Increasing Graphing Literacy and Graphing Ability in Undergraduate Psychology Majors Through Active Learning Based Exercises

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This resource contains a series of activities designed to increase graphing literacy and graphing ability in undergraduate psychology majors. The activities involve an activity based approach to graphing, emphasizing the importance of being able to read/understand graphs and providing detailed instructions (including screen shots) of how to create a variety of types of graphs in Excel 2007 (v12.0).

This resource should be relevant to all psychology students and educators. However, it is primarily aimed at faculty who teach statistics and/or research methods. More specifically, all of the activities are designed to be completed in class thereby encouraging their inclusion in the graphing unit of a statistics and/or research methods class.

Outside of a statistics and/or research methods class, any instructor that teaches a class involving student consumption of journal articles (or other primary sources) might find the resource relevant as it contains information not only on how to create graphs, but also how to understand them. Additionally, each activity was designed as "stand alone" activity so they can be incorporated as individual activities in any class that deals with graphs or graphing.

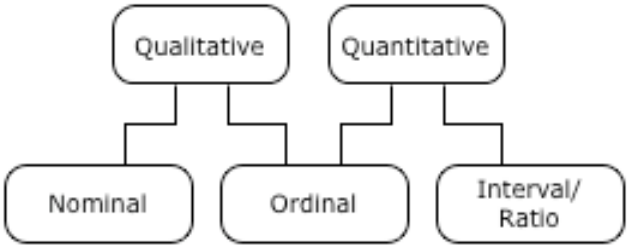
Types of Data

Qualitative and Quantitative Data

Qualitative Data. Classified based on characteristics and not measured in amounts.

Quantitative Data. Measured in and indicates amounts (e.g., number present).

The graphic below illustrates how data are classified after being identified as qualitative or quantitative.



Four Traditional Measurement Scales

Nominal scale. Scores are used for identification and classification with no quantitative properties. Each score represents belonging to a group, not an amount. For example, if a class were split into males and females, this would be a nominal scale.

The nominal scale represents qualitative data and is the most basic measurement scale. It is a discrete measurement meaning that membership in one category precludes membership in another group. For ease of understanding, nominal scales often assign numbers to the categories (e.g., Males = 1, Females = 2). However, the number has no inherent value associated with it and is only used for identification so a female (assigned a 2) is not any better or worse than a male (assigned a 1).

With nominal data, a **bar graph** is the best way to show the data.

Ordinal. Scores indicate rank order. Categories are more than merely different and can be rank ordered from highest to lowest or from best to worst. For example, if a class were split according to grade (i.e., A, B, C, D, F), this would be an ordinal scale. With ordinal scales, like with nominal scales, membership in one category precludes membership in another group.

There is some disagreement about whether ordinal data represent qualitative or quantitative data. Although ordinal data can be ranked, only the respective rankings can be discussed; nothing can be said about data between the ranks. That is to say, it is known that an A is higher than a B but it cannot be known by how much. It is possible the A (e.g., 90%) may only differ from the B (e.g., 89%) by one point. However, it is equally possible that the A (e.g., 99%) differs from the B (e.g., 80%) by 19 points.

With ordinal data, a **bar graph** is the best way to show the data.

Interval/Ratio. Interval scales have scores that represent an actual quantity with an equal distance between the scores (e.g., 100 is 10 points higher than 90 and 90 is 10 points higher than 80). Interval scores do not contain a true zero and thus do not measure the complete absence of a quantity. For example, if a class were organized based on IQ score, this would be an interval scale. There is not a true zero here because one cannot score a zero (indicating a complete lack of intelligence) on the IQ test and we cannot say that someone who scores a 100 is twice as smart as someone who scored a 50.

Ratio scales, on the other hand, also have scores that represent an actual quantity with an equal distance between the scores. However, ratio scales contain a true zero. For example, if a class were organized based on the time it took to complete the first exam, this would be a ratio scale. There is a true zero here because it is possible to take no time to complete the exam (e.g.,

the student did not attempt the exam at all), and a student who spends 60 minutes takes twice as long as a student who spends 30 minutes to complete the exam.

The appropriate way to present data and the statistical tests are identical for interval and ratio scales. Additionally, both interval and ratio scales contain continuous data. Thus, the scores can have decimal places (e.g., 90.5), indicating that a score falls between two whole numbers. As such, with Interval/Ratio data, either a **histogram** or a **frequency polygon**, both of which show the continuous nature of the data, is the best way to show the data. A histogram, which is appropriate when there are fewer scores, contains bars that abut one another. A frequency polygon, which is appropriate when there are a larger number of scores, contains an unbroken line.

It is worth noting one special case of interval and ratio scales in which the data are discrete. Namely, when one presents counts (e.g., the number of babies born a year) the data are discrete but also ratio. In this case, even though the data cannot technically be a decimal (e.g., 2.3 babies), a histogram or a frequency polygon is still the appropriate way to show the data.

Research Methods and Variables

Psychological research commonly uses three methods: descriptive, correlational, and experimental.

Descriptive

Of the three commonly used types of research, descriptive research is the most basic. Descriptive research does exactly what it sounds like; it *describes* a data set. All of the information presented in descriptive research can be directly verified by the data. In other words, no inferences are drawn about other data or other situations.

All of the following (made up) examples represent descriptive research: The average statistics grade on the first exam was 71.43, two thirds of the students enrolled in general psychology are women, and only one first-year student is enrolled in research methods. As you can see, all of these examples describe something about a group of people and can be verified by examining the data. None of the examples make claims about other groups or do anything beyond conveying basic information about the data set.

With descriptive research, three types of graphs are typically used: bar graphs, histograms, and frequency polygons.

Correlational

Correlational research is sometimes classified as descriptive and sometimes classified as its own separate category. This ambiguity arises because a correlation can be used to merely describe the strength of a relationship or it can be used to test for the presence of a relationship. In either situation, the purpose of correlational research is to examine the relationship between two variables. The difference between descriptive research and correlational research is that correlational research emphasizes relationships whereas descriptive research does not.

All of the following (made up) examples represent correlational research: There is a positive relationship between the number of hours studied and the grade earned on the first statistics exam, increased amounts of estrogen are related to higher levels of empathy, and the amount of beer a person consumes is negatively related to the person's ability to drive well.

With correlational research, only one type of graph is typically used: a scatterplot.

Experimental

Experimental research is the most complicated of the three types of research. Consequently, it provides the richest data. Experimental research separates itself from other

types of research in that the experimenter has control over one (or more) variable(s). For example, if researchers want to examine whether consuming caffeine makes someone more alert, they will need to conduct an experiment. One potential (although simplistic) way of examining this effect would be to give participants different amounts of caffeine (e.g., 50 mg, 100 mg, and 150 mg) in a between-subjects design and test for alertness. In this case, the experimenters control the amount of caffeine a person consumes and it is this control that makes the study an experiment. Additionally, because the experimenters are giving different amounts of caffeine to different participants, they are manipulating the amount of caffeine received. Manipulation is a key component of experimental research. Although experiments are powerful and frequently used, they may be less realistic because the experimenter controls and manipulates the situation.

Experimental research has two types of variables unique to experiments. One is the variable that is under the control of and deliberately manipulated by the experimenter. This variable is called the independent variable (IV). The independent variable will always have at least two discrete (nonoverlapping) levels. In the example described above, the experimenter created three levels: 50 mg, 100 mg, and 150 mg of caffeine. Often, experiments will consist of more than one independent variable. Multiple independent variables allow for the study of complex human behavior. For example, with the caffeine study discussed above, it is entirely possible that the time of day the caffeine is consumed may have an effect on a person's ability to focus. Therefore, the experiment can create two levels corresponding to the time of day the caffeine is consumed: morning (10:00 am) or afternoon (3:00 pm). The experimenter would assign participants to either the morning group or the afternoon group, thereby manipulating the time of day the caffeine is consumed.

The second type of variable that all experimental research has is called the dependent variable (DV). The dependent variable is the variable being measured and is not controlled by the researcher. The DV is the data (D) the researcher collects. In the above example, the researcher measures each participant's level of alertness so the level of alertness is the DV. Another way of thinking of a DV is that it depends on the IV. That is to say, the person's level of alertness depends on the amount of caffeine consumed (assuming caffeine has an effect on alertness). As opposed to the IV, the DV in this example is continuous (the opposite of discrete data and includes all data that have the potential to include fractions or decimals).

A final quality of experimental research is that it is often inferential. That means it is used to make inferences about other similar situations and groups of people. Although it is interesting to know that caffeine has an effect on the level of alertness for a particular sample, the goal is to be able to apply that knowledge in other situations. In other words, the goal of the study is to be able to draw the inference that in general caffeine increases alertness, not just in the specific situation studied.

With experimental research, two types of graphs are typically used: bar graphs and line graphs.

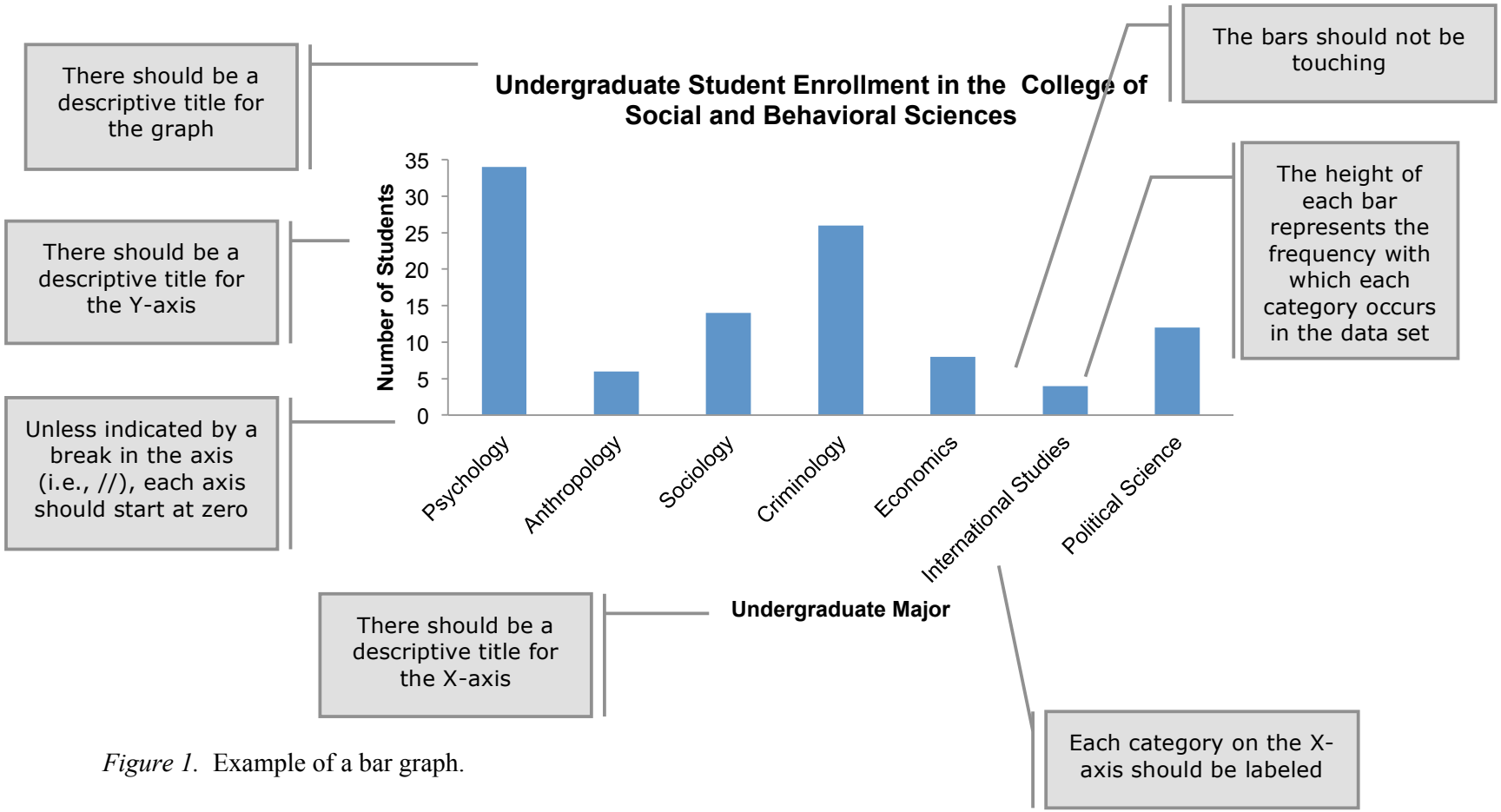


Figure 1. Example of a bar graph.

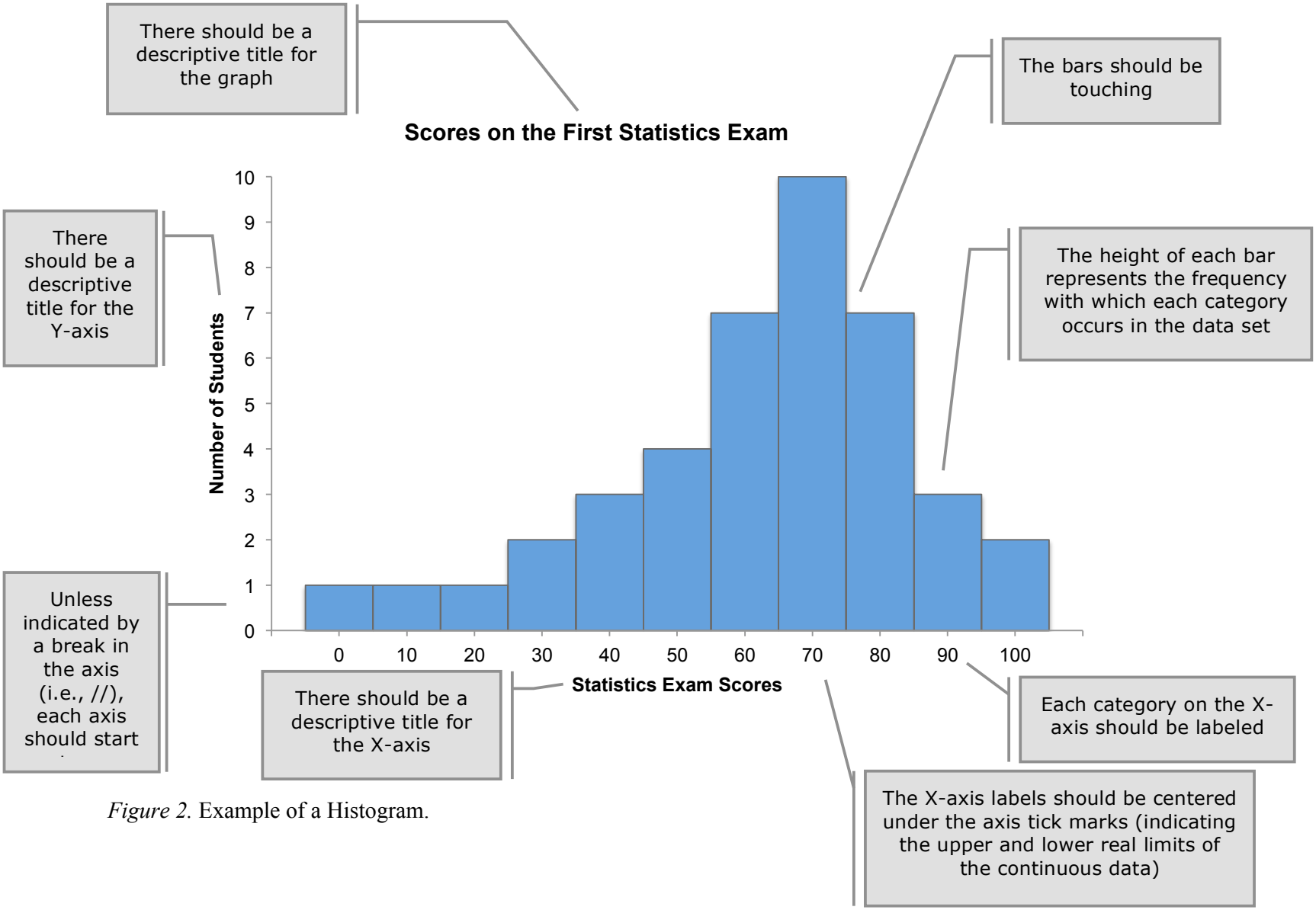


Figure 2. Example of a Histogram.

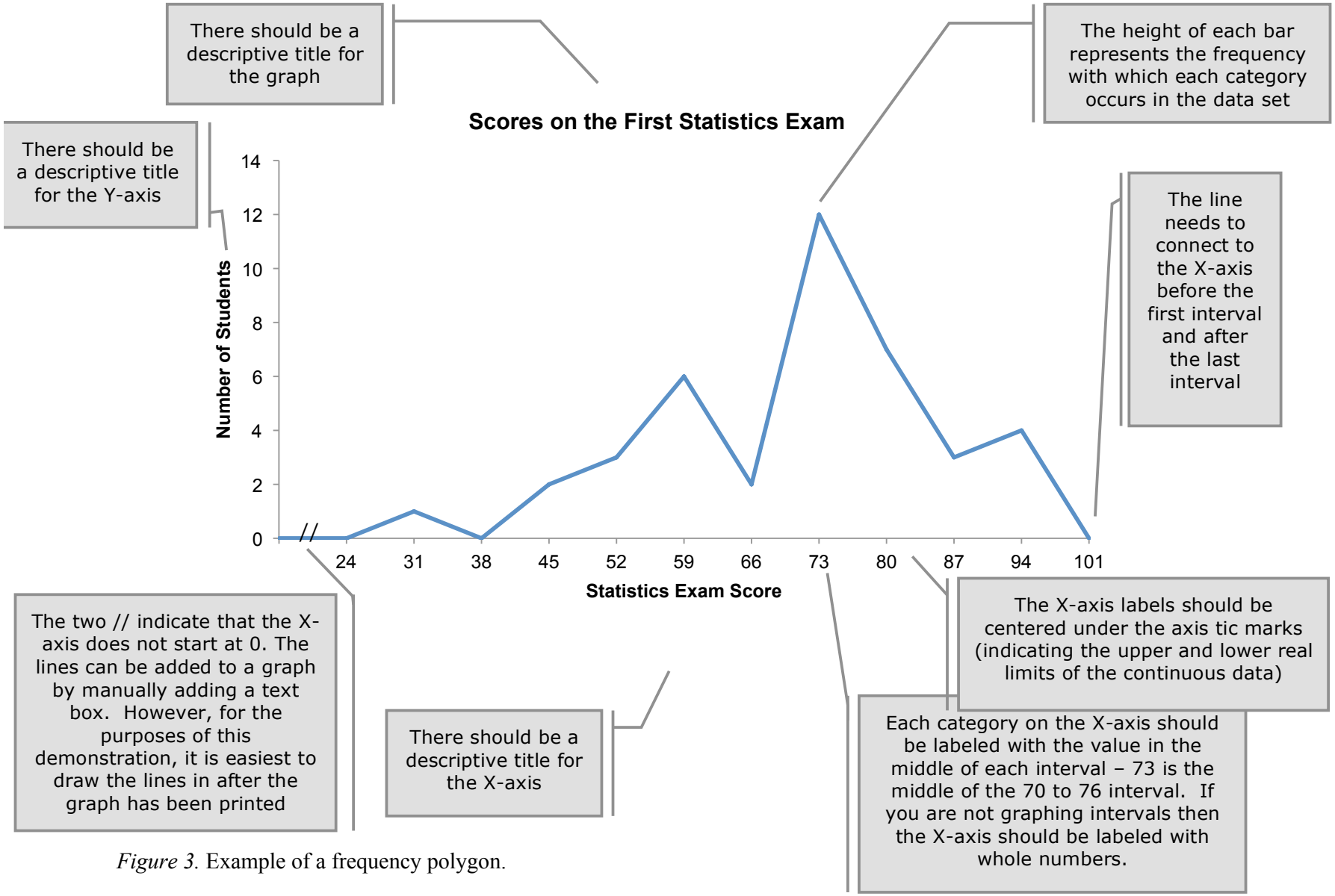


Figure 3. Example of a frequency polygon.

