To complete this technology assignment, you should already have created a scatter plot for your data on your calculator and/or in Excel. You could do this with any two columns of data, but for demonstration purposes we'll work with the data in the table below. The first column of the table is aligned to years after 2000 and corresponds to the years 2000, 2001, …, 2006. The second column contains the student to teacher ratios for US public primary and secondary schools in the corresponding years. For this demonstration we'll graph the Years after 2000 on the horizontal axis and the corresponding US Student to Teacher Ratios on the vertical axis. Thus each row in the table will be graphed as an ordered pair like (0, 16.048), (1, 15.893), …, (6, 15.540).

Years after 2000	US Student to Teacher Ratio
0	16.048
1	15.893
2	15.900
3	15.900
4	15.800
5	15.657
6	15.540

The first row of data indicates that in 2000, there were 16.048 students per teacher in US public primary and secondary schools.

In this technology assignment we'll find the equation of a line that passes through any two points on the scatter plot. For this demonstration, we'll choose the second and last data points (1, 15.893) and (6, 15.540). You should use the data specified for your specific assignment to complete this technology assignment.

Find the Equation of a Line Passing Through Two Points

To find the equation of a line passing through two points, you'll need to important bits of information. An equation of a line that is appropriate to this situation is the point-slope form of a line. The point-slope form of a line is

$$y - y_1 = m(x - x_1)$$

where x and y are the variables, (x_1, y_1) is one of the given ordered pairs on the line and m is the slope of the line.

The slope of the line can be found from the formula

$$m = \frac{y_2 - y_1}{x_2 - x_1}.$$

The points (x_1, y_1) and (x_2, y_2) are two points on the line. It is easy to misuse this formula so you will want to insure that you substitute y-values in the numerator and x-values in the denominator. From 2001 to 2006, the student to teacher ratio dropped from 15.893 students per teacher to 15.540 students per teacher so you should expect that the slope should be negative. If the ratio had increased, you would have expected the slope to be positive. If the ratio had not changed, the slope would be equal to zero. This insight provides you with a check on whether you placed the numbers into the slope formula in the proper order.

To find the equation of the line passing through (1, 15.893) and (6, 15.540), we'll follow a straightforward strategy:

1. Put one of the points (say (1, 15.893)) into the point-slope form of a line.
2. Find the slope of the line between (1, 15.893) and (6, 15.540).
3. Substitute the slope into the point-slope form of a line from step 1.
4. Solve the point-slope form of a line for y.

Let's carry out this strategy for these numbers. You'll want to complete the steps above for your specific data points.

Step 1:

Substitute (1, 15.893) into the point-slope form of a line to give

$$y - 15.893 = m(x - 1)$$

Either point could be used to solve this problem. Both points will lead to the same final equation of a line.

Step 2:

If you substitute $(x_1, y_1) = (1, 15.893)$ and $(x_2, y_2) = (6, 15.540)$ into the formula for slope yields

$$m = \frac{15.540 - 15.893}{6 - 1} = \frac{-.353}{5}$$

The value of this fraction is exactly -0.0706. This means that this decimal can be used for the slope and the line will pass through the points exactly. If the slope is rounded, the line will not go through both points exactly. To avoid rounding you should use the fraction form of the slope instead of the decimal form. In this case, it makes no difference.

Step 3:

Adding the slope to the point-slope form of the line leads to

$$y - 15.893 = -0.0706(x - 1).$$

Step 4:

To solve for y, add 15.893 to both sides of the equation. The point-slope form of the line becomes

$$y = -0.0706(x - 1) + 15.893.$$

To simplify this equation, remove the parentheses to yield

$$y = -0.0706x + 0.0706 + 15.893$$

Combine like terms to give the equation

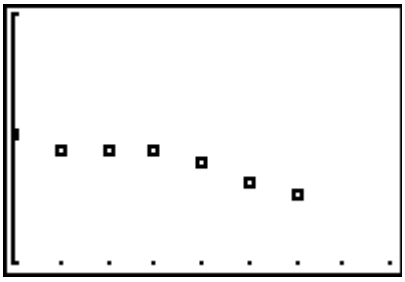
$$y = -0.0706x + 15.9636$$

Since none of the numbers have been rounded during these steps, this line will pass through both points exactly.

