, select "Lines and Connectors." This will bring up several options of lines you can choose from to make your Phase Change Line.



15. After selecting a straight line, you will notice that your cursor has changed into a small cross-hair. Move the cross-hair to a point on the *X*-axis that is between the Baseline and Intervention data. Hold down the "Shift" key on the key board, click your mouse, and drag the mouse upward. When you reach the top of your graph, let go of the mouse and *then* the "Shift" key. Holding down the "Shift" key while dragging keeps the line straight.

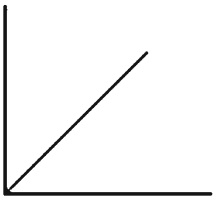


Following these steps will produce a basic graph in Excel. All versions of Microsoft Excel have many features, allowing a user to change the colors of lines, the shape of markers on a line, adding trendlines, etc. The best way to learn about additional functions in Excel is to explore. When you have time, click into different areas and try different features. There is no need to worry about messing up your graph. If something happens to your graph that you did not want to happen, click "Undo" and then keep trying. Just be sure to save you work often as you are going.

Guidelines for Evaluating Outcomes

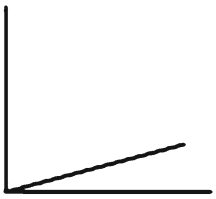
Once you have five or more progress monitoring data points graphed, you can use your graph to begin evaluating how well your intervention is working. One of three different decisions can be made: (1) continue the intervention; (2) modify the intervention; or (3) discontinue the intervention.

Continue the Intervention



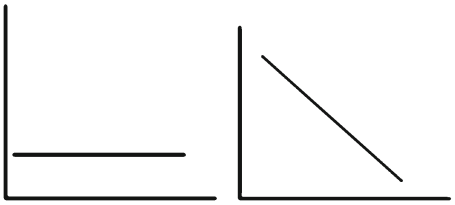
Interventions should continue when they are working, meaning that the desired behavior is increasing (and the challenging behavior is decreasing). When this is the case, the trend of your graph may look like the one above (when graphing the desired behavior). In this situation, continue implementing your intervention.

Modify the Intervention



Interventions should be modified when they are working but are working too slowly. Although some interventions work, they may not be working as fast as we would like. Therefore, the intensity of the intervention should be increased, such as increasing the amount of time spent on the intervention.

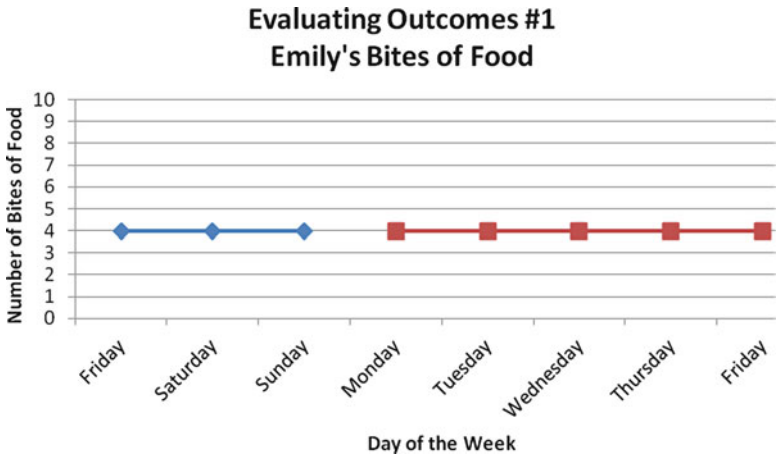
Discontinue the Intervention



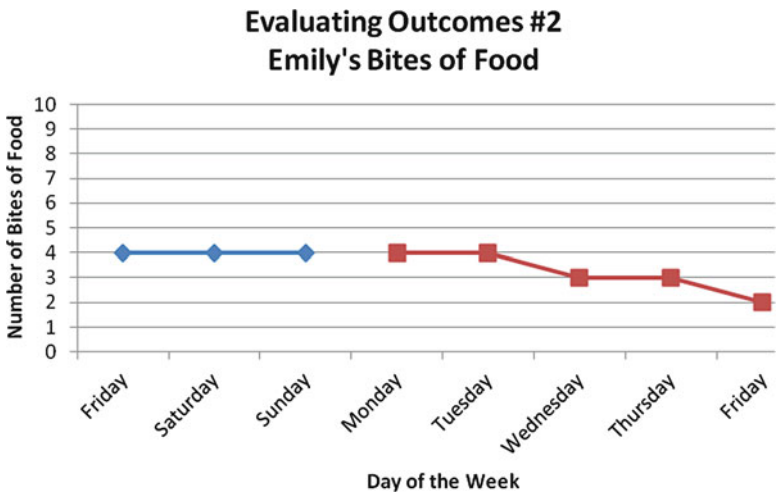
Interventions that have no effect or are detrimental should be discontinued. These progress monitoring lines will have a negative slope or no change at all. In this situation, you should go back to the problem solving process and revise your intervention.