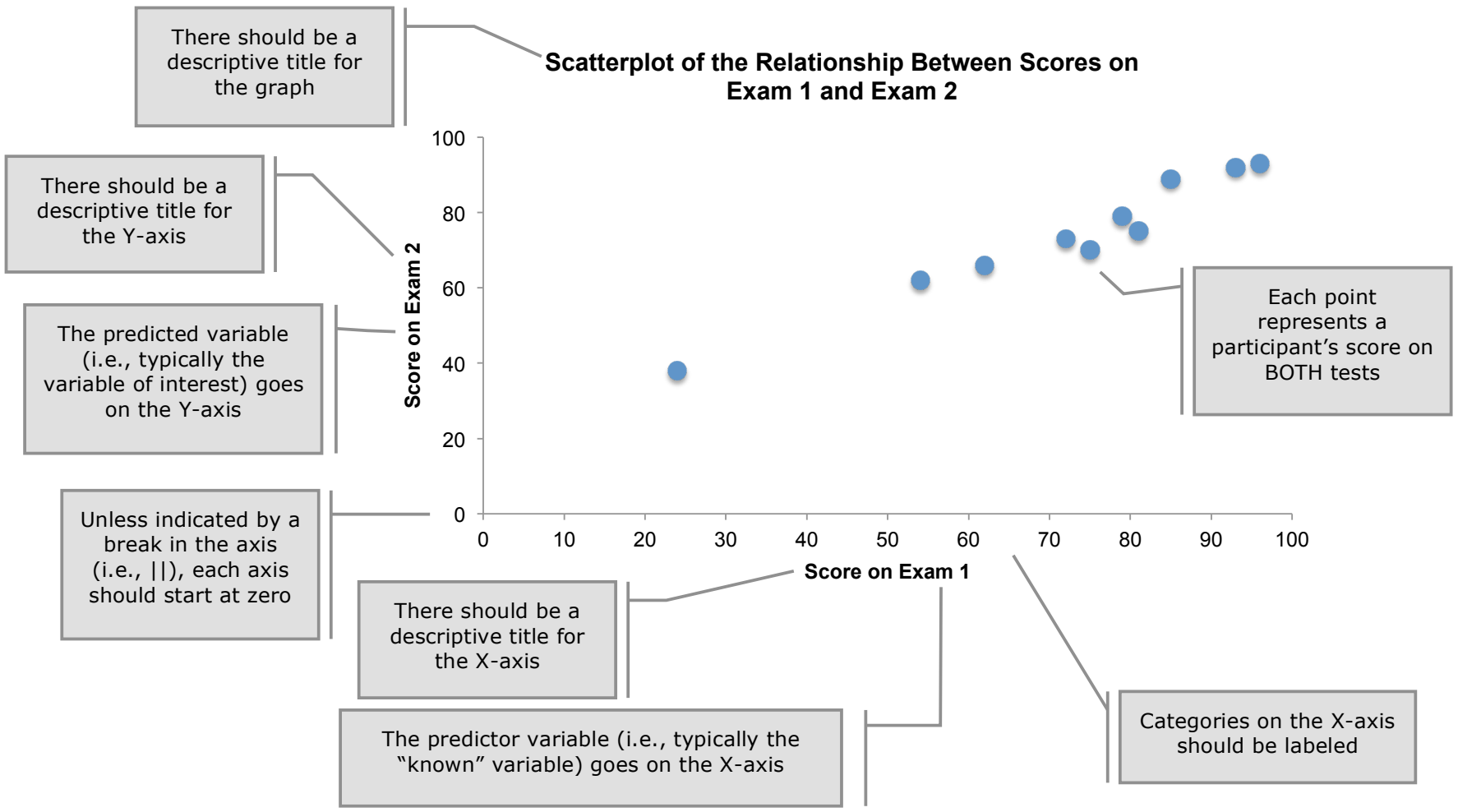


Figure 4. Example of a scatterplot.

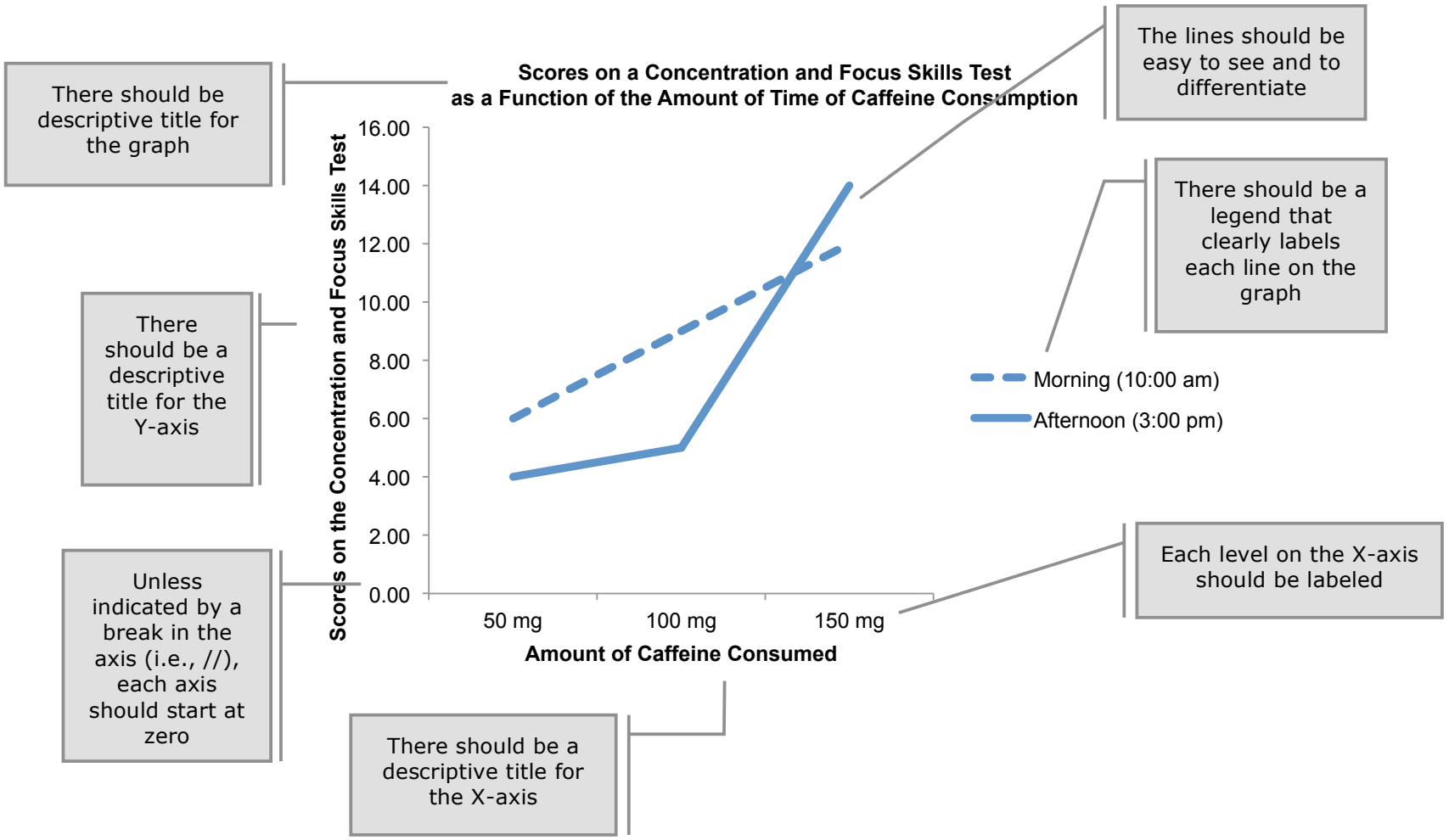


Figure 5. Example of a line graph.

Types of Data Questions

1. Social psychologists often use nominal variables in their research. What are some nominal variables you would expect a social psychologist to regularly use?

2. Cognitive psychologists often use interval/ratio variables in their research. What are some interval/ratio variables you would expect a cognitive psychologist to regularly use?

3. Provide an example of a research scenario where a psychologist would collect ordinal data.

    a. Do you think rank data are better classified as quantitative or qualitative? Why?

4. In social science research, which do you think you will encounter more as a *dependent variable*: nominal, ordinal, or interval/ratio data? Why?

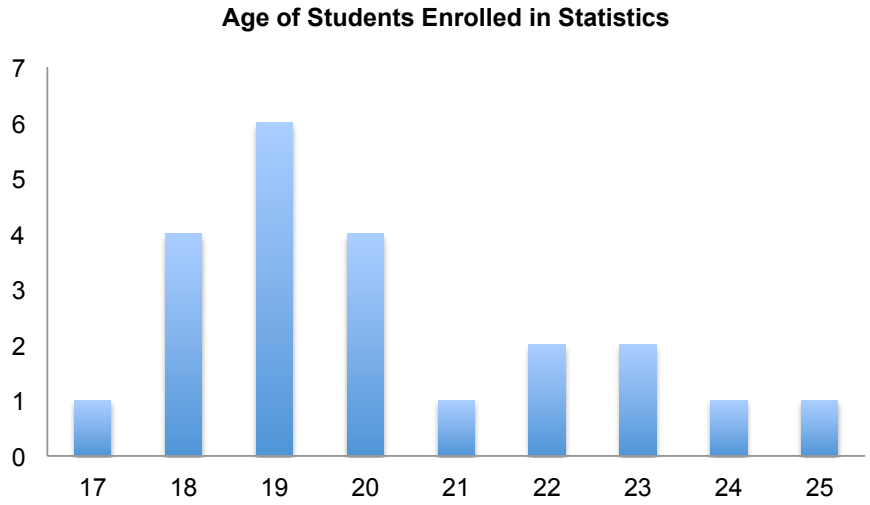
5. One controversy among social science researchers regards multiple-choice measures such as Likert-type questions (e.g., 1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neither Agree nor Disagree*, 4 = *Agree*, 5 = *Strongly Agree*). Some researchers consider these types of questions to be ordinal and some consider them to be interval. Which do you consider them to be, ordinal or interval? Why?

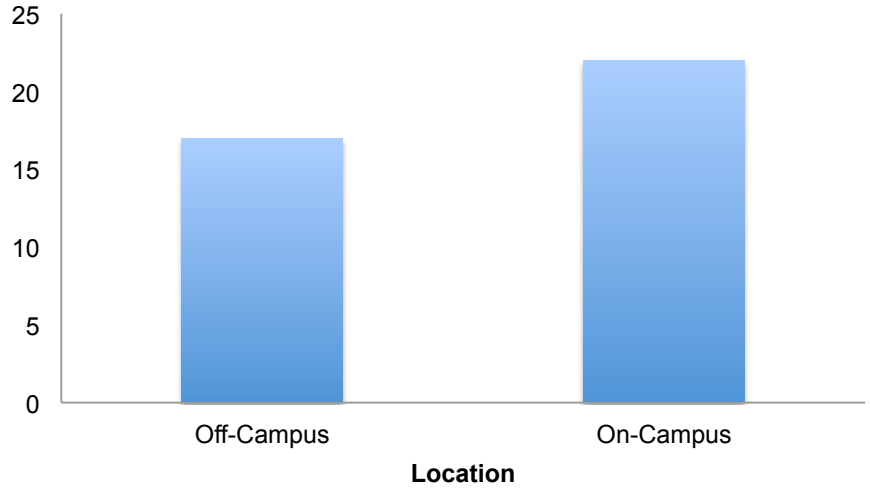
    a. What are the possible ramifications of classifying the measure as ordinal?

    b. What are the possible ramifications of classifying the measure as interval?

Fix the Graph

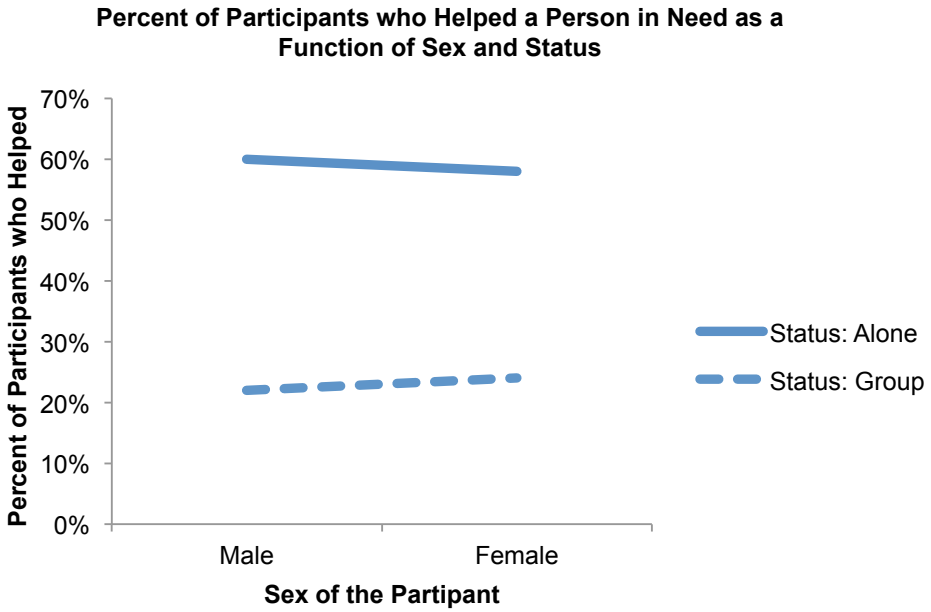
Below are two flawed graphs. Determine what is wrong with each graph and fix it. If you need to draw a new graph, you can.





Graph Questions 1

Use the graph below to answer the following questions:



1. What kind of graph is it?

2. What is the Dependent Variable (DV)?

3. How many Independent Variables (IVs) are there?

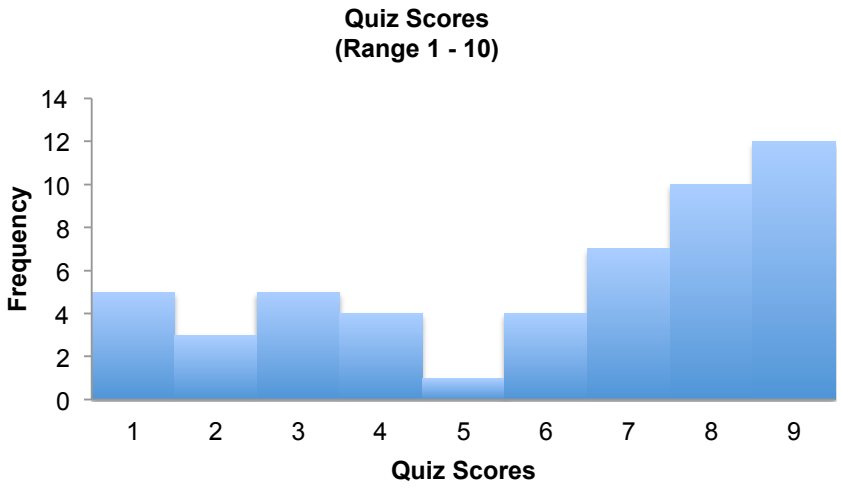
    a. How can you tell?

    b. What are they?

4. When are people the most likely to help, when they are alone or in a group?

Graph Questions 2

Use the graph below to answer the following questions:



1. What kind of graph is it?

2. What kind of data (nominal, ordinal, interval, or ratio) were used to make the graph? How do you know?

3. Are there any other graph types that would be appropriate to use? If so, what kind?

4. How many students scored a 6?

5. Which score was the most frequently occurring score in the class?

6. How many students are enrolled in the class?

M&Ms Activity*

For this activity, you will need a pack of M&Ms and access to a computer with Microsoft Excel. Using the M&Ms, you will need to do the following:

1. Divide the candies by color.
2. Count the number of each color.
3. Create a graph in Microsoft Excel** that shows the breakdown by color.
    a. Make sure to select the most appropriate type of graph.
    b. Don't forget to include labels and a descriptive title!

*NOTE: Although this activity was not taken from a specific source, there are many versions of it in use by a variety of people. However, none of the existing versions were consulting when making this activity.

**See the "How-to" guides at the end of this workbook for step-by-step instructions on how to make each of the five main types of graphs (i.e., bar, histogram, frequency polygon, scatterplot, and line graph)

Wadded Up "Paperball" Toss Activity

For this activity, you will need a sheet of paper, a yardstick or tape measure, and access to a computer with Microsoft Excel. Using the sheet of paper and the ruler, you will need to do the following:

1. Wad up a sheet of paper to make a "paperball."

2. Mark a spot on the floor from which everyone will throw their paperball.

3. Each person in the class should throw a paperball and then measure the number of inches it flew.

    a. To ensure consistency in the measurement, each person should measure from the tips of their toes (at the time of the toss) to the final resting place of the "paperball"

        i. Try to measure the most direct route possible.

    b. All measurements should be in inches

4. Create a graph in Microsoft Excel* that shows the paperball distances

    a. Make sure to select the most appropriate type of graph.

    b. Don't forget to include labels and a descriptive title!

*See the "How-to" guides at the end of this workbook for step-by-step instructions on how to make each of the five main types of graphs (i.e., bar, histogram, frequency polygon, scatterplot, and line graph)

Survey Activity

For this activity, you will need the survey that is included with this workbook on the next page and access to a computer with Microsoft Excel. You will need to do the following:

1. Have each person in the class complete a survey.
2. Collect and enter the data into Microsoft Excel*.
3. Select a question that interests you and that uses **nominal** data.
    a. Create the appropriate type of graph in Microsoft Excel.
    b. Don't forget to include labels and a descriptive title!
4. Select a question that interests you and that use **ordinal** data.
    a. Create the appropriate type of graph in Microsoft Excel.
    b. Don't forget to include labels and a descriptive title!
5. Select a question that interests you and that uses **interval/ratio** data.
    a. Create the appropriate type of graph in Microsoft Excel.
    b. Don't forget to include labels and a descriptive title!

*See the "How-to" guides at the end of this workbook for step-by-step instructions on how to make each of the five main types of graphs (i.e., bar, histogram, frequency polygon, scatterplot, and line graph)

Survey

1. How old (in years) are you? _____

2. Are you working? Yes Full-time Yes Part-time No

If yes, how many hours a week do you work?
(Provide a number from 0 to 40) _____

3. What is your sex? Male Female

4. Student Status? Full-time Part-time

5. What is your current residence as a student? On-campus Off-campus

6. What year are you in school?

Freshman Sophomore Junior Senior

7. Are you a psychology major? Yes No

8. What percentage do you hope to earn in this class?
(Provide a percent from 0% to 100%) _____

9. How many hours a week do you plan to study for this class?
(Provide a number from 0 to 40) _____

10. Approximately, how many miles away from campus did you grow up?

0 to 20 miles
21 to 40 miles
41 to 60 miles
61 to 80 miles
81 to 100 miles
More than 100 miles

11. What do you think is the best thing about your university?

12. What do you think is the worst thing about your university?

Survey (Types of Data) Questions

1. Which of the questions on the survey resulted in nominal data?

    a. Sketch an example of the type of graph that should be used to show the data.