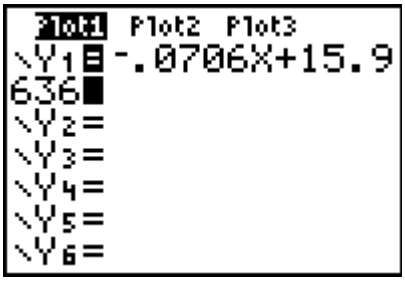
Graph the Line on the Calculator Scatter Plot

In an earlier technology assignment, you graphed the data in the table in a scatter plot. Starting from this scatter plot on your calculator, we'll add the equation of the line and check to see if the line passes through both points.

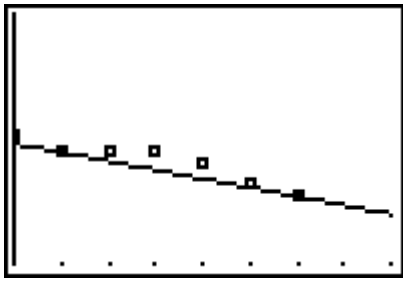
1. You should have the graph shown to the right on your calculator utilizing a window of [0, 8] by [15, 17]. You may need to refer back to the earlier technology assignment if you no longer have the scatter plot or data in your calculator.



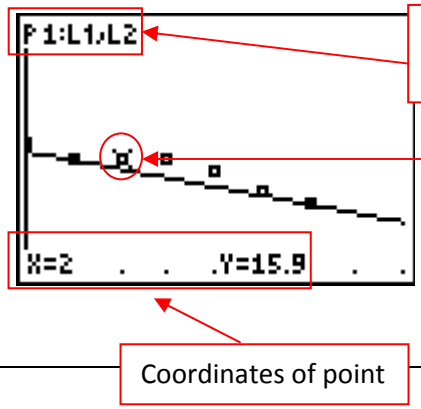
2. Press the [Y=] button to access the equation editor.
3. Delete any equations in the editor or turn them off by moving the cursor over the = sign in the equation and press [ENTER]. An eq2uation will not appear in the graphing window if its = sign is not highlighted.
4. Enter the formula for the equation you want to graph. Your formula will differ from the one shown to the right. This equation was entered by pressing [(-)][0][.][0][7][0][6][X,T,Θ,n][+][1][5][.][9][6][3][6]. Make sure you use the [(-)] to indicate a negative number and [X,T,Θ,n] for the variable.

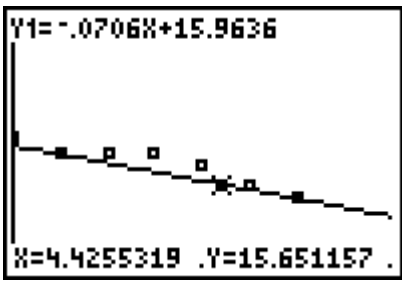
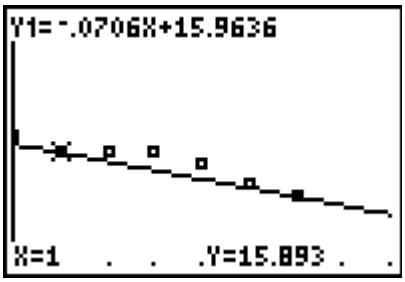
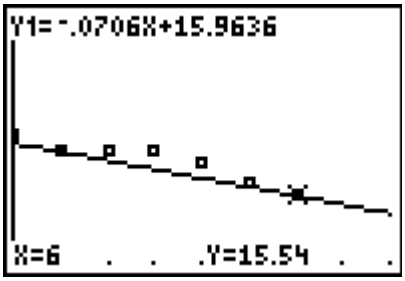


5. Since you already set up the window when you created the scatter plot, press [GRAPH] to see the graph of the formula and the scatter plot. If either the scatter plot is missing, press [2nd][Y=] to check to see if the plot is turned on. If the line is missing, press [Y=] to check your equation. Aklso check your algebra to insure you have the proper line.