Evaluating Outcomes Examples

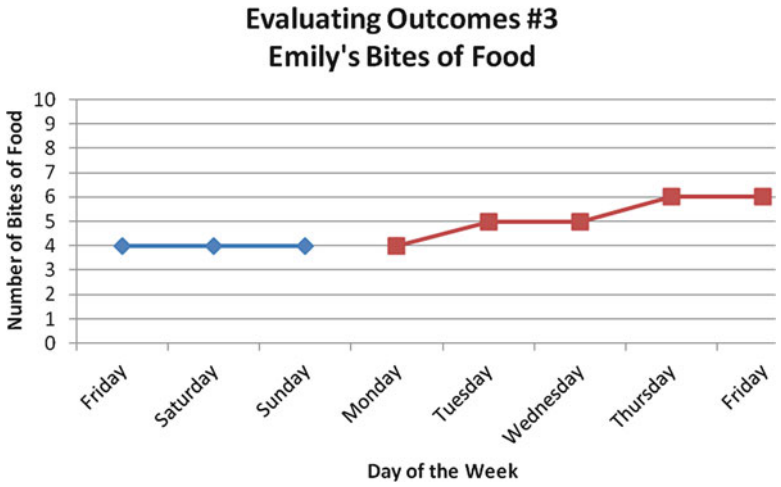
Below are four different examples of graphed progress monitoring data and the decisions made about each. Keep in mind that the goal of this intervention was to increase the number of bites of food Emily eats to nine. Ideally, the *progress monitoring* line should increase above zero.



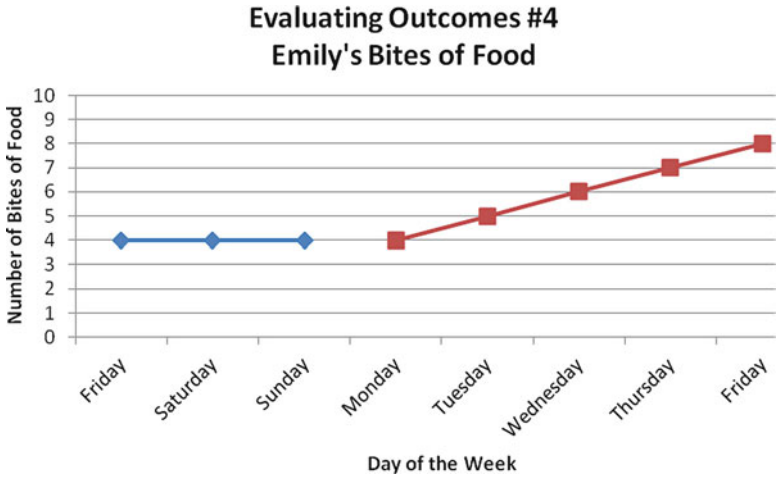
The progress monitoring line is completely flat. This flat line, or slope of zero, indicates that the number of bites of food Emily is eating is not changing and thus not increasing toward the goal of nine bites. Therefore, it appears that this *intervention is not working*. The intervention should be discontinued and a new one should be developed by recycling through the problem solving process. You may also want to check to make sure that the intervention is actually being implemented.



The progress monitoring line on this graph has a negative slope and is moving *toward* zero, meaning that the number of bites of food Emily is eating is decreasing. This line indicates that the intervention is having a detrimental impact on Emily's behavior and *the intervention is not working*. This intervention should be discontinued and a new one should be developed.



This progress monitoring line has a positive slope and is slowly moving *away* from zero, meaning that the number of bites is increasing toward the goal of nine bites, but slowly. *This intervention is working, but not as quickly as we would like*. This intervention should be adjusted to increase the intensity of the intervention.



This progress monitoring line has a positive slope and is moving *away* from zero, meaning that the number of bites is increasing toward the goal of nine bites. *This intervention is working*. The intervention should continue as should progress monitoring.