2. Which of the questions on the survey resulted in ordinal data?

    a. Sketch an example of the type of graph that should be used to show the data.

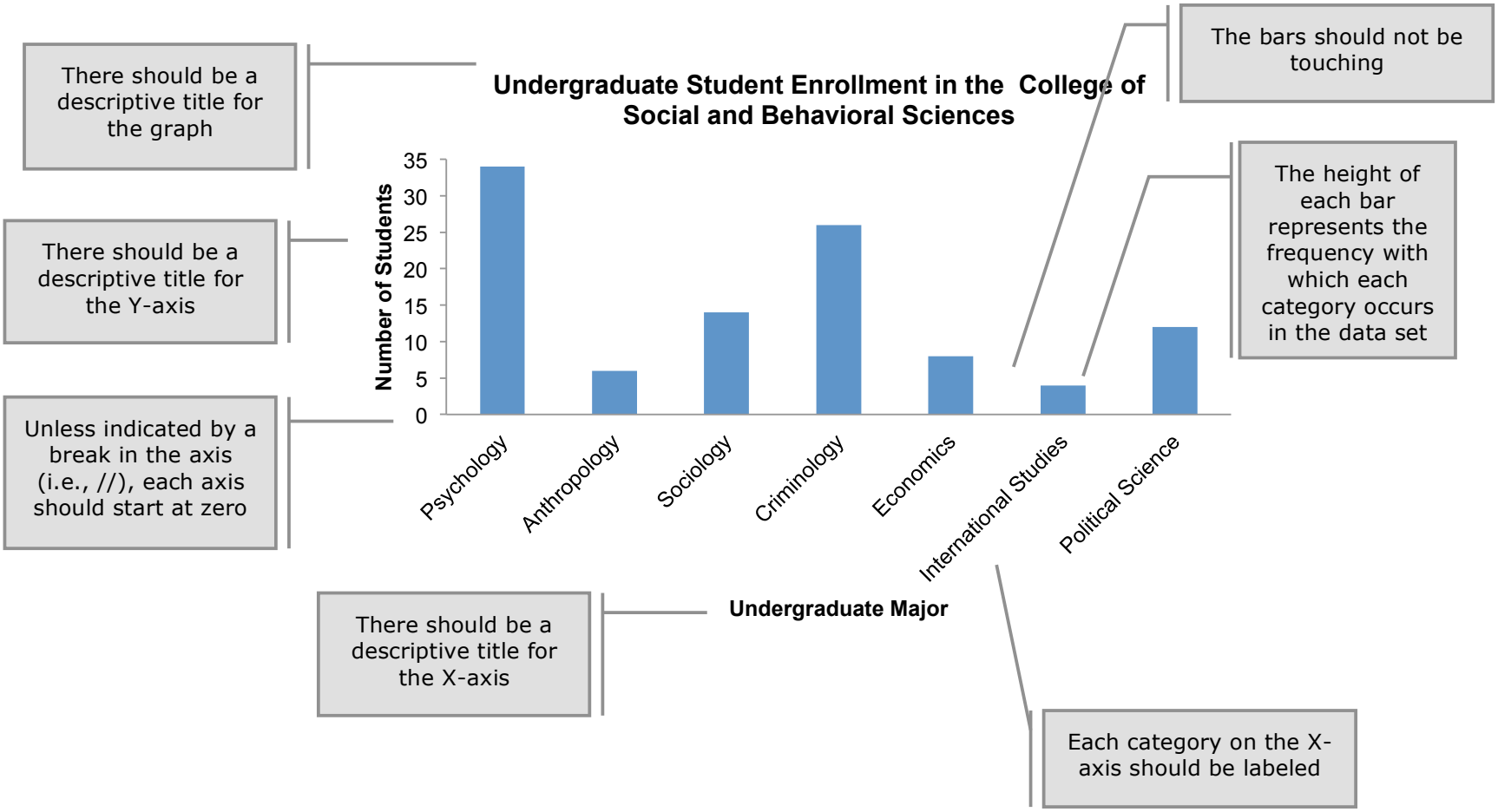
3. Which of the questions on the survey resulted in ratio data?

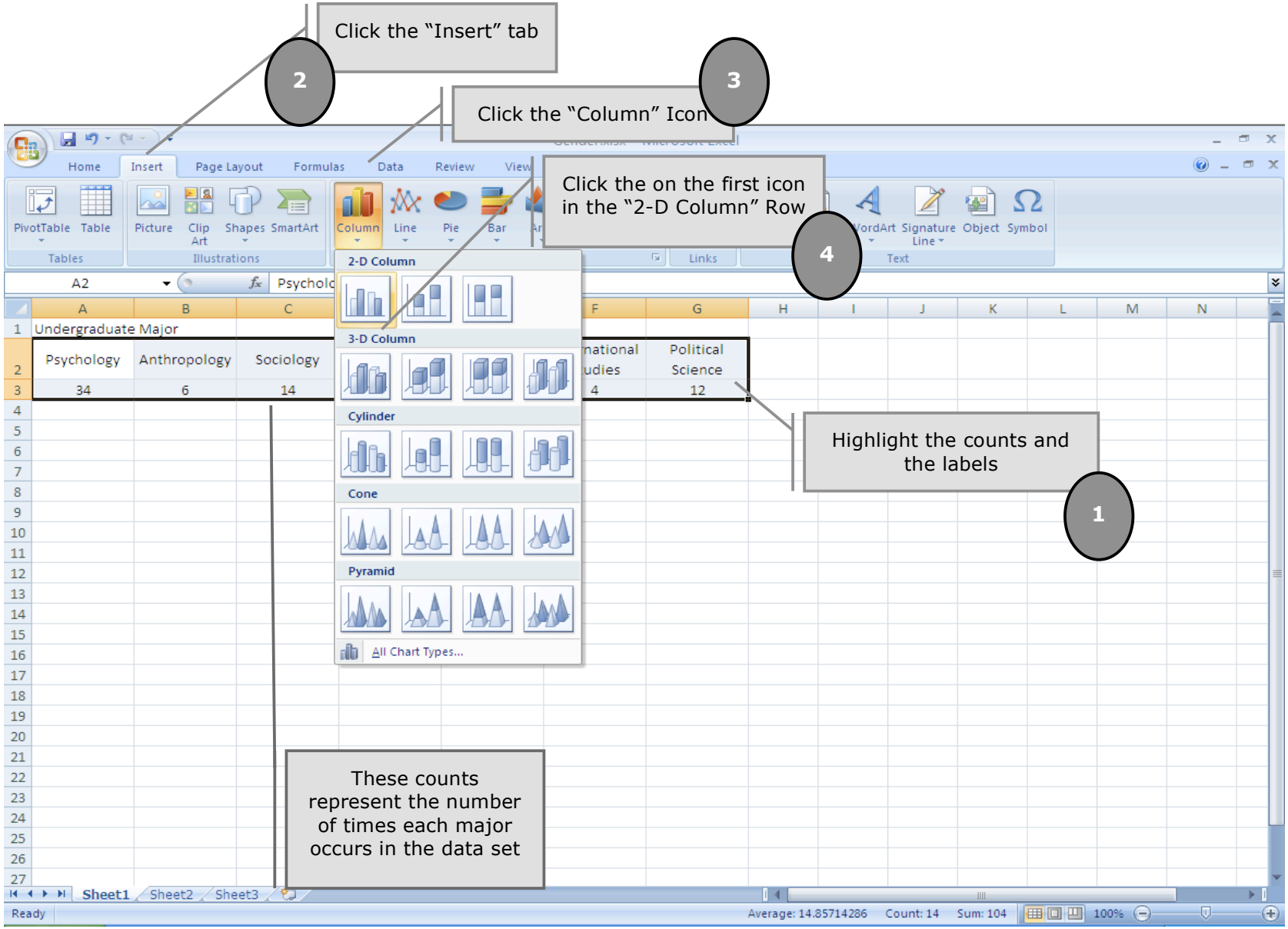
    a. Sketch an example of the two types of graphs that should be used to show the data.

4. In addition to the survey's nominal questions, the open-ended questions at the end are also qualitative questions. How do you think the data collected from these qualitative questions will differ from the data collected from the other questions?

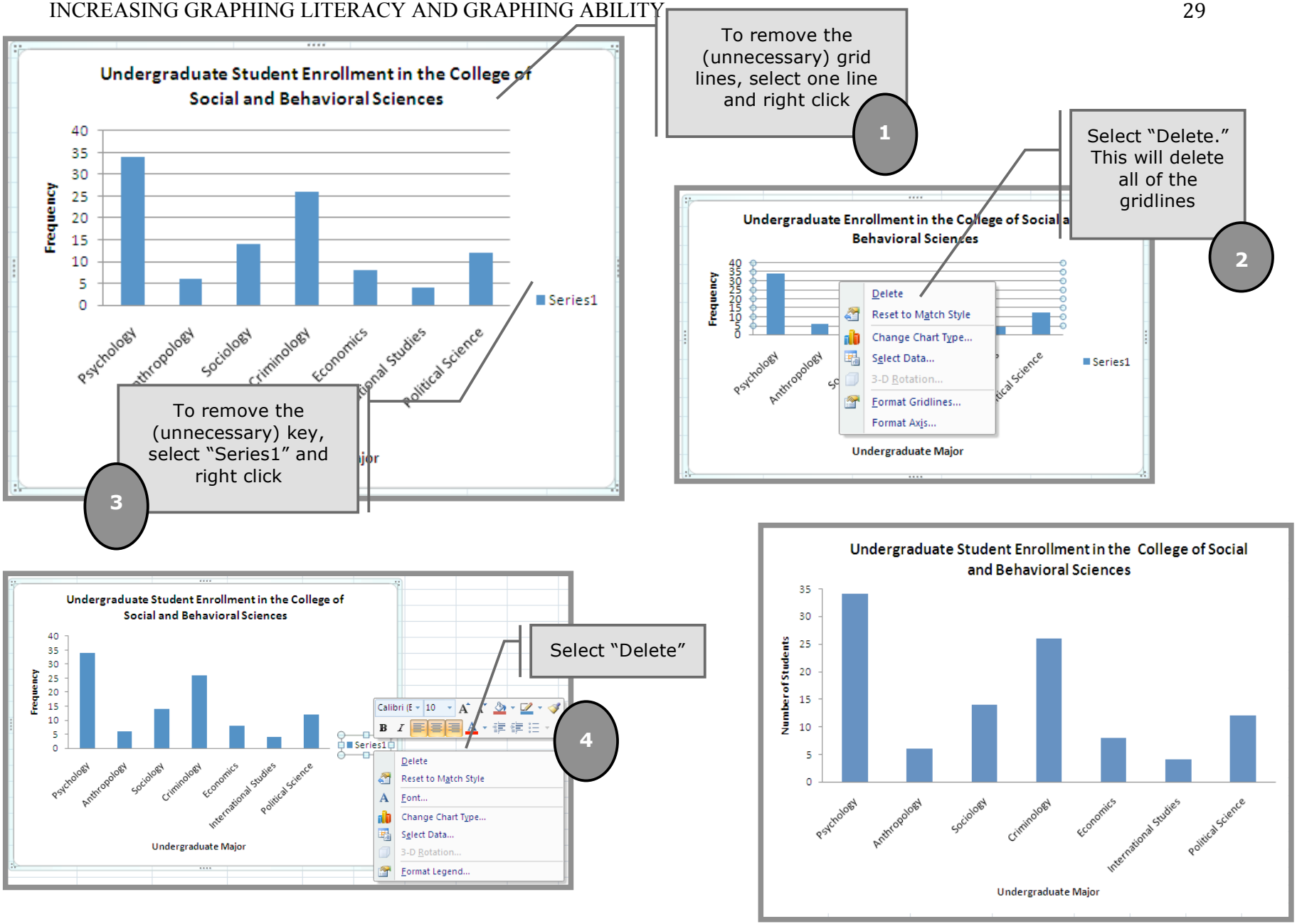
    a. Which type of data do you think you would prefer to work with, qualitative or quantitative? Why?

How to Create a Bar Graph

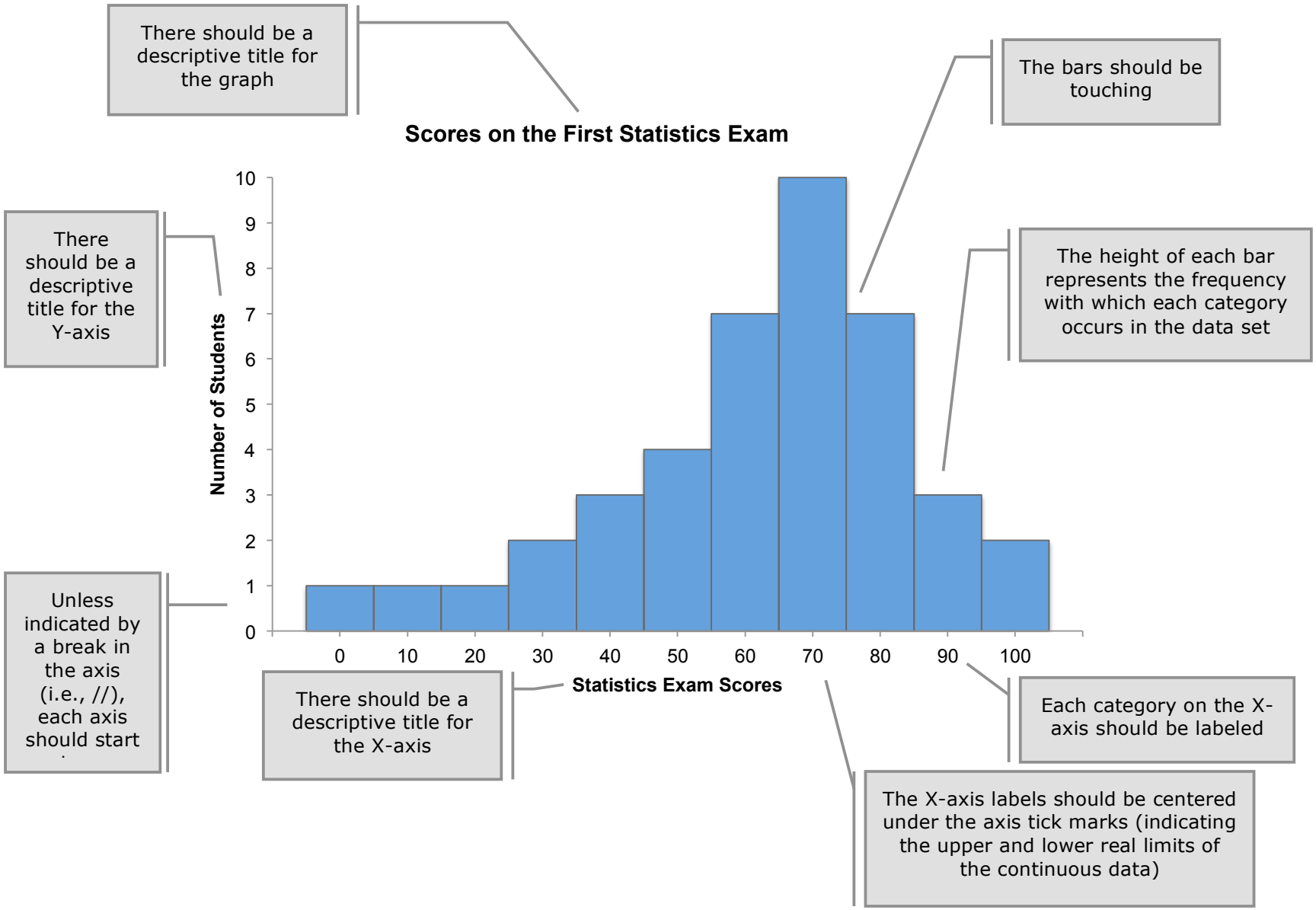



Click the "Insert" tab
2
Click the "Column" Icon
3
Click the on the first icon in the "2-D Column" Row
4
Highlight the counts and the labels
1
These counts represent the number of times each major occurs in the data set
Undergraduate Major
Psychology
Anthropology
Sociology
Political Science
34
6
14
12
2-D Column
3-D Column
Cylinder
Cone
Pyramid
All Chart Types...
Sheet1
Sheet2
Sheet3
Ready
Average: 14.85714286
Count: 14
Sum: 104

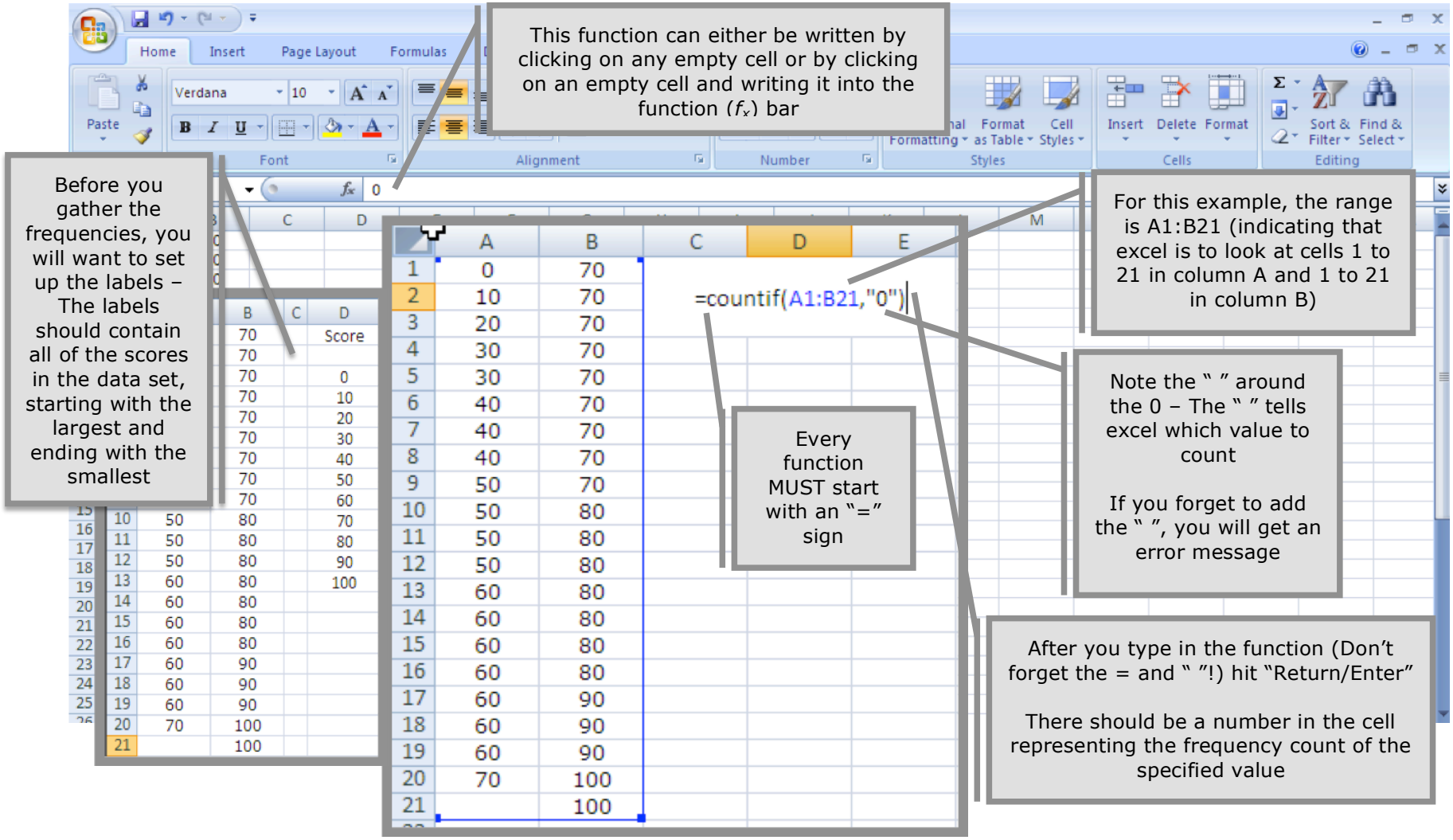

The graph needs a title and the axes need to be labeled
With the graph highlighted, select the bottom arrow under "Chart Layouts"
1
Chart Layouts
Selecting the bottom arrow will provide a drop down menu. Select the graph preview image that contains spaces for a title and both axes. (In this case, that image is the ninth image)
2
UndergraduateMajor.xlsx - Microsoft Excel
Home
Insert
Page Layout
Formulas
Data
Review
View
Change Chart Type
Save As Template
Type
Switch Row/Column
Select Data
Data
Chart
Chart 1
Undergraduate Major
Psychology
Anthropology
34
6
Add a descriptive title and label both axes
HINT: The Y-axis contains the counts and the X-axis contains the variable in which you are interested
3
Chart Title
Axis Title
Psychology
Anthropology
Sociology
Criminology
Economics
International Studies
Political Science
Series1
Axis Title
Typically, the Independent Variable (IV) goes on the X-axis and Dependent Variable (DV)