6. The line appears to go through the points. To make sure the line goes through the points (1, 15.893) and (6, 15.540) (remember your points will be different), you'll use the Trace feature of your calculator to locate ordered pairs on your line. Press [TRACE] to activate the Trace feature. In the top left corner of the screen you'll see the label P1 : L1 , L2. This label indicates that the scatter plot is being traced and that the scatter plot contains data from L1 and L2. By

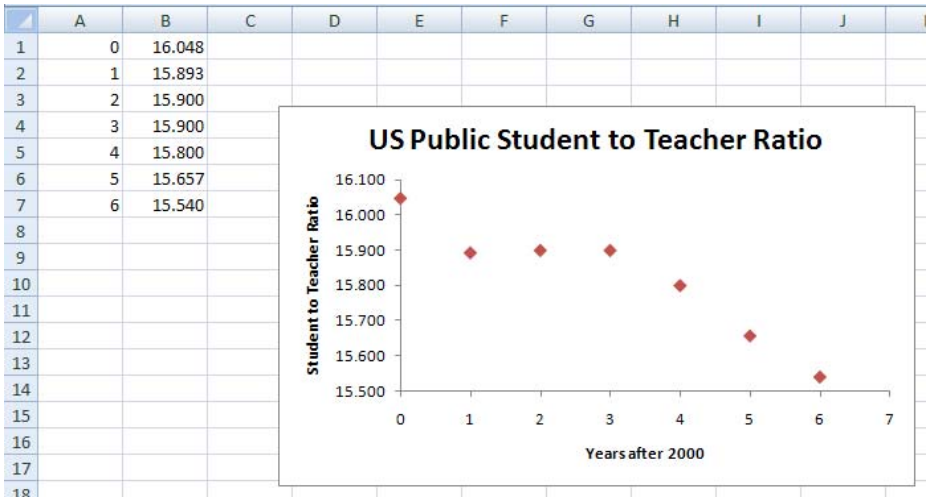


pressing ◄ or ►, you can cycle through the points on the scatter plot. Notice how the coordinates change as you move from point to point.	
7. Press the ▲ or ▼ button. This will jump the trace to the equation. This is indicated by the label in the upper left corner of the screen. You can move the trace point by pressing ◄ or ►.	
8. To trace to a specific point like x = 1, enter the x-value you want to trace to like 1 followed by ENTER. This takes the trace point to (1, 15.893) as hoped. This means that the data point and the line both go through (1, 15.893) exactly. Check to see if your line goes through one of your points.	
9. Press 6 ENTER to check to see if the line goes through (6, 15.540). The coordinates displayed at the bottom of the screen indicate that the line goes through the second point. Check to see if your line goes through the other point you used to make your line. If the coordinates do not match exactly, check your equation in the equation editor and your algebra for mistakes.	

Graph the Line on the Excel Scatter Plot

In an earlier technology assignment, you graphed the data in the table in a scatter plot. Starting from this scatter plot in Excel, we'll add the equation of the line and check to see if the line passes through both points.

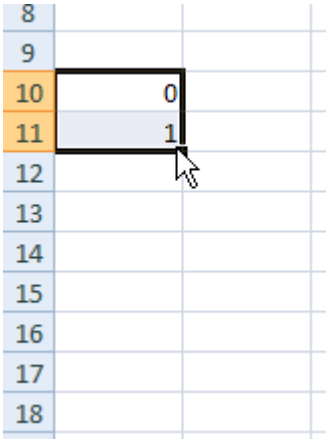
1. Start from the worksheet you created in an earlier technology assignment.