Conclusions

Progress monitoring data makes it possible to determine whether or not the intervention is successful, and can be used to make decisions about the intervention. Graphing data provides a visual display which aids in answering questions as to whether the intervention is working or not, and if it is working as efficiently as intended. Graphs can be completed manually or by using programs such as Microsoft Excel.

Assess Your Knowledge

Use the questions below to assess your knowledge of the information presented in this chapter. Answers appear after the last question.

1. A child is referred to you for frequent head banging. On which axis would you plot head banging?

   a. *X*-axis
   b. *Y*-axis
   c. *XY*-axis
   d. Not enough information to tell

2. What is the primary purpose of collecting baseline data?

   a. To put it on your graph
   b. To be able to tell if your intervention was effective
   c. To show what data you are collecting
   d. To speed up when you can implement your intervention

3. When drawing a graph in Excel, which step comes first?

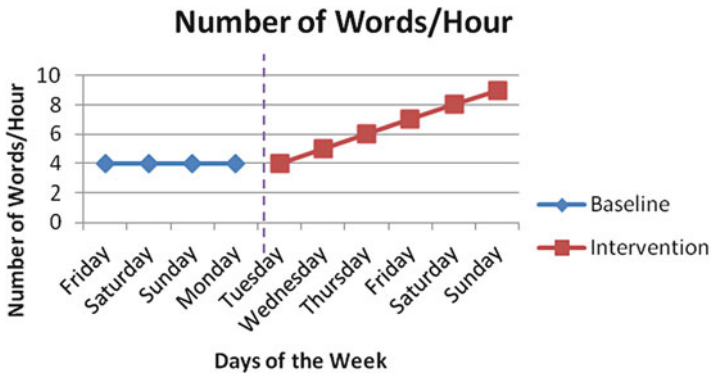
   a. Label your phases
   b. Format the *X*-axis
   c. Enter the raw data in columns
   d. Draw the phase change line

4. What is the purpose of the phase change line?

   a. To separate the baseline and intervention data
   b. To show the child's progress during baseline

c. To show the child's progress during the intervention phase
d. To label your graph

5. If your graph looks like the graph below, what should be your next step?

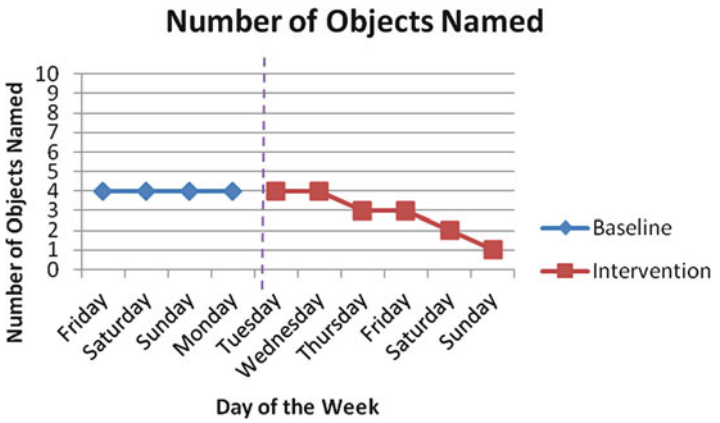


a. Continue your intervention
b. Stop the intervention
c. Change the intervention
d. Start over with the intervention

6. Data are collected on the number of nights where the child has remained dry through the night (for toileting). On which axis should you place the days of the week?

a. *X*-axis
b. *Y*-axis
c. *XY*-axis
d. Not enough information to tell

7. If your graph looks like the graph below, what should be your next step?



a. Continue your intervention
b. Stop the intervention
c. Change the intervention
d. Start over with the intervention

8. What is the last step in graphing with Excel?

a. Label your *x*- and *y*-axes
b. Create the scale for your data
c. Enter your data in the spreadsheet
d. Inserting the phase change line.

9. When graphing by hand, which points are not connected?

a. The baseline points
b. The last baseline and first intervention data points
c. The intervention points

10. You are implementing an intervention to increase the number of words a 26-month-old child is saying per hour. Your baseline data shows that the child is saying approximately 1 word per hour. You implement an intervention and track the child's progress. Immediately following the intervention, the child begins using 5 words per hour, and then 10 the next day, and so on. What should you do next?

a. Continue with the intervention
b. Modify the intervention
c. Discontinue the intervention
d. Change the intervention

Assess Your Knowledge Answers
1) b 2) b 3) c 4) a 5) a 6) a 7) b 8) d 9) b 10) a