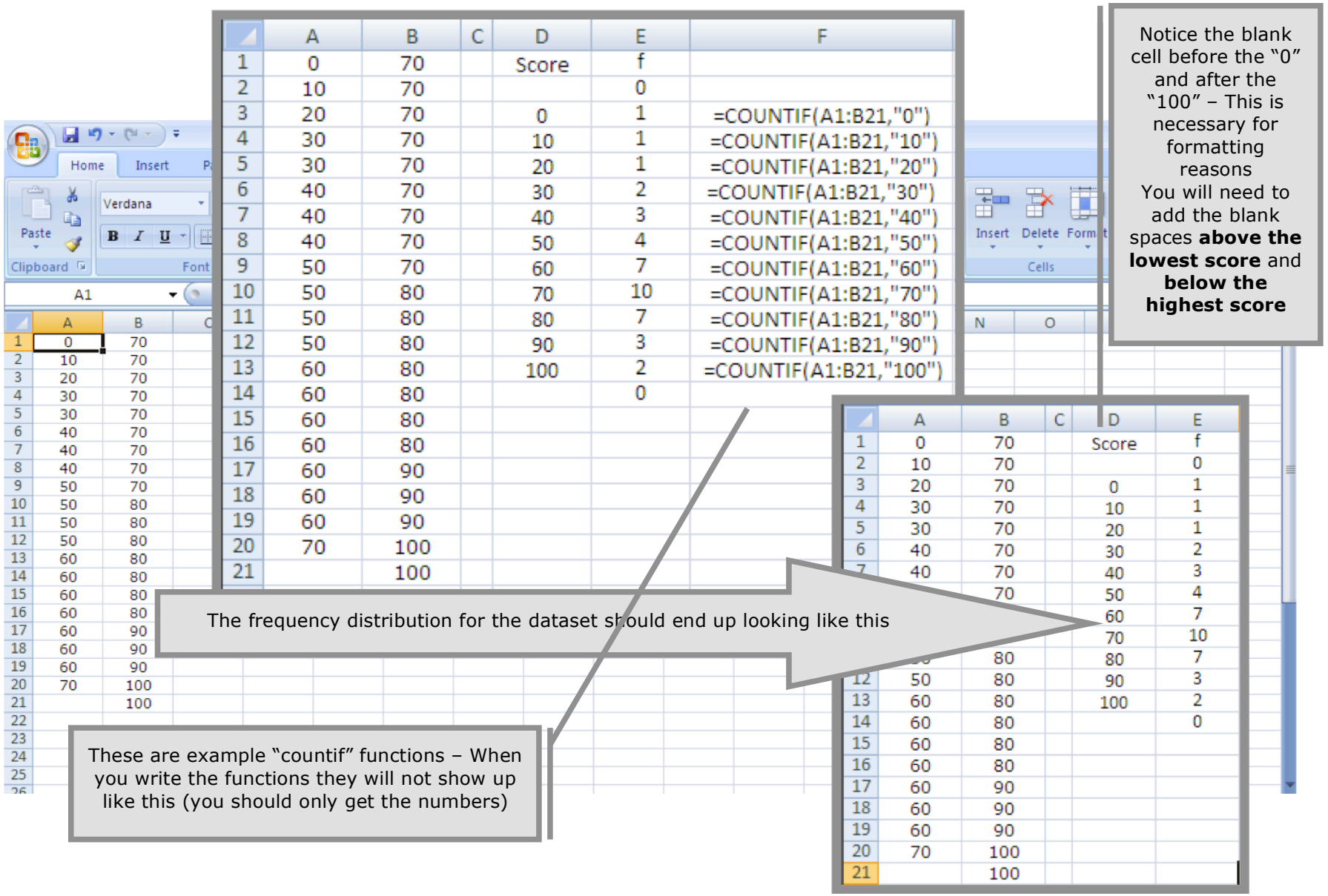

To remove the (unnecessary) grid lines, select one line and right click
1
Undergraduate Student Enrollment in the College of Social and Behavioral Sciences
Frequency
Psychology
Anthropology
Sociology
Criminology
Economics
International Studies
Political Science
Series1
Select "Delete." This will delete all of the gridlines
2
Delete
Reset to Match Style
Change Chart Type...
Select Data...
3-D Rotation...
Format Gridlines...
Format Axis...
Undergraduate Major
To remove the (unnecessary) key, select "Series1" and right click
3
Select "Delete"
4
Font...
Format Legend...
Number of Students

How to Create a Histogram



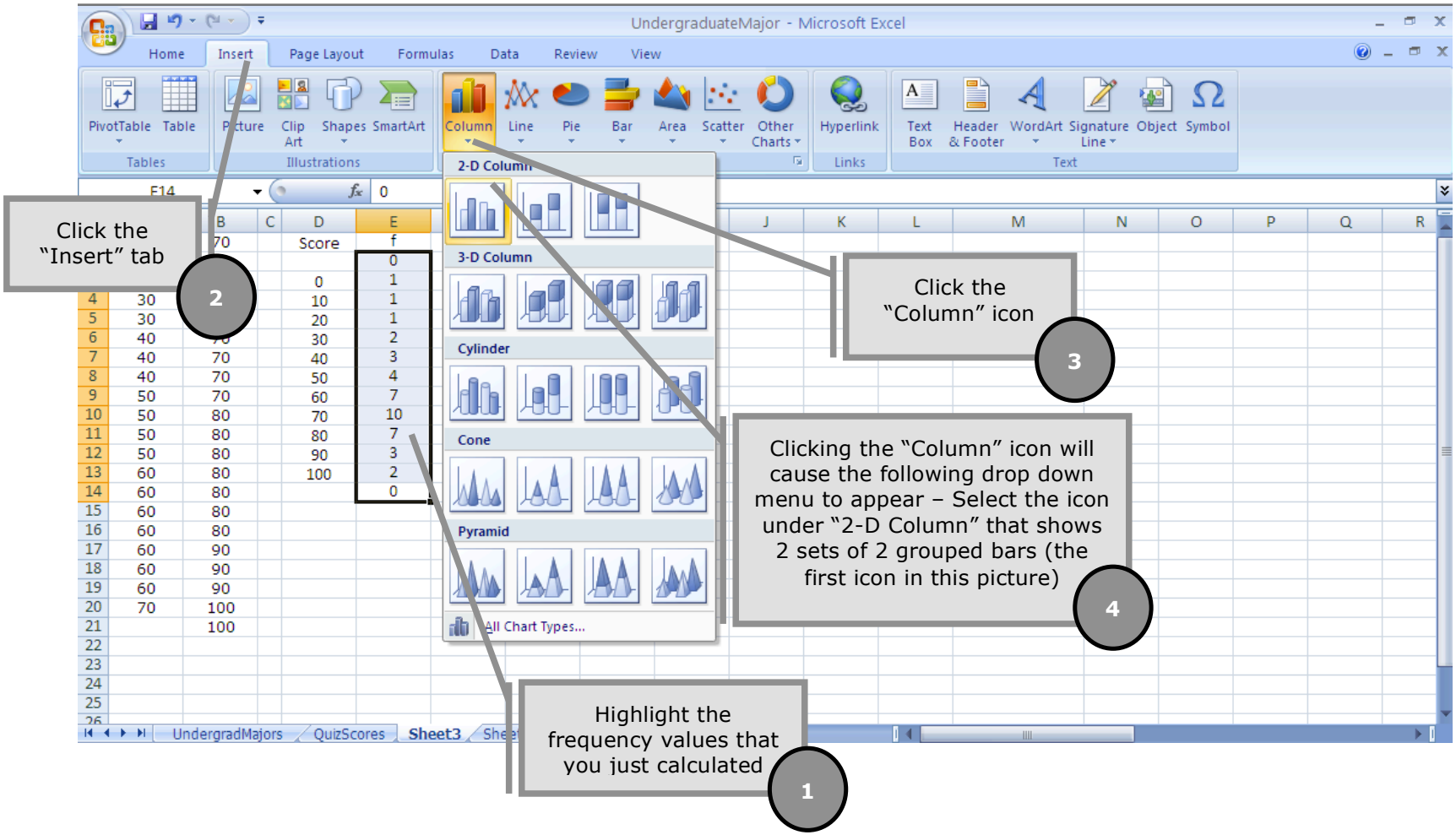
You will need to **gather the frequencies of each score**. To do this you will need to write a "countif" function for each score. The "countif" function tells Excel to count all of the specified values in a specified range. Since there are 11 scores (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, & 100) you will write 11 "countif" functions.