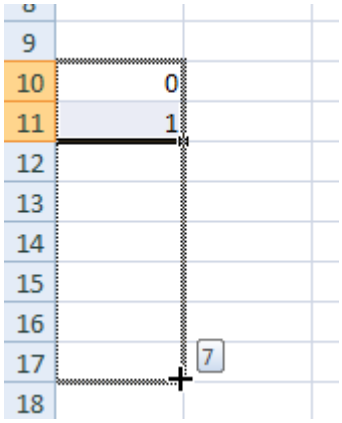
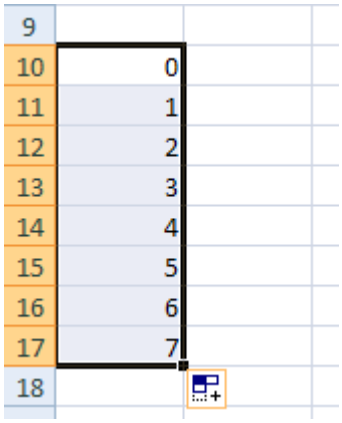
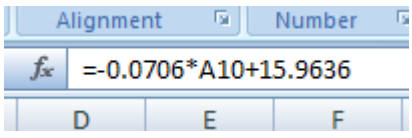


	A	B
1	0	16.048
2	1	15.893
3	2	15.900
4	3	15.900
5	4	15.800
6	5	15.657
7	6	15.540

You will modify this worksheet to add the line (in this case $y = -0.0706x + 15.9636$). You'll want to add the line that is appropriate for your scatter plot.

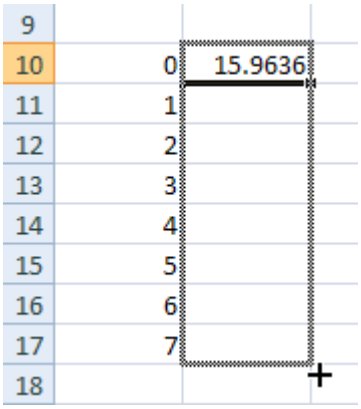
2. The horizontal window for the scatter plot is [0, 7]. This means smallest x-value will be 0 and the largest x-value will be 7. This includes all of the x-values in the scatter plot. In cell A 10, you'll place the first x-value you want for the graph. For this example, we'll start with 0. In the cell below it, place a 1. Left click on cell A10. Hold the button down and drag the mouse to cell A11 to select the two cells as shown.



3. Release the mouse button and move the cursor to the fill handle in the lower right corner. 4. Left mouse click on the fill handle. Hold and drag the mouse to cell A17. As you drag, Excel will show the values it will fill in the cells with. Release the mouse button.	
5. Once the button is released, you'll see the x-values for your window. In this case, point will be plotted at x = 0, 1, …, 7. If you had placed a smaller number in cell A11 like 0.5, the points would be spaced at increments of 0.5 but you would need more of them to span the entire window to 7. A bigger value in A11 like 2 would space the points farther apart. Remember that the numbers in A10 and A11 are the first two points that will be plotted in the window and establish the pattern for the rest of the fill.	
6. Click on cell B10 to select it. This is where you'll place the first y-value based on the formula you want to graph. For this example, type =-0.0706*A10+15.9636. You can click on cell A10 instead of typing A10 and make sure you type a * for multiplication. The = at the beginning of the formula is critical since it tells Excel to calculate the formula. The formula will appear in the Formula Bar as shown to the right.	

7. Press the Enter key on the keyboard to calculate the formula in cell A10. You'll see the y-value in the cell B10 corresponding to the x-value in cell A10. These cells form the first ordered pair you'll graph.

8. Left click on cell B10 again. You'll see a fill handle appear on the selection rectangle. Click and drag the fill handle to cell B17 to fill cells B11 through B17 with y-values. You may need to drag farther if you have more x-values in your window.



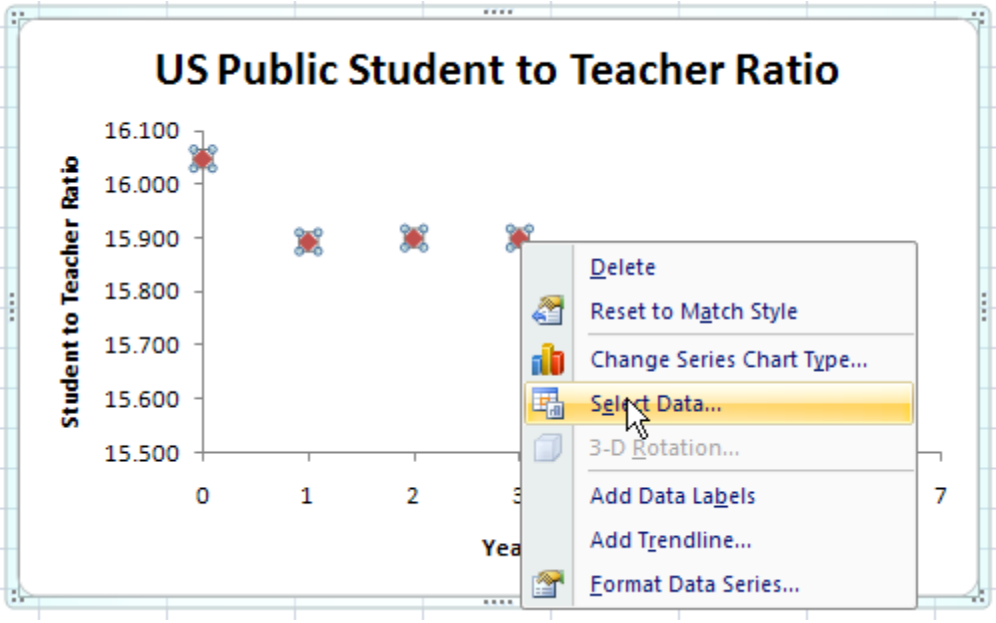
9		
10	0	15.9636
11	1	
12	2	
13	3	
14	4	
15	5	
16	6	
17	7	
18		

9. Release the mouse button to fill the cells. You now should have the x- and y-values that will be used to create the graph of the formula. Notice that row 11 and row 16 correspond to the points (1, 15.893) and (6, 15.540) exactly. Because of this, the line will go through the two ordered pairs perfectly.

9		
10	0	15.9636
11	1	15.893
12	2	15.8224
13	3	15.7518
14	4	15.6812
15	5	15.6106
16	6	15.54
17	7	15.4694
18		

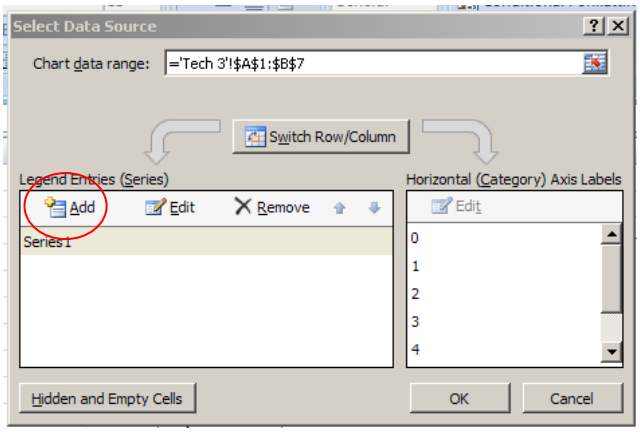
10. Right mouse click on one of the points in your scatter plot.

11. You will see a menu appear like the one shown below. If the menu doesn't appear immediately, right click on the point again.

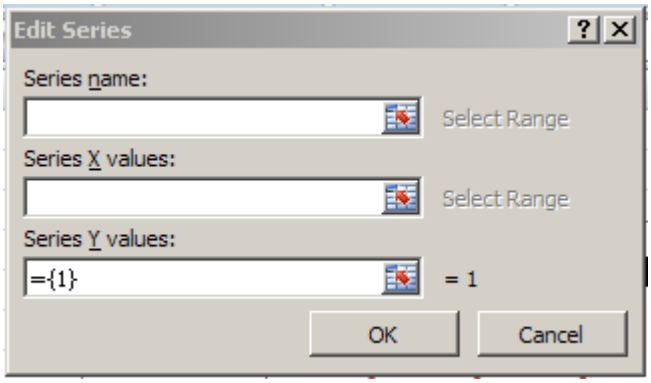


12. Left click on Select Data… This option will allow us to select the ordered pairs we just created and add them to the scatter plot.