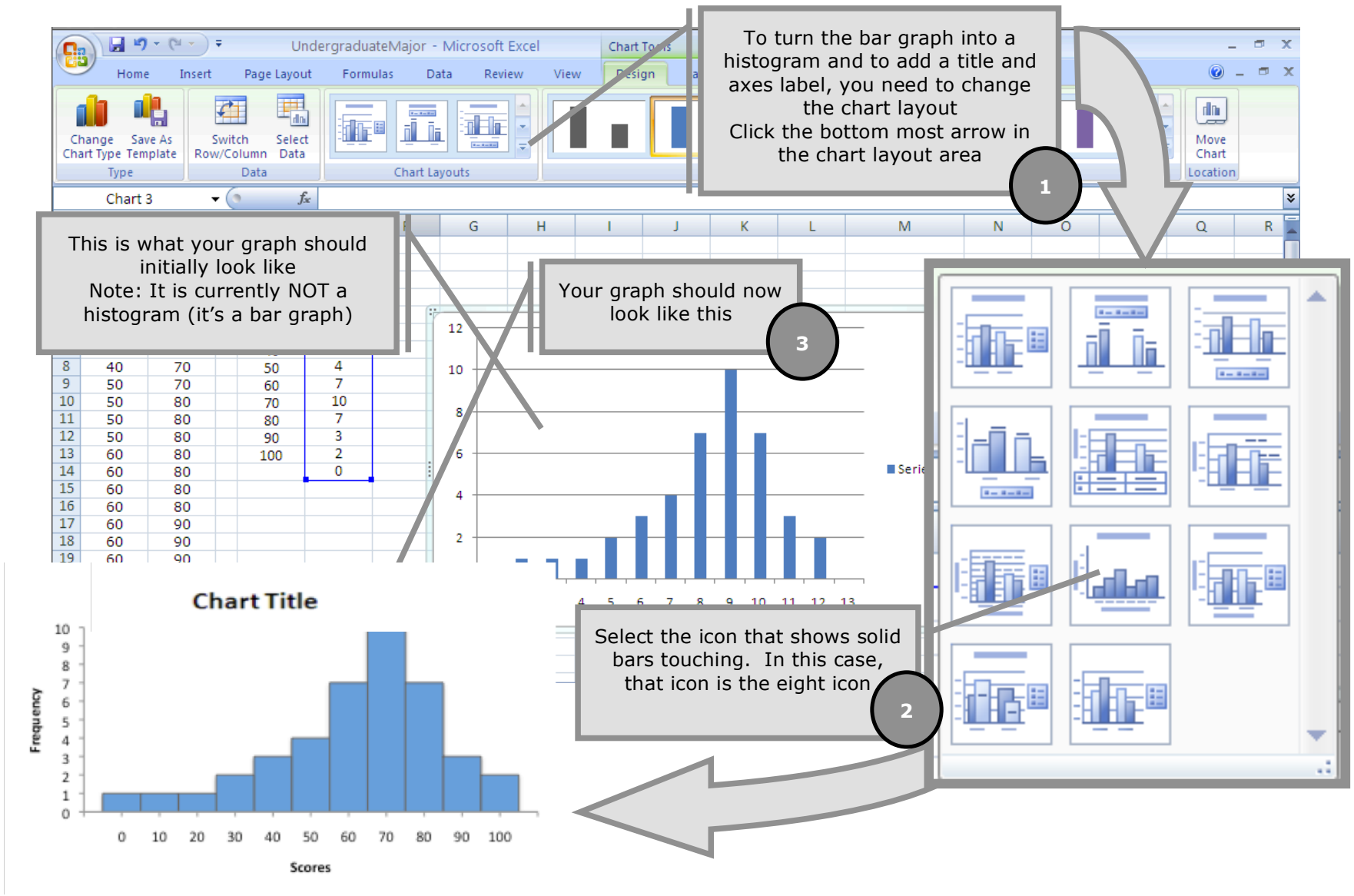


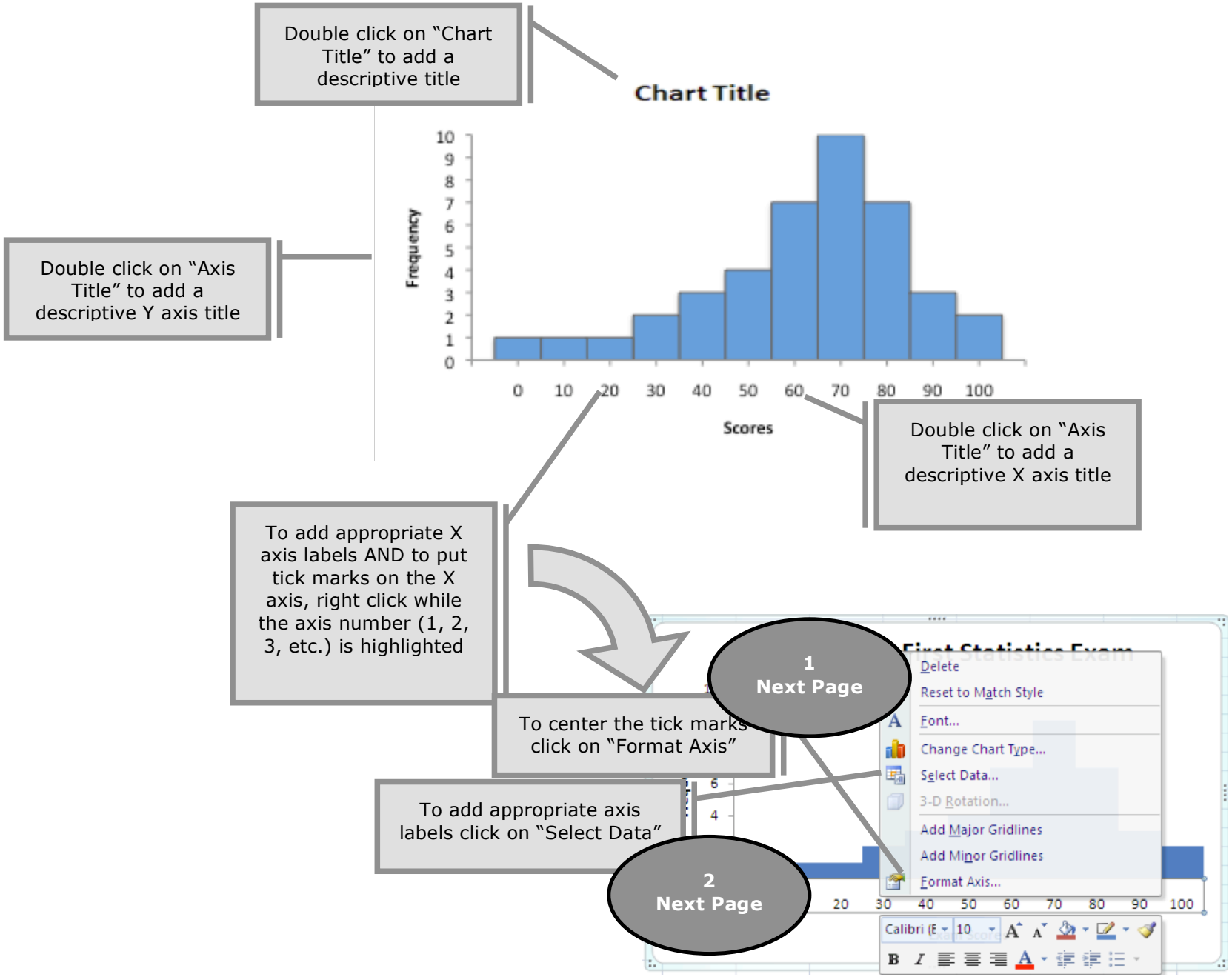


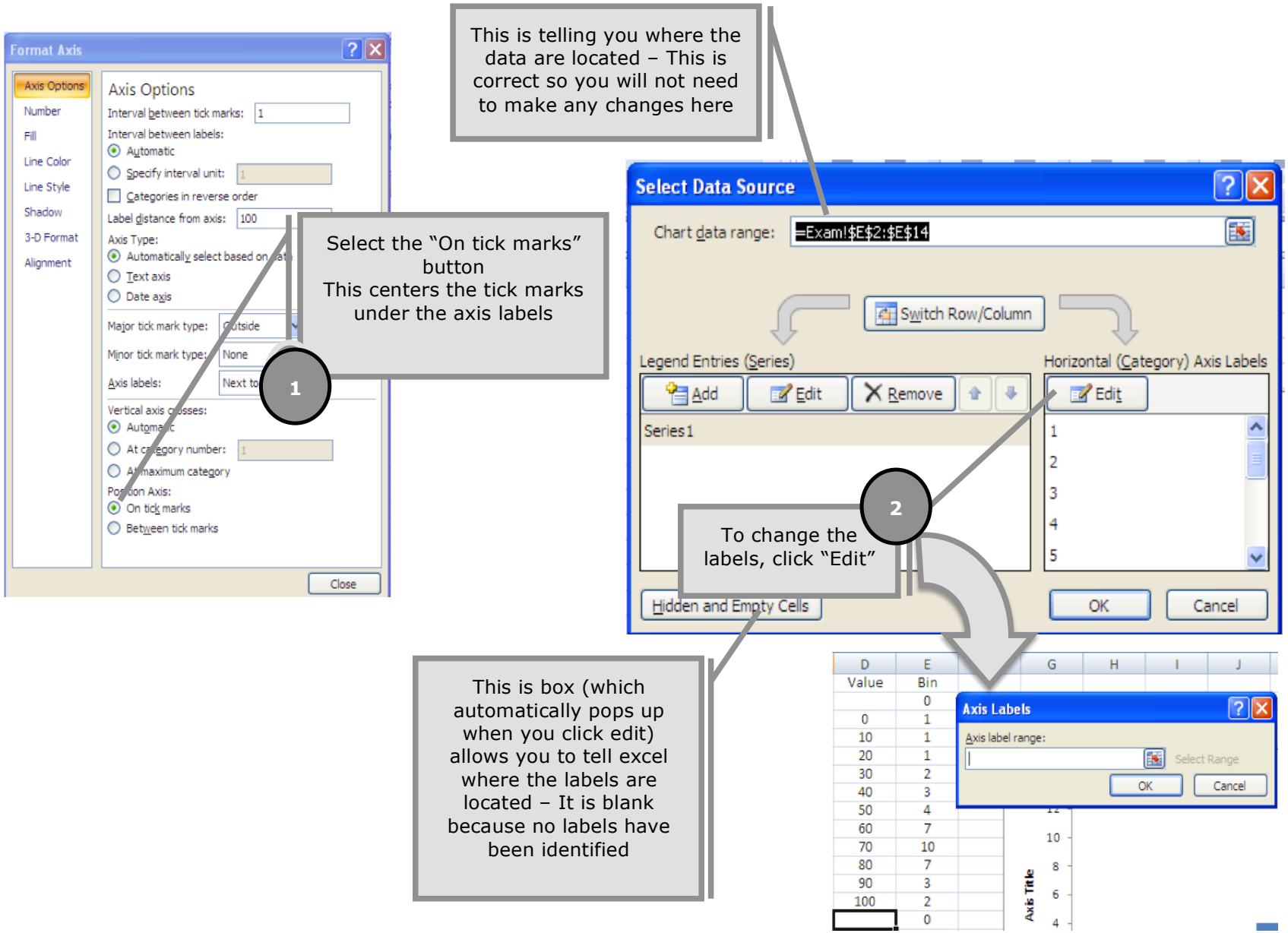
	A	B	C	D	E	F
1	0	70		Score	f	
2	10	70			0	
3	20	70		0	1	=COUNTIF(A1:B21,"0")
4	30	70		10	1	=COUNTIF(A1:B21,"10")
5	30	70		20	1	=COUNTIF(A1:B21,"20")
6	40	70		30	2	=COUNTIF(A1:B21,"30")
7	40	70		40	3	=COUNTIF(A1:B21,"40")
8	40	70		50	4	=COUNTIF(A1:B21,"50")
9	50	70		60	7	=COUNTIF(A1:B21,"60")
10	50	80		70	10	=COUNTIF(A1:B21,"70")
11	50	80		80	7	=COUNTIF(A1:B21,"80")
12	50	80		90	3	=COUNTIF(A1:B21,"90")
13	60	80		100	2	=COUNTIF(A1:B21,"100")
14	60	80			0	
15	60	80				
16	60	80				
17	60	90				
18	60	90				
19	60	90				
20	70	100				
21		100				

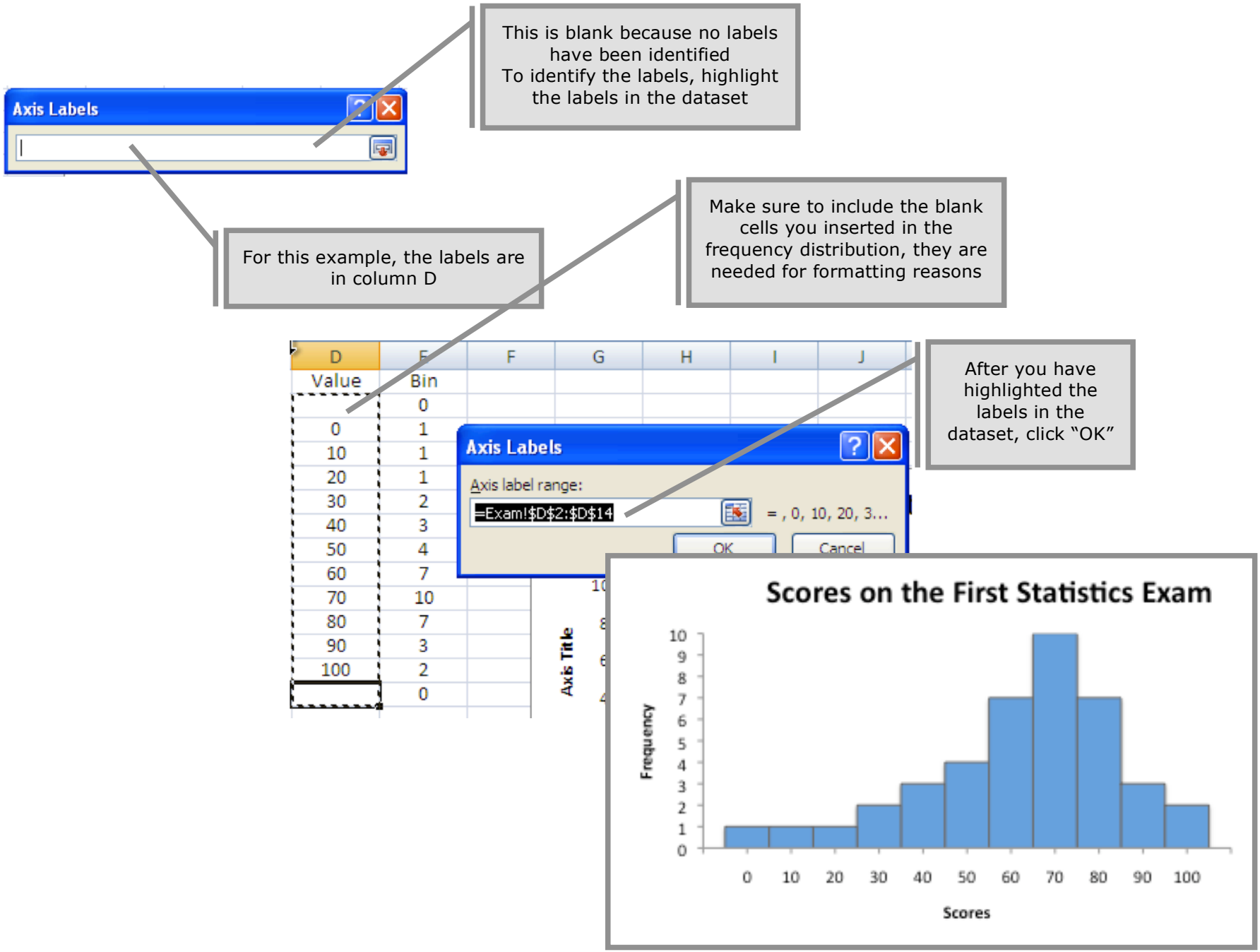
	A	B	C	D	E
1	0	70		Score	f
2	10	70			0
3	20	70		0	1
4	30	70		10	1
5	30	70		20	1
6	40	70		30	2
7	40	70		40	3
		70		50	4
				60	7
				70	10
		80		80	7
12	50	80		90	3
13	60	80		100	2
14	60	80			0
15	60	80			
16	60	80			
17	60	90			
18	60	90			
19	60	90			
20	70	100			
21		100			


UndergraduateMajor - Microsoft Excel
Home
Insert
Page Layout
Formulas
Data
Review
View
PivotTable
Table
Picture
Clip Art
Shapes
SmartArt
Column
Line
Pie
Bar
Area
Scatter
Other Charts
Hyperlink
Text Box
Header & Footer
WordArt
Signature Line
Object
Symbol
Tables
Illustrations
Links
Text
2-D Column
3-D Column
Cylinder
Cone
Pyramid
All Chart Types...
Score
f
UndergradMajors
QuizScores
Sheet3
Click the "Insert" tab
2
Click the "Column" icon
3
Clicking the "Column" icon will cause the following drop down menu to appear – Select the icon under "2-D Column" that shows 2 sets of 2 grouped bars (the first icon in this picture)
4
Highlight the frequency values that you just calculated
1

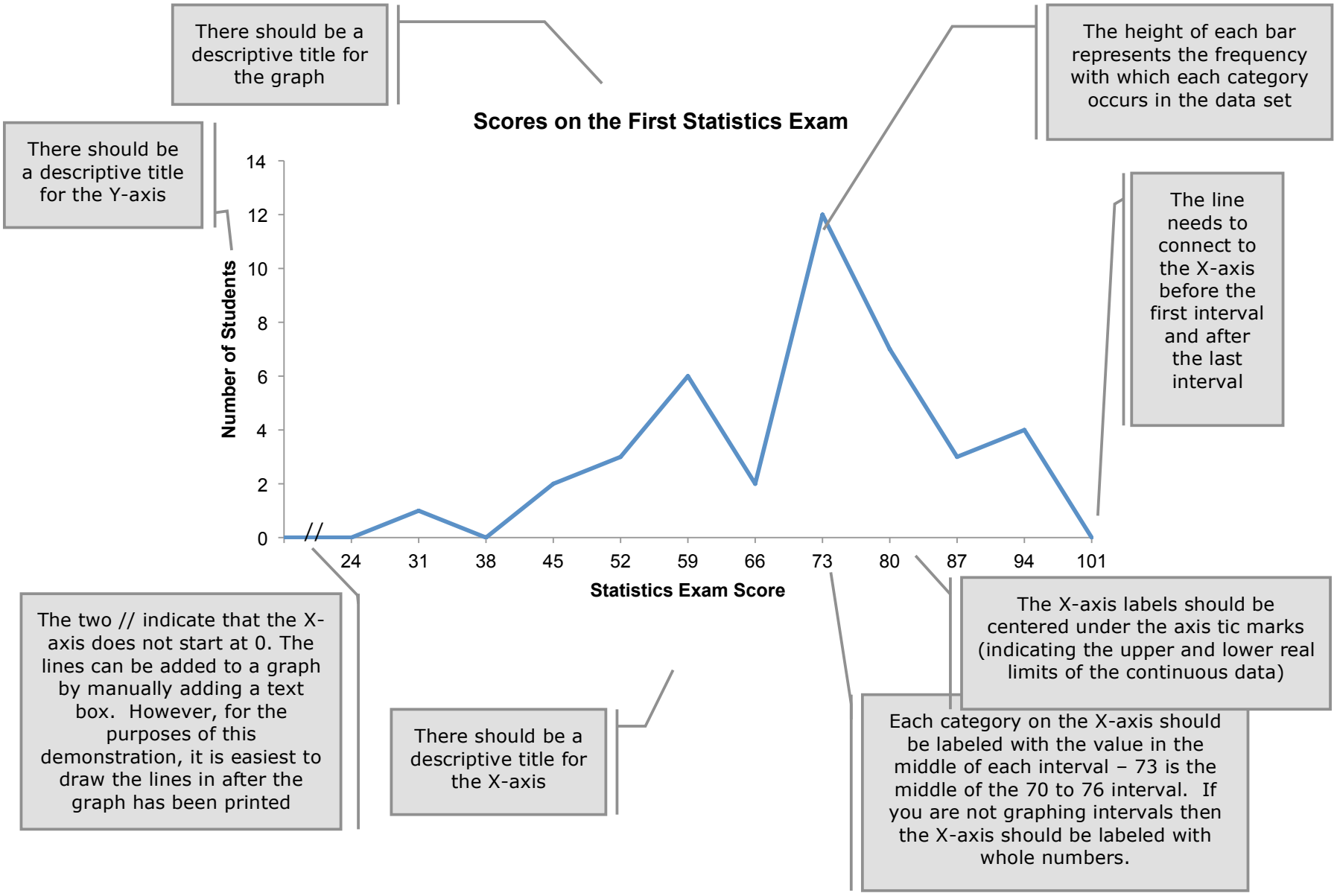

To turn the bar graph into a histogram and to add a title and axes label, you need to change the chart layout
Click the bottom most arrow in the chart layout area
1
This is what your graph should initially look like
Note: It is currently NOT a histogram (it's a bar graph)
Your graph should now look like this
3
Select the icon that shows solid bars touching. In this case, that icon is the eight icon
2
UndergraduateMajor - Microsoft Excel
Chart Title
Frequency
Scores


Double click on "Chart Title" to add a descriptive title
Chart Title
Double click on "Axis Title" to add a descriptive Y axis title
Frequency
Scores
Double click on "Axis Title" to add a descriptive X axis title
To add appropriate X axis labels AND to put tick marks on the X axis, right click while the axis number (1, 2, 3, etc.) is highlighted
1
Next Page
To center the tick marks click on "Format Axis"
To add appropriate axis labels click on "Select Data"
2
Next Page
Delete
Reset to Match Style
Font...
Change Chart Type...
Select Data...
3-D Rotation...
Add Major Gridlines
Add Minor Gridlines
Format Axis...


This is telling you where the data are located – This is correct so you will not need to make any changes here
Format Axis
Axis Options
Number
Fill
Line Color
Line Style
Shadow
3-D Format
Alignment
Axis Options
Interval between tick marks: 1
Interval between labels:
Automatic
Specify interval unit: 1
Categories in reverse order
Label distance from axis: 100
Axis Type:
Automatically select based on data
Text axis
Date axis
Major tick mark type: Outside
Minor tick mark type: None
Axis labels: Next to
Vertical axis crosses:
Automatic
At category number: 1
At maximum category
Position Axis:
On tick marks
Between tick marks
Close
Select the "On tick marks" button
This centers the tick marks under the axis labels
1
Select Data Source
Chart data range: =Exam!$E$2:$E$14
Switch Row/Column
Legend Entries (Series)
Add
Edit
Remove
Series1
Horizontal (Category) Axis Labels
Edit
1
2
3
4
5
2
To change the labels, click "Edit"
Hidden and Empty Cells
OK
Cancel
This is box (which automatically pops up when you click edit) allows you to tell excel where the labels are located – It is blank because no labels have been identified
D
E
G
H
I
J
Value
Bin
0
1
10
1
20
1
30
2
40
3
50
4
60
7
70
10
80
7
90
3
100
2
0
Axis Labels
Axis label range:
Select Range
OK
Cancel
Axis Title
12
10
8
6
4

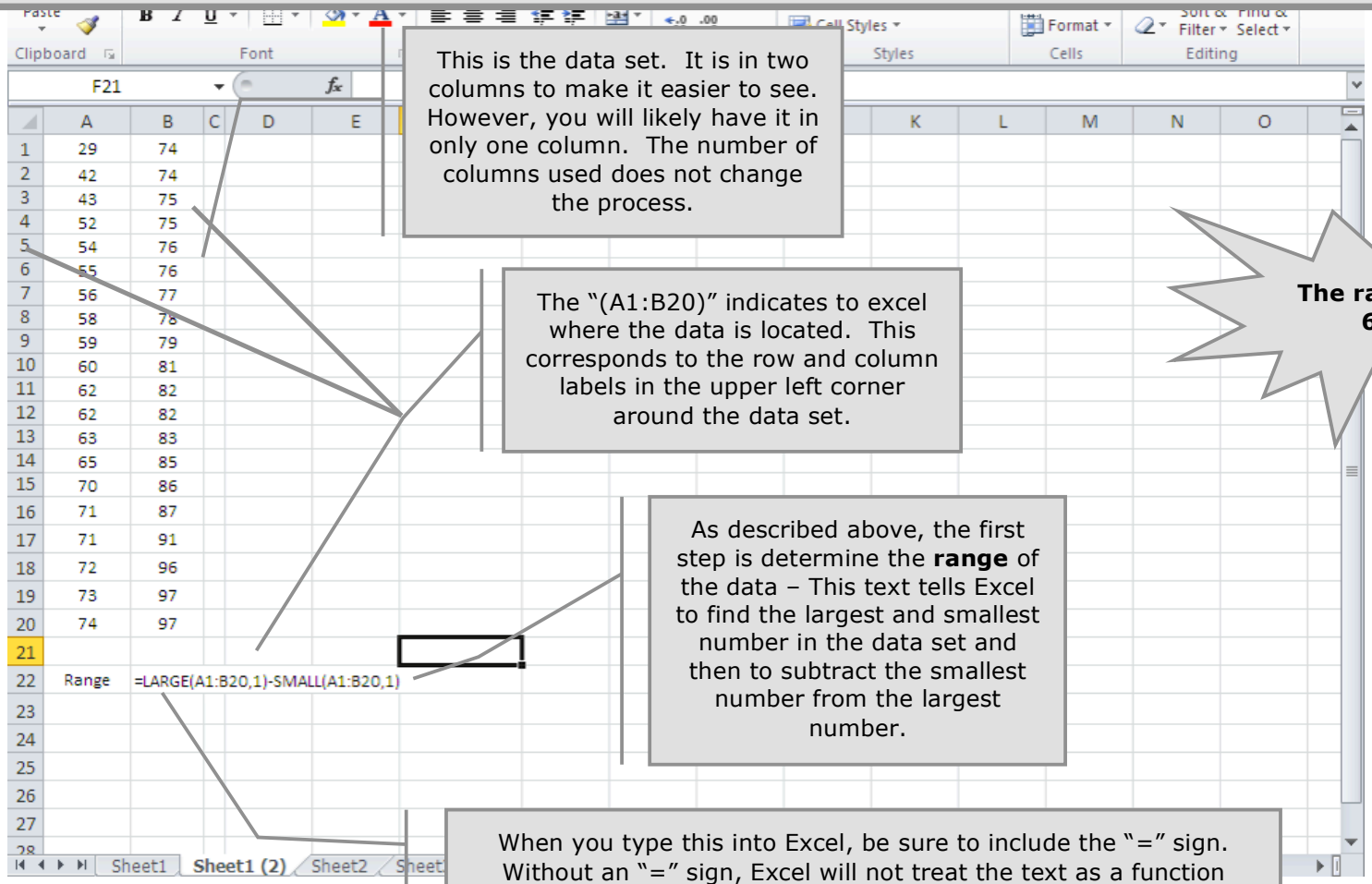

Axis Labels
This is blank because no labels have been identified
To identify the labels, highlight the labels in the dataset
For this example, the labels are in column D
Make sure to include the blank cells you inserted in the frequency distribution, they are needed for formatting reasons
After you have highlighted the labels in the dataset, click "OK"
Axis label range:
=Exam!$D$2:$D$14
= , 0, 10, 20, 3...
OK
Cancel
Value
Bin
Scores on the First Statistics Exam
Frequency
Scores
Axis Title