13. The Select Data Source box will appear. To add the data to the scatter plot, select Add.

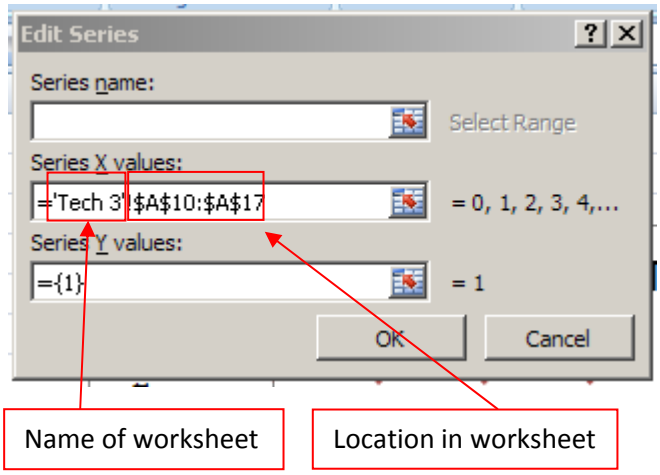


14. Another box will appear like the one shown to the right. You can enter a name for the data in the space for Series name, but it is not necessary.



15. Left click in the space under Series X values. This is where the location of the x-values are placed.

16. You can easily place the location in that place by clicking and dragging the mouse on A10 through A17. The location will be pasted into the space as shown to the right. $A$10:$A$17 indicates that the x-values are in cells A10 through A17.

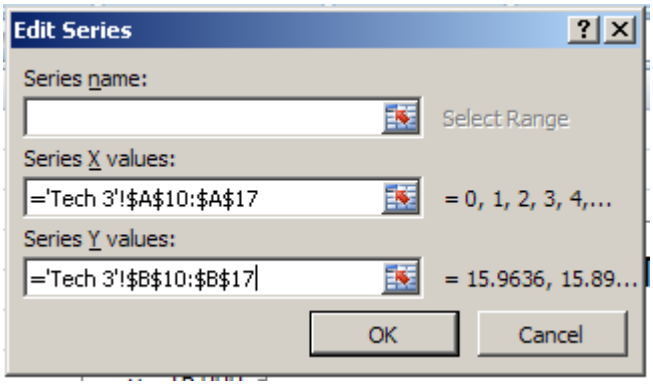


17. Delete the ={1} under Series Y values.

18. Put the location of the y-values in the space by clicking and dragging the mouse on B10 through B17. The location will be pasted into the space as shown to the right. $B$10:$B$17 indicates that the y-values are in cells B10 through B17.

19. Click on OK.

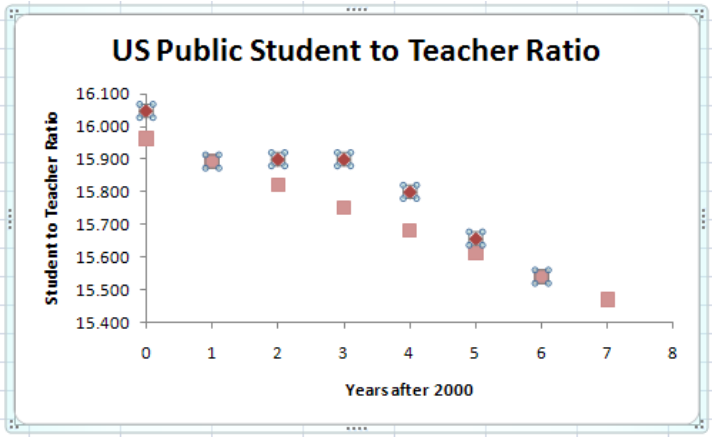
20. The Select Data Source box will appear again with Series 2 appearing. Series 2 is the data for the formula and Series 1 is the data for the scatter plot. If you need to edit the locations, you can



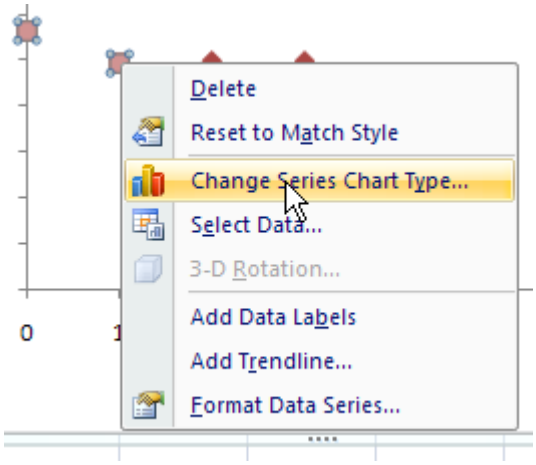
select the series and click on Edit.