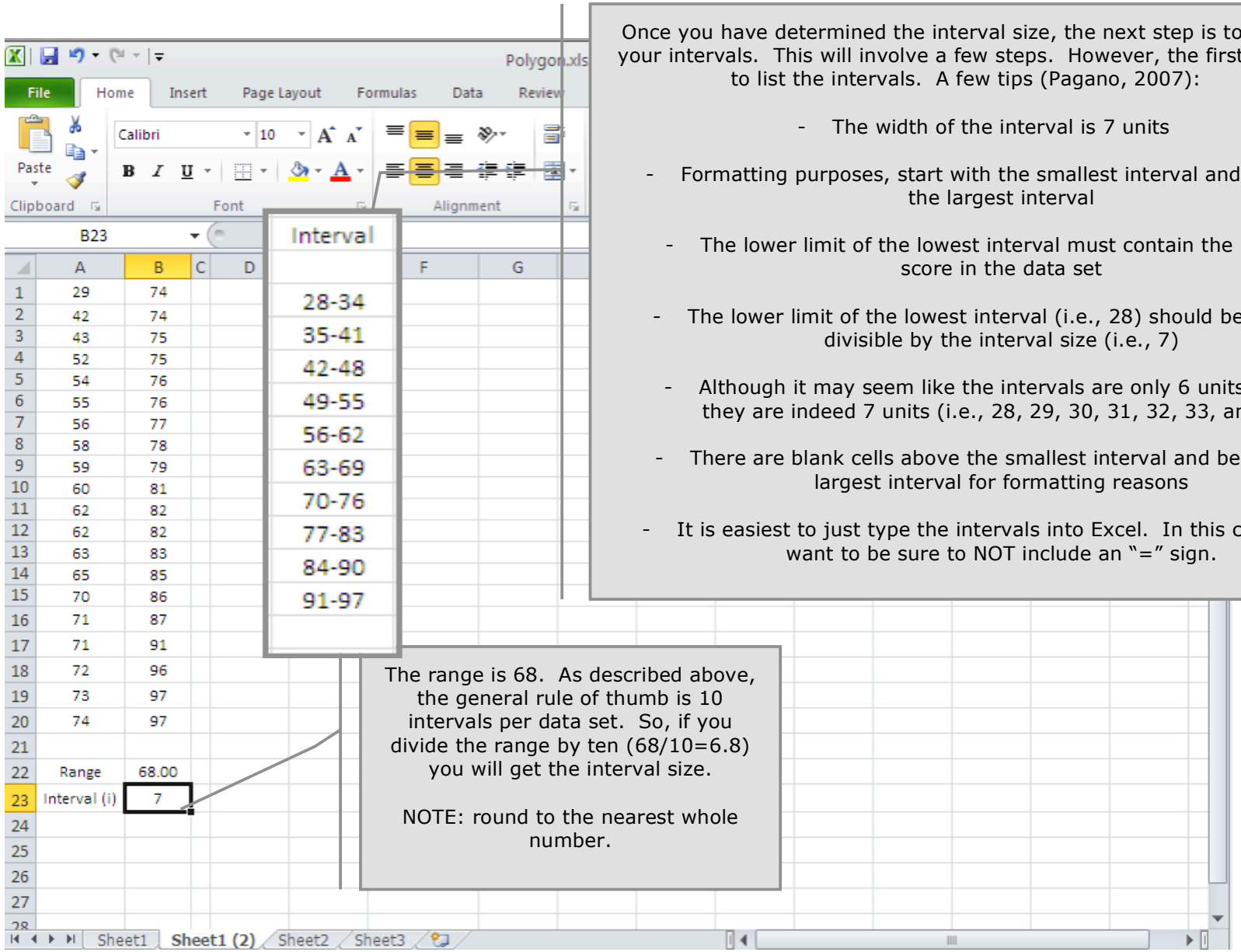
How to Create a Frequency Polygon



Before creating the graph, you will need to **create intervals**. Intervals group the data into manageable categories. A general rule of thumb is to have approximately 10 intervals per data set. Therefore, the easiest way to determine the appropriate interval size for a data set is to take the range (i.e., highest score – lowest score) of the data set and divide it by 10. (NOTE: It is also possible to create a polygon using ungrouped data. If you are using ungrouped data you can skip following grouping steps.)

After determining the interval size, you will need to write a "countif" function for each interval. The "countif" function tells Excel to count all of the specified values in a specified range. You will need to specify each value in the interval that is to be counted. Since there are 10 intervals you will write 10 "countif" functions.



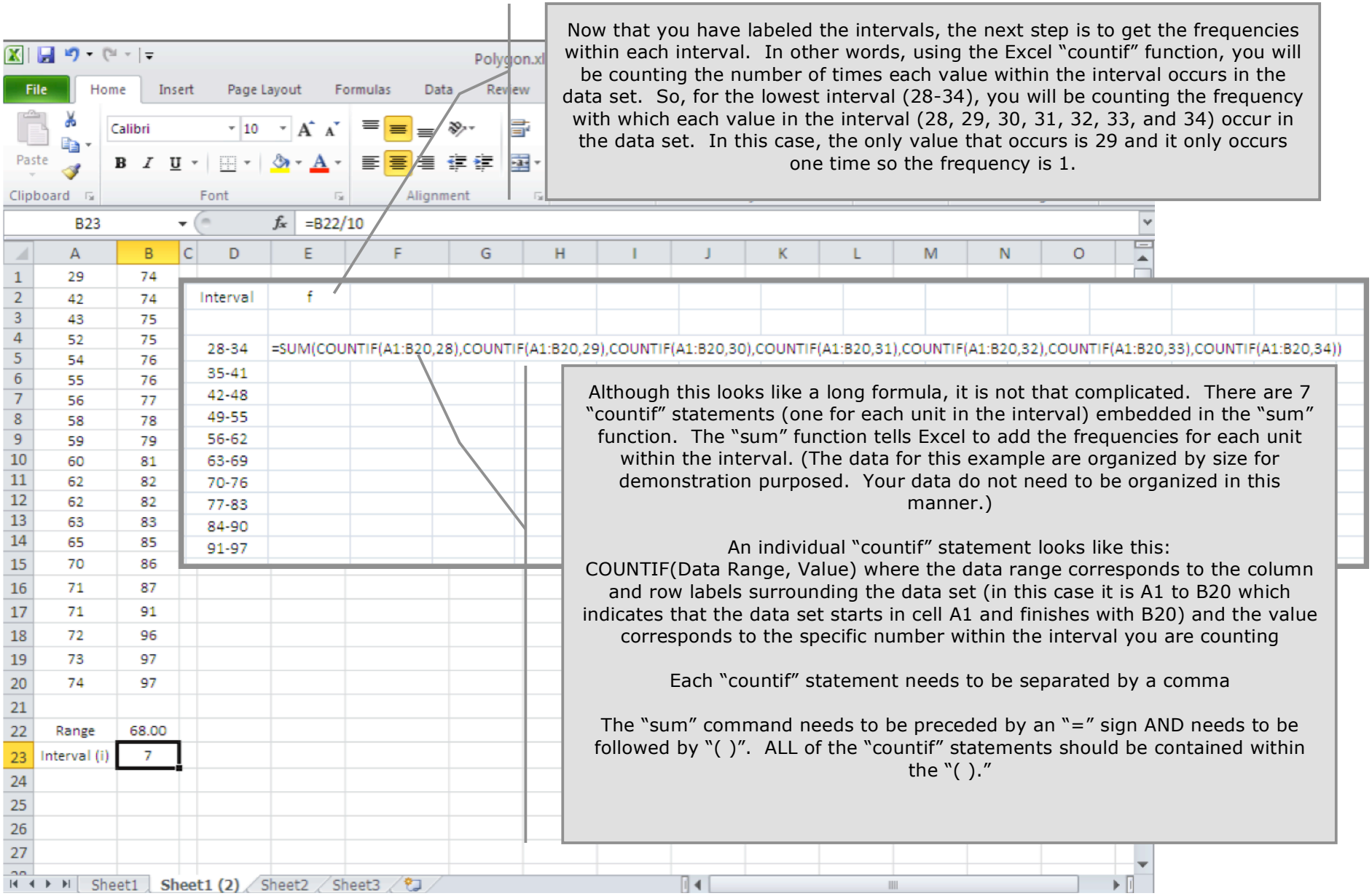


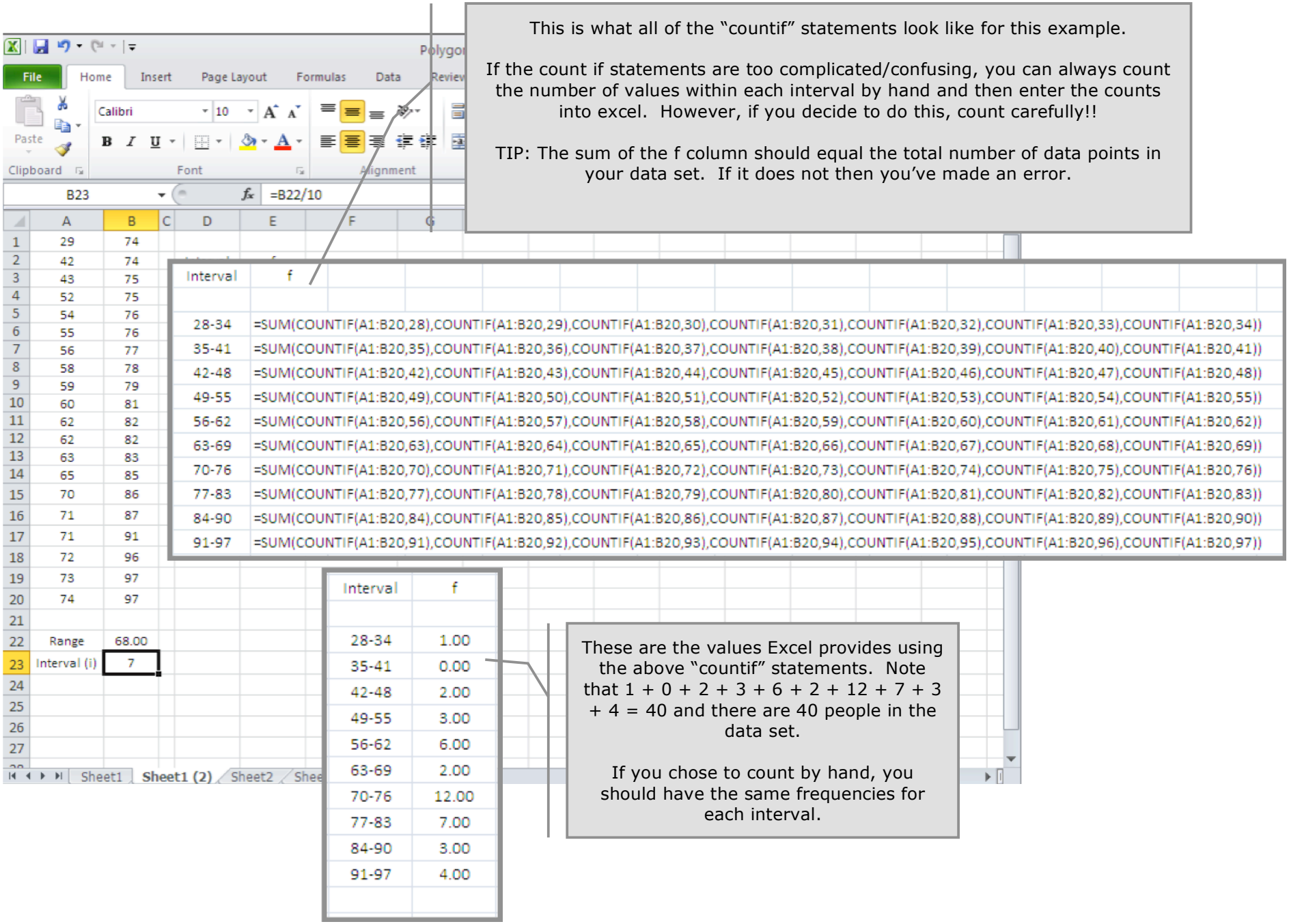
Once you have determined the interval size, the next step is to create your intervals. This will involve a few steps. However, the first step is to list the intervals. A few tips (Pagano, 2007):

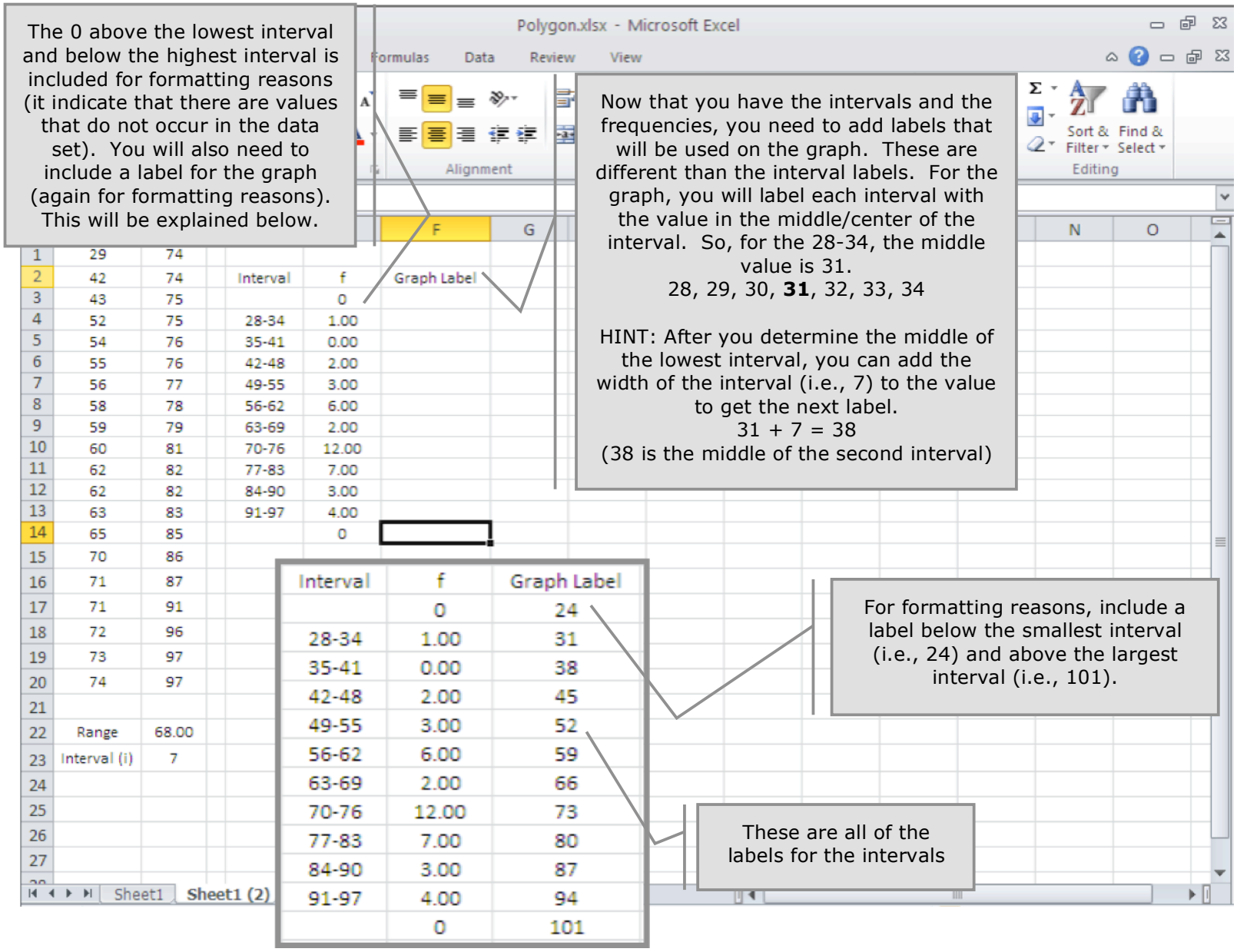
- The width of the interval is 7 units
- Formatting purposes, start with the smallest interval and work to the largest interval
- The lower limit of the lowest interval must contain the lowest score in the data set
- The lower limit of the lowest interval (i.e., 28) should be evenly divisible by the interval size (i.e., 7)
- Although it may seem like the intervals are only 6 units wide, they are indeed 7 units (i.e., 28, 29, 30, 31, 32, 33, and 34)
- There are blank cells above the smallest interval and below the largest interval for formatting reasons
- It is easiest to just type the intervals into Excel. In this case, you want to be sure to NOT include an "=" sign.

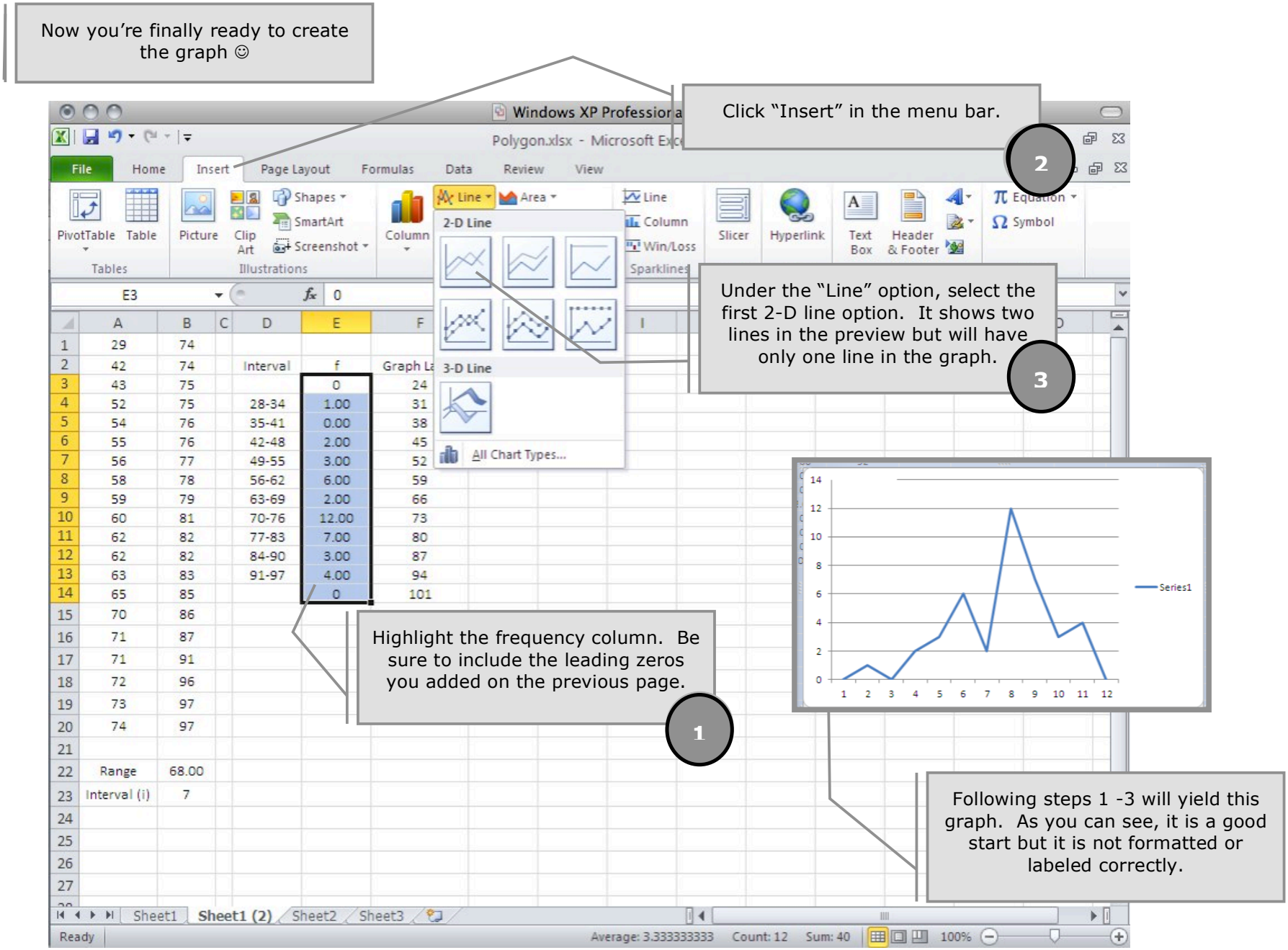
The range is 68. As described above, the general rule of thumb is 10 intervals per data set. So, if you divide the range by ten (68/10=6.8) you will get the interval size.

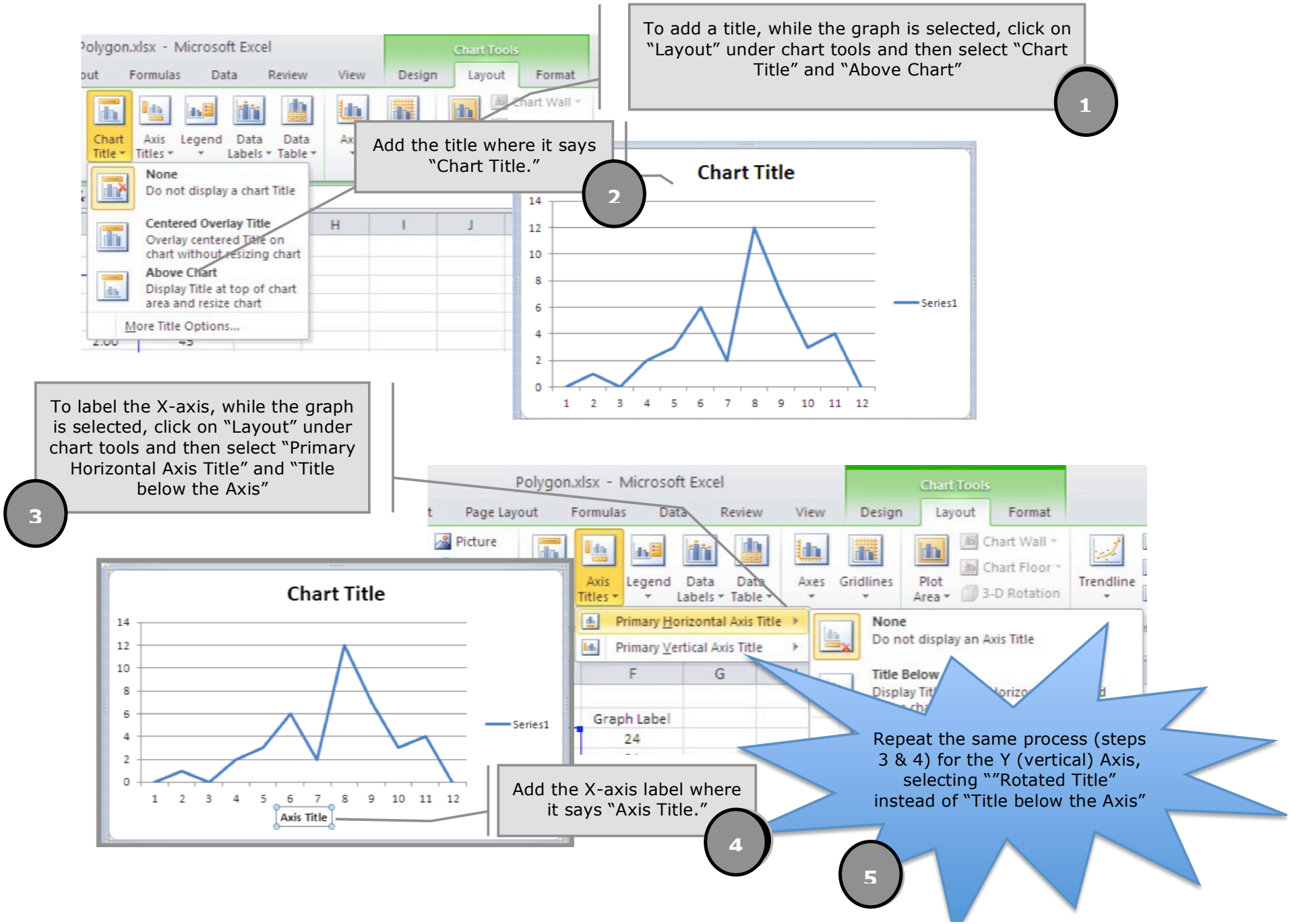
NOTE: round to the nearest whole number.

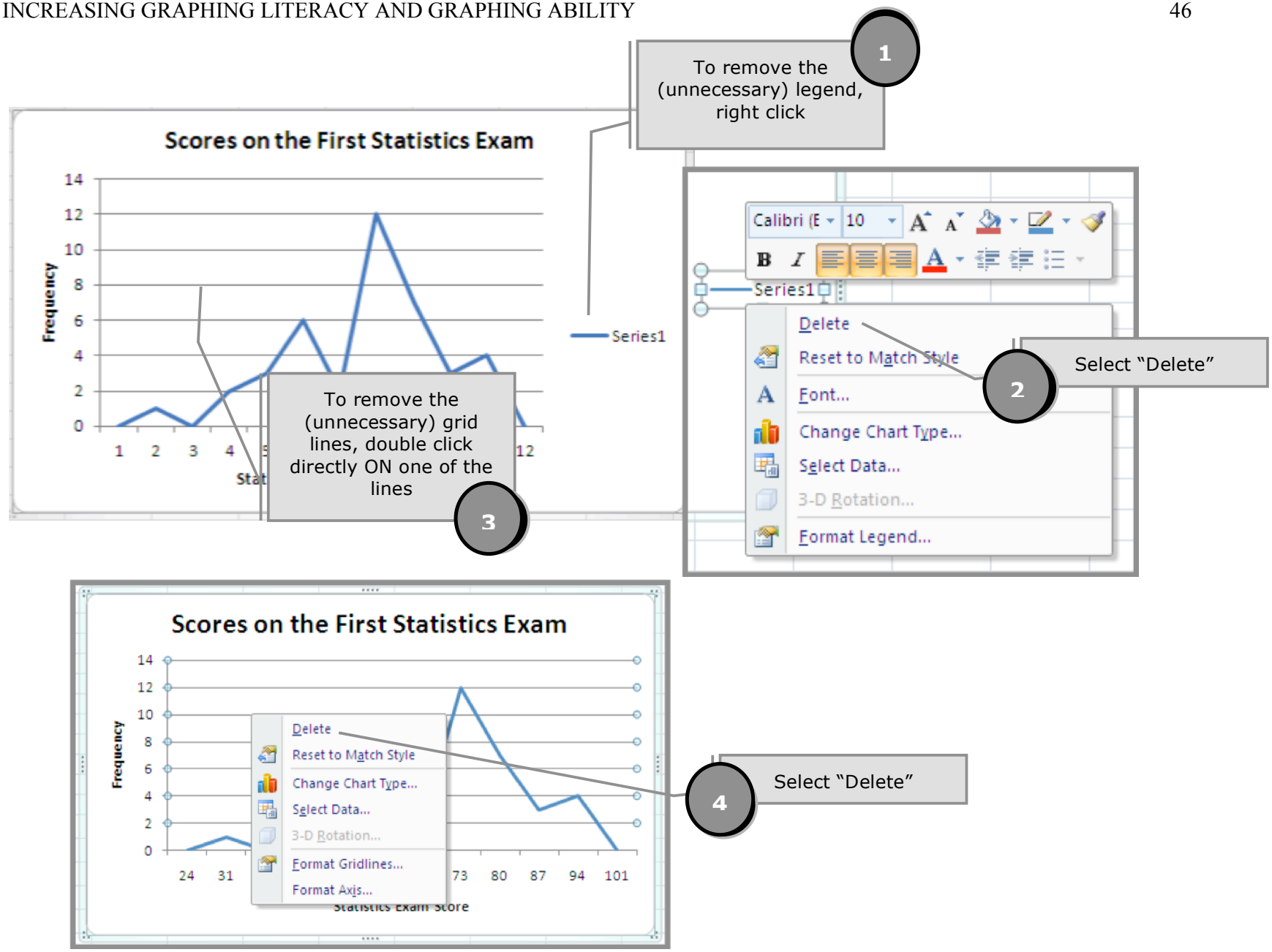

Now that you have labeled the intervals, the next step is to get the frequencies within each interval. In other words, using the Excel "countif" function, you will be counting the number of times each value within the interval occurs in the data set. So, for the lowest interval (28-34), you will be counting the frequency with which each value in the interval (28, 29, 30, 31, 32, 33, and 34) occur in the data set. In this case, the only value that occurs is 29 and it only occurs one time so the frequency is 1.
Polygon.xl
File
Home
Insert
Page Layout
Formulas
Data
Review
Calibri
10
Paste
Clipboard
Font
Alignment
B23
=B22/10
Interval
f
28-34
=SUM(COUNTIF(A1:B20,28),COUNTIF(A1:B20,29),COUNTIF(A1:B20,30),COUNTIF(A1:B20,31),COUNTIF(A1:B20,32),COUNTIF(A1:B20,33),COUNTIF(A1:B20,34))
35-41
42-48
49-55
56-62
63-69
70-76
77-83
84-90
91-97
Range
68.00
Interval (i)
7
Sheet1
Sheet1 (2)
Sheet2
Sheet3
Although this looks like a long formula, it is not that complicated. There are 7 "countif" statements (one for each unit in the interval) embedded in the "sum" function. The "sum" function tells Excel to add the frequencies for each unit within the interval. (The data for this example are organized by size for demonstration purposed. Your data do not need to be organized in this manner.)
An individual "countif" statement looks like this:
COUNTIF(Data Range, Value) where the data range corresponds to the column and row labels surrounding the data set (in this case it is A1 to B20 which indicates that the data set starts in cell A1 and finishes with B20) and the value corresponds to the specific number within the interval you are counting
Each "countif" statement needs to be separated by a comma
The "sum" command needs to be preceded by an "=" sign AND needs to be followed by "( )". ALL of the "countif" statements should be contained within the "( )."

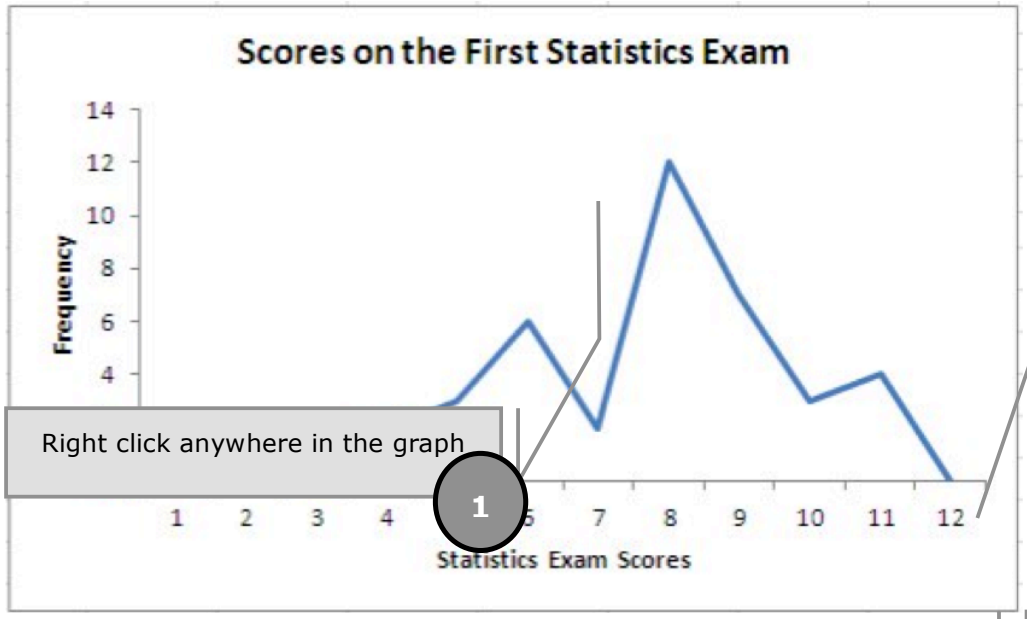

This is what all of the "countif" statements look like for this example.
If the count if statements are too complicated/confusing, you can always count the number of values within each interval by hand and then enter the counts into excel. However, if you decide to do this, count carefully!!
TIP: The sum of the f column should equal the total number of data points in your data set. If it does not then you've made an error.
File
Home
Insert
Page Layout
Formulas
Data
Clipboard
Font
Alignment
B23
=B22/10
Range 68.00
Interval (i) 7
Sheet1
Sheet1 (2)
Sheet2
Interval f
28-34 =SUM(COUNTIF(A1:B20,28),COUNTIF(A1:B20,29),COUNTIF(A1:B20,30),COUNTIF(A1:B20,31),COUNTIF(A1:B20,32),COUNTIF(A1:B20,33),COUNTIF(A1:B20,34))
35-41 =SUM(COUNTIF(A1:B20,35),COUNTIF(A1:B20,36),COUNTIF(A1:B20,37),COUNTIF(A1:B20,38),COUNTIF(A1:B20,39),COUNTIF(A1:B20,40),COUNTIF(A1:B20,41))
42-48 =SUM(COUNTIF(A1:B20,42),COUNTIF(A1:B20,43),COUNTIF(A1:B20,44),COUNTIF(A1:B20,45),COUNTIF(A1:B20,46),COUNTIF(A1:B20,47),COUNTIF(A1:B20,48))
49-55 =SUM(COUNTIF(A1:B20,49),COUNTIF(A1:B20,50),COUNTIF(A1:B20,51),COUNTIF(A1:B20,52),COUNTIF(A1:B20,53),COUNTIF(A1:B20,54),COUNTIF(A1:B20,55))
56-62 =SUM(COUNTIF(A1:B20,56),COUNTIF(A1:B20,57),COUNTIF(A1:B20,58),COUNTIF(A1:B20,59),COUNTIF(A1:B20,60),COUNTIF(A1:B20,61),COUNTIF(A1:B20,62))
63-69 =SUM(COUNTIF(A1:B20,63),COUNTIF(A1:B20,64),COUNTIF(A1:B20,65),COUNTIF(A1:B20,66),COUNTIF(A1:B20,67),COUNTIF(A1:B20,68),COUNTIF(A1:B20,69))
70-76 =SUM(COUNTIF(A1:B20,70),COUNTIF(A1:B20,71),COUNTIF(A1:B20,72),COUNTIF(A1:B20,73),COUNTIF(A1:B20,74),COUNTIF(A1:B20,75),COUNTIF(A1:B20,76))
77-83 =SUM(COUNTIF(A1:B20,77),COUNTIF(A1:B20,78),COUNTIF(A1:B20,79),COUNTIF(A1:B20,80),COUNTIF(A1:B20,81),COUNTIF(A1:B20,82),COUNTIF(A1:B20,83))
84-90 =SUM(COUNTIF(A1:B20,84),COUNTIF(A1:B20,85),COUNTIF(A1:B20,86),COUNTIF(A1:B20,87),COUNTIF(A1:B20,88),COUNTIF(A1:B20,89),COUNTIF(A1:B20,90))
91-97 =SUM(COUNTIF(A1:B20,91),COUNTIF(A1:B20,92),COUNTIF(A1:B20,93),COUNTIF(A1:B20,94),COUNTIF(A1:B20,95),COUNTIF(A1:B20,96),COUNTIF(A1:B20,97))
Interval f
28-34 1.00
35-41 0.00
42-48 2.00
49-55 3.00
56-62 6.00
63-69 2.00
70-76 12.00
77-83 7.00
84-90 3.00
91-97 4.00
These are the values Excel provides using the above "countif" statements. Note that 1 + 0 + 2 + 3 + 6 + 2 + 12 + 7 + 3 + 4 = 40 and there are 40 people in the data set.
If you chose to count by hand, you should have the same frequencies for each interval.


The 0 above the lowest interval and below the highest interval is included for formatting reasons (it indicate that there are values that do not occur in the data set). You will also need to include a label for the graph (again for formatting reasons). This will be explained below.
Polygon.xlsx - Microsoft Excel
Formulas Data Review View
Alignment
Editing
Sort & Filter
Find & Select
Now that you have the intervals and the frequencies, you need to add labels that will be used on the graph. These are different than the interval labels. For the graph, you will label each interval with the value in the middle/center of the interval. So, for the 28-34, the middle value is 31.
28, 29, 30, 31, 32, 33, 34
HINT: After you determine the middle of the lowest interval, you can add the width of the interval (i.e., 7) to the value to get the next label.
31 + 7 = 38
(38 is the middle of the second interval)
Interval
f
Graph Label
0
28-34 1.00
35-41 0.00
42-48 2.00
49-55 3.00
56-62 6.00
63-69 2.00
70-76 12.00
77-83 7.00
84-90 3.00
91-97 4.00
0
Range 68.00
Interval (i) 7
Sheet1
Sheet1 (2)
24
31
38
45
52
59
66
73
80
87
94
101
For formatting reasons, include a label below the smallest interval (i.e., 24) and above the largest interval (i.e., 101).
These are all of the labels for the intervals


Now you're finally ready to create the graph ☺
Click "Insert" in the menu bar.
2
Under the "Line" option, select the first 2-D line option. It shows two lines in the preview but will have only one line in the graph.
3
Highlight the frequency column. Be sure to include the leading zeros you added on the previous page.
1
Following steps 1 -3 will yield this graph. As you can see, it is a good start but it is not formatted or labeled correctly.
Windows XP Professional
Polygon.xlsx - Microsoft Excel
File
Home
Insert
Page Layout
Formulas
Data
Review
View
PivotTable
Table
Picture
Clip Art
Shapes
SmartArt
Screenshot
Column
Line
Area
2-D Line
3-D Line
All Chart Types...
Line
Column
Win/Loss
Slicer
Hyperlink
Text Box
Header & Footer
Equation
Symbol
Tables
Illustrations
Sparklines
E3
Interval
f
Graph La
28-34
35-41
42-48
49-55
56-62
63-69
70-76
77-83
84-90
91-97
Range
68.00
Interval (i)
7
Series1
Sheet1
Sheet1 (2)
Sheet2
Sheet3
Ready
Average: 3.333333333
Count: 12
Sum: 40
100%


To add a title, while the graph is selected, click on "Layout" under chart tools and then select "Chart Title" and "Above Chart"
1
Add the title where it says "Chart Title."
2
Chart Title
Series1
To label the X-axis, while the graph is selected, click on "Layout" under chart tools and then select "Primary Horizontal Axis Title" and "Title below the Axis"
3
Add the X-axis label where it says "Axis Title."
4
Repeat the same process (steps 3 & 4) for the Y (vertical) Axis, selecting ""Rotated Title" instead of "Title below the Axis"
5


1
To remove the (unnecessary) legend, right click
Scores on the First Statistics Exam
Frequency
Series1
To remove the (unnecessary) grid lines, double click directly ON one of the lines
3
Calibri (E
10
Series1
Delete
Reset to Match Style
Font...
Change Chart Type...
Select Data...
3-D Rotation...
Format Legend...
2
Select "Delete"
Scores on the First Statistics Exam
Frequency
Delete
Reset to Match Style
Change Chart Type...
Select Data...
3-D Rotation...
Format Gridlines...
Format Axis...
4
Select "Delete"



Right click anywhere in the graph

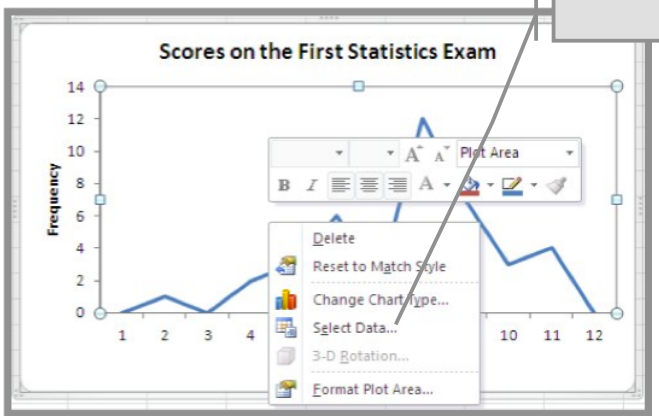
1

The final thing that needs to be done is to label the X-axis. You will use the label you created previously.

Interval	f	Graph Label
	0	24
28-34	1.00	31
35-41	0.00	38
42-48	2.00	45
49-55	3.00	52
56-62	6.00	59
63-69	2.00	66
70-76	12.00	73
77-83	7.00	80
84-90	3.00	87
91-97	4.00	94

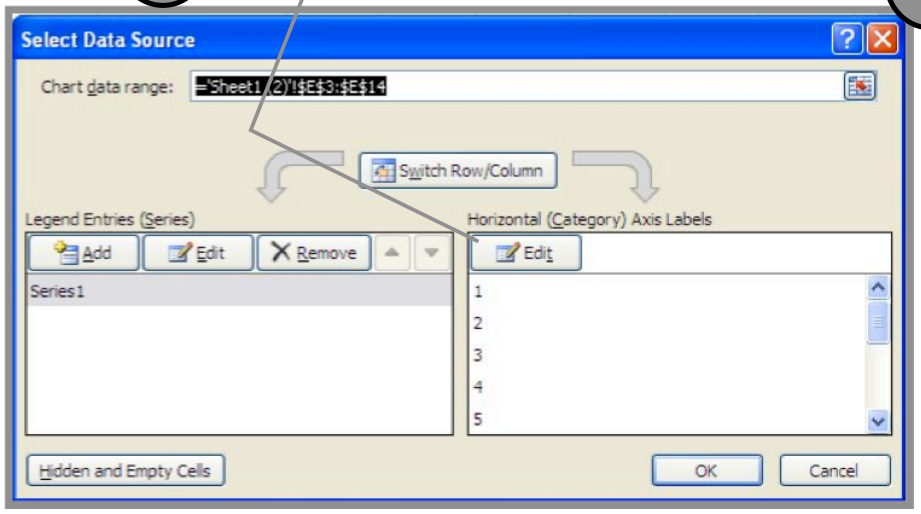
Select "Select Data"

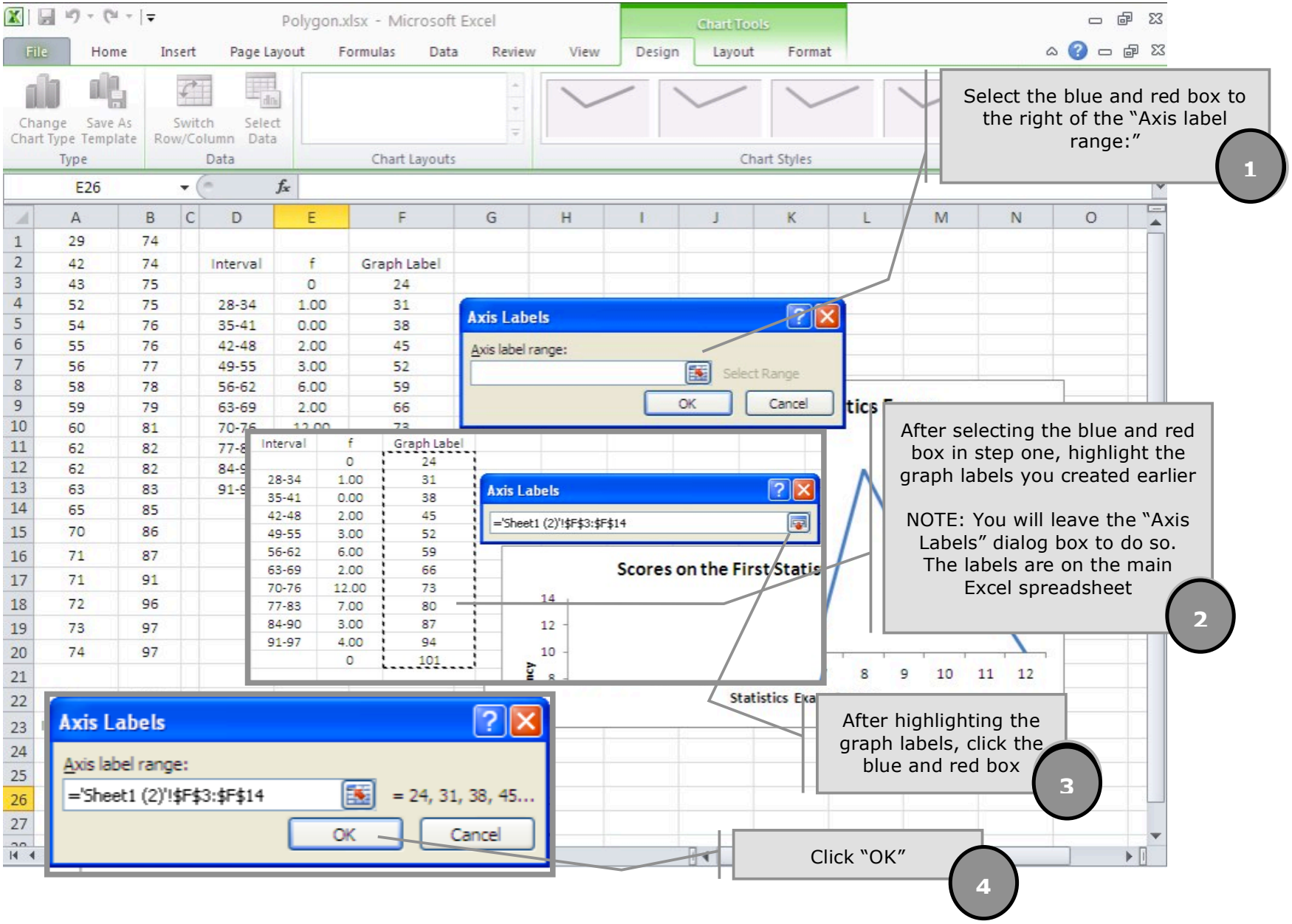
2

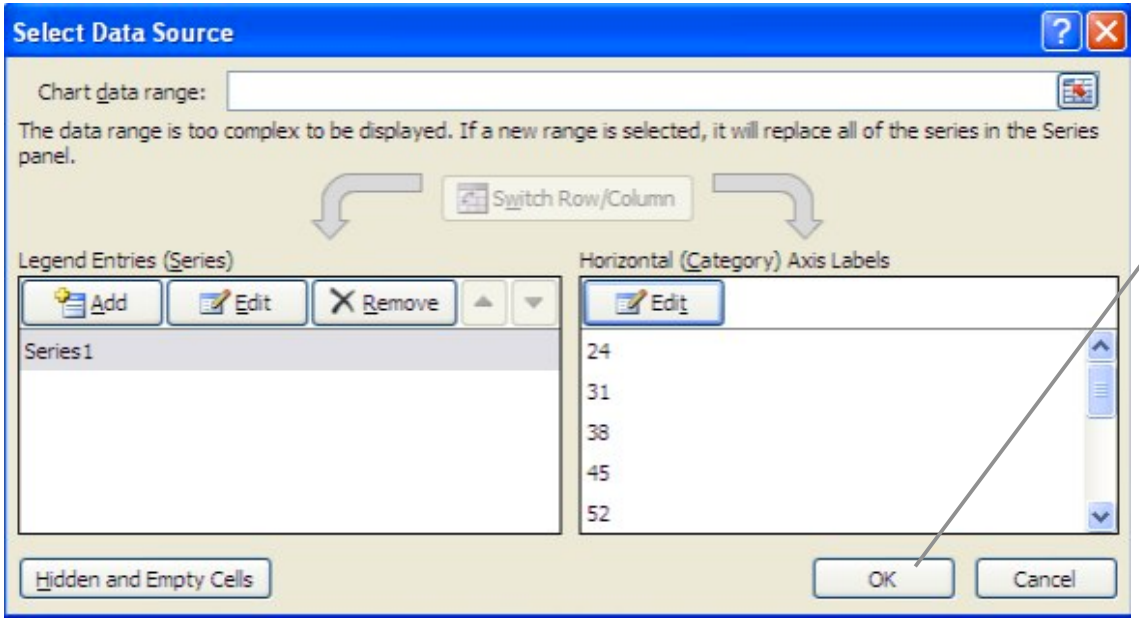


You will be changing the Axis label only. Click "Edit" under the Horizontal (Category) Axis Labels"

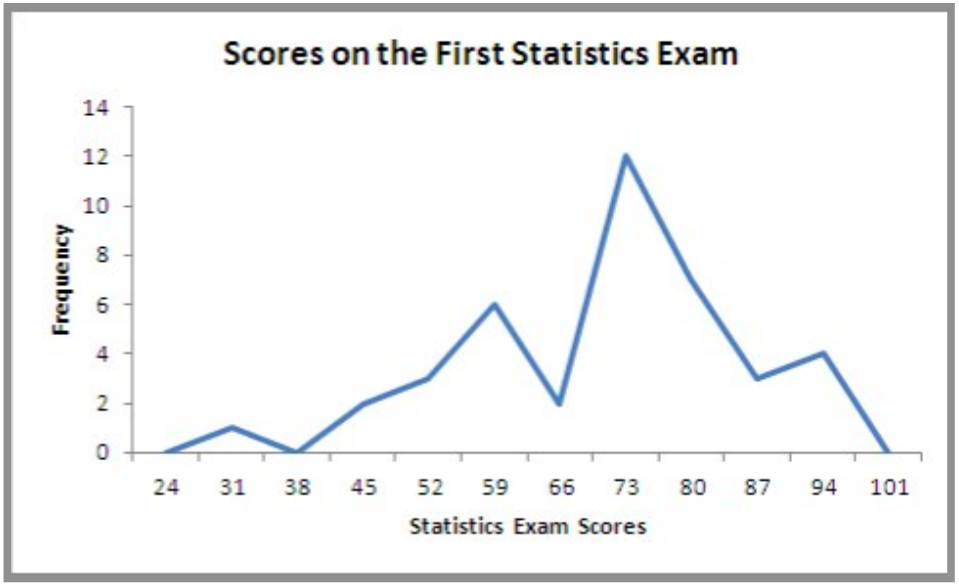
3



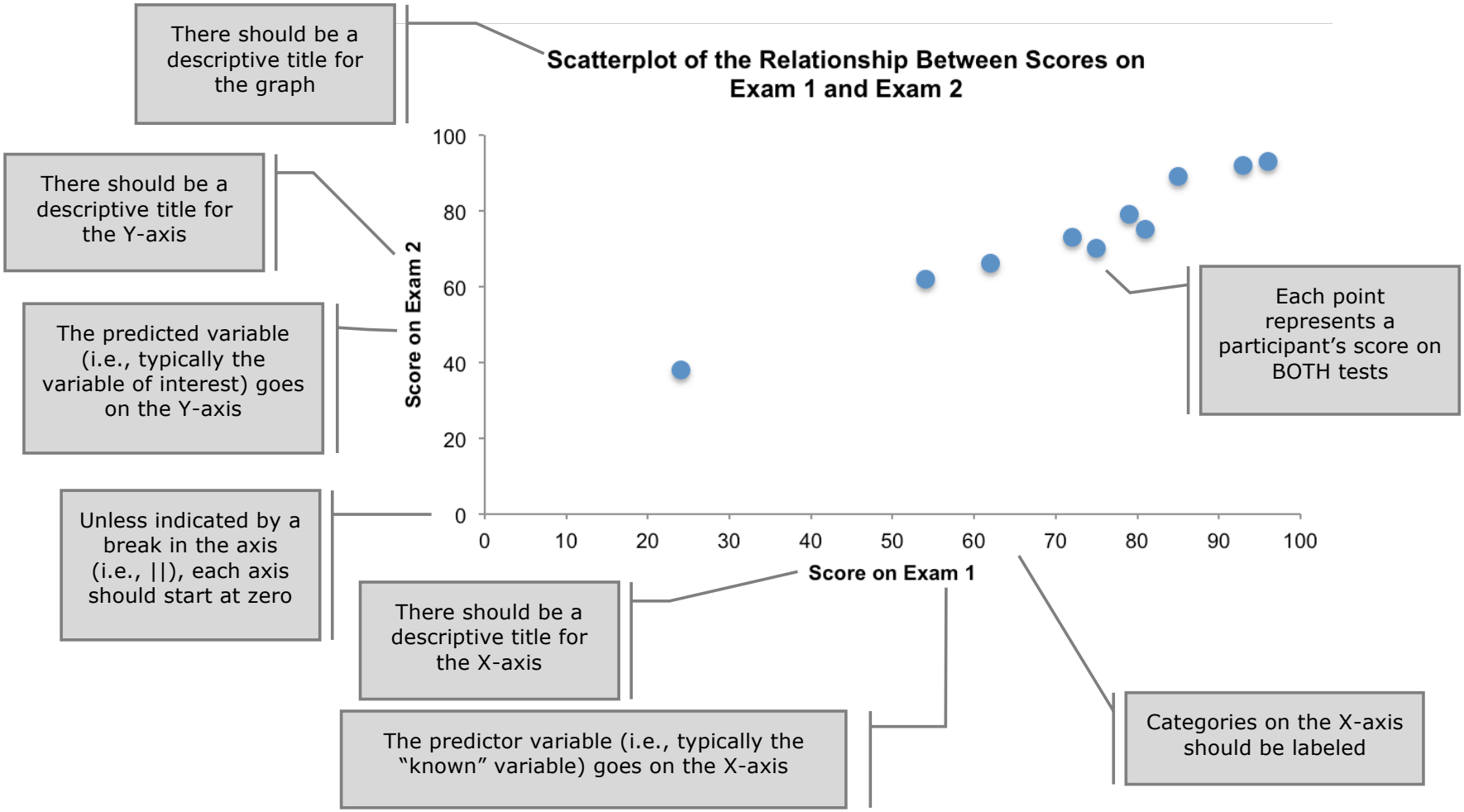

Polygon.xlsx - Microsoft Excel
Chart Tools
Select the blue and red box to the right of the "Axis label range:"
1
Axis Labels
Axis label range:
Select Range
OK
Cancel
After selecting the blue and red box in step one, highlight the graph labels you created earlier
NOTE: You will leave the "Axis Labels" dialog box to do so. The labels are on the main Excel spreadsheet
2
Interval f Graph Label
0 24
28-34 1.00 31
35-41 0.00 38
42-48 2.00 45
49-55 3.00 52
56-62 6.00 59
63-69 2.00 66
70-76 12.00 73
77-83 7.00 80
84-90 3.00 87
91-97 4.00 94
0 101
Axis Labels
='Sheet1 (2)'!$F$3:$F$14
Scores on the First Statis
Statistics Exa
Axis Labels
Axis label range:
='Sheet1 (2)'!$F$3:$F$14
= 24, 31, 38, 45...
OK
Cancel
After highlighting the graph labels, click the blue and red box
3
Click "OK"
4

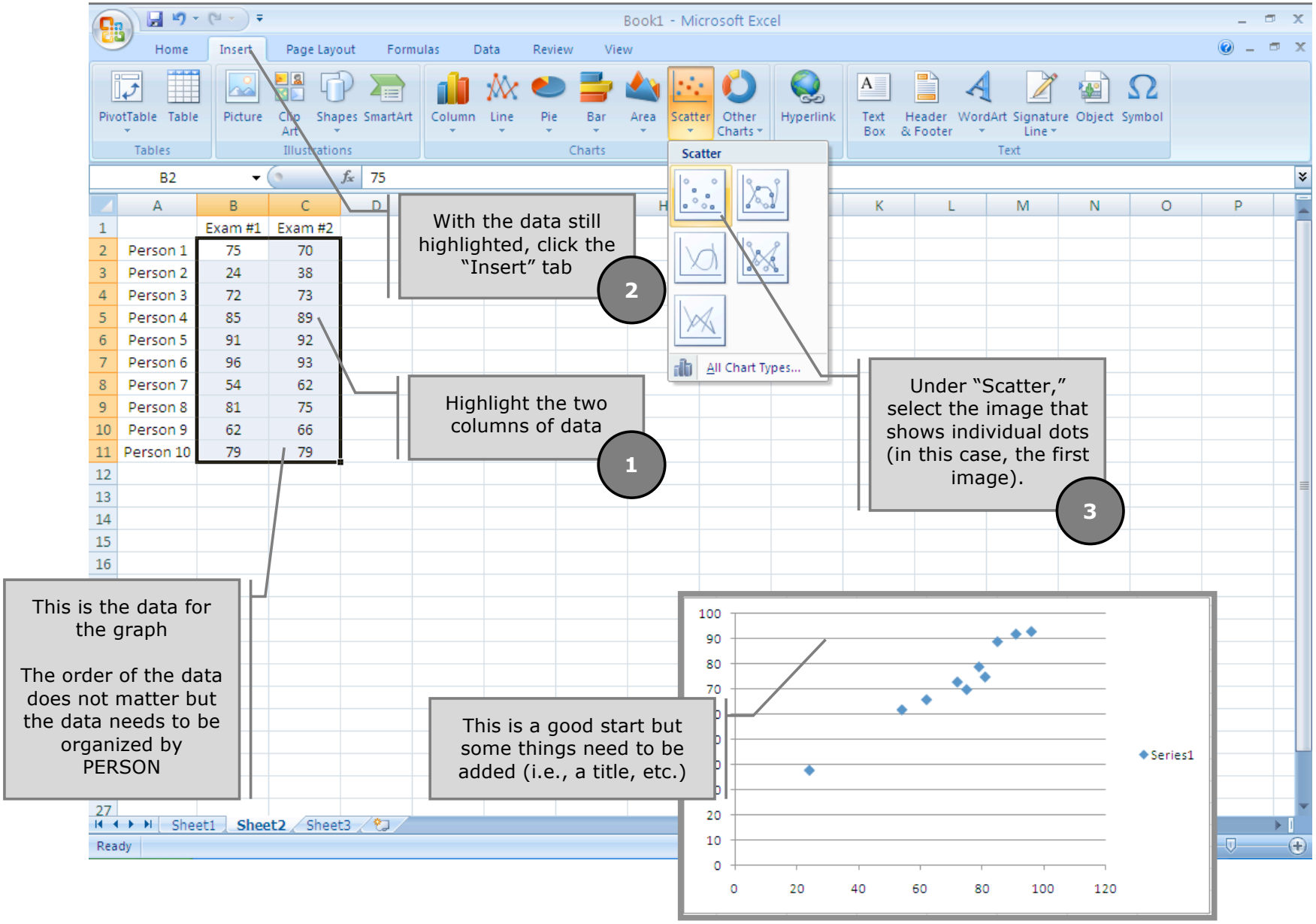

Select Data Source
Chart data range:
The data range is too complex to be displayed. If a new range is selected, it will replace all of the series in the Series panel.
Switch Row/Column
Legend Entries (Series)
Add
Edit
Remove
Series1
Horizontal (Category) Axis Labels
Edit
24
31
38
45
52
Hidden and Empty Cells
OK
Cancel