21. Click on OK in the Select Data Source box to plot your formula.

22. The data for the formula will be plotted like in the graph below. However, the points for the formula are plotted as a scatter plot. Since we want a solid corve, we'll need to modify the graph slightly.

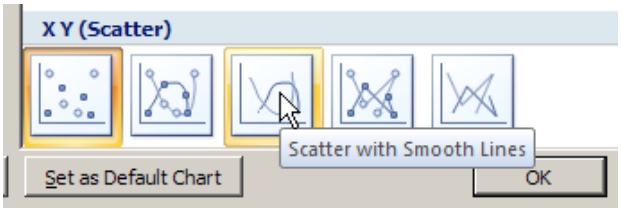


23. Right mouse click on one of the data points for the formula. Make sure you click on the formula's points and not the points on the scatter plot. You may have to right click on the point more than once to see the menu shown to the right.



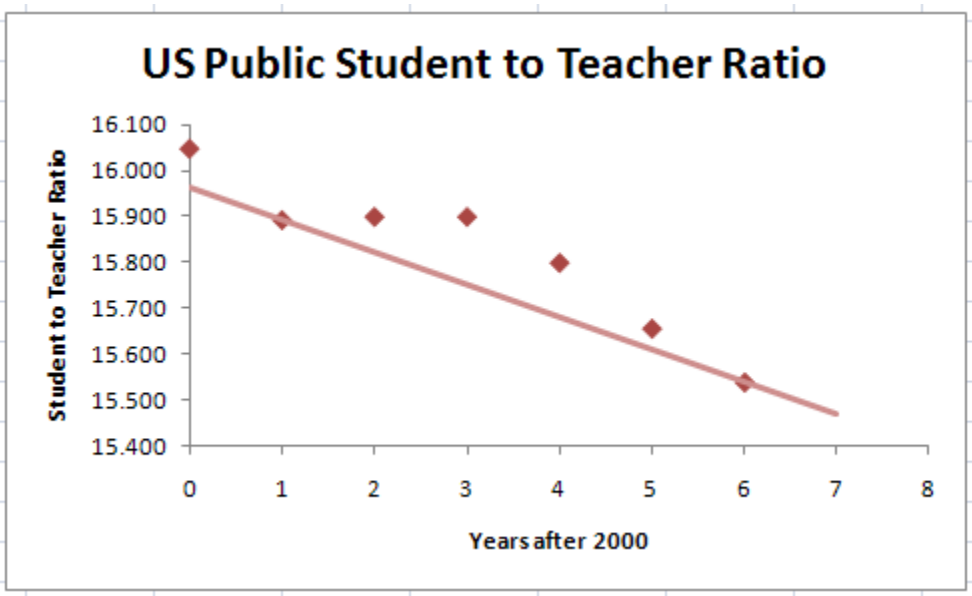
24. Left mouse click on Change Series Chart Type… This option will allow us to change how the points for the formula are plotted. The Change Chart Type box will appear.

25. From the options under X Y (Scatter),



select Scatter with Smooth Lines and then OK. This will create a curve through the points without symbols for the points.	

26. The scatter plot will change as shown below.



27. Notice that the horizontal scale has enlarged slightly to accommodate the formulas values from x = 0 to x = 7. You can modify the scale if desired to run from x = 0 to x = 7 instead of x = 0 to x = 8. Changing the window was covered in an earlier technology assignment.

28. Save your Excel worksheet.

29. To complete the assignment, copy the graph and paste it into a Word document along with your name, class and the date. Make sure you save the Word document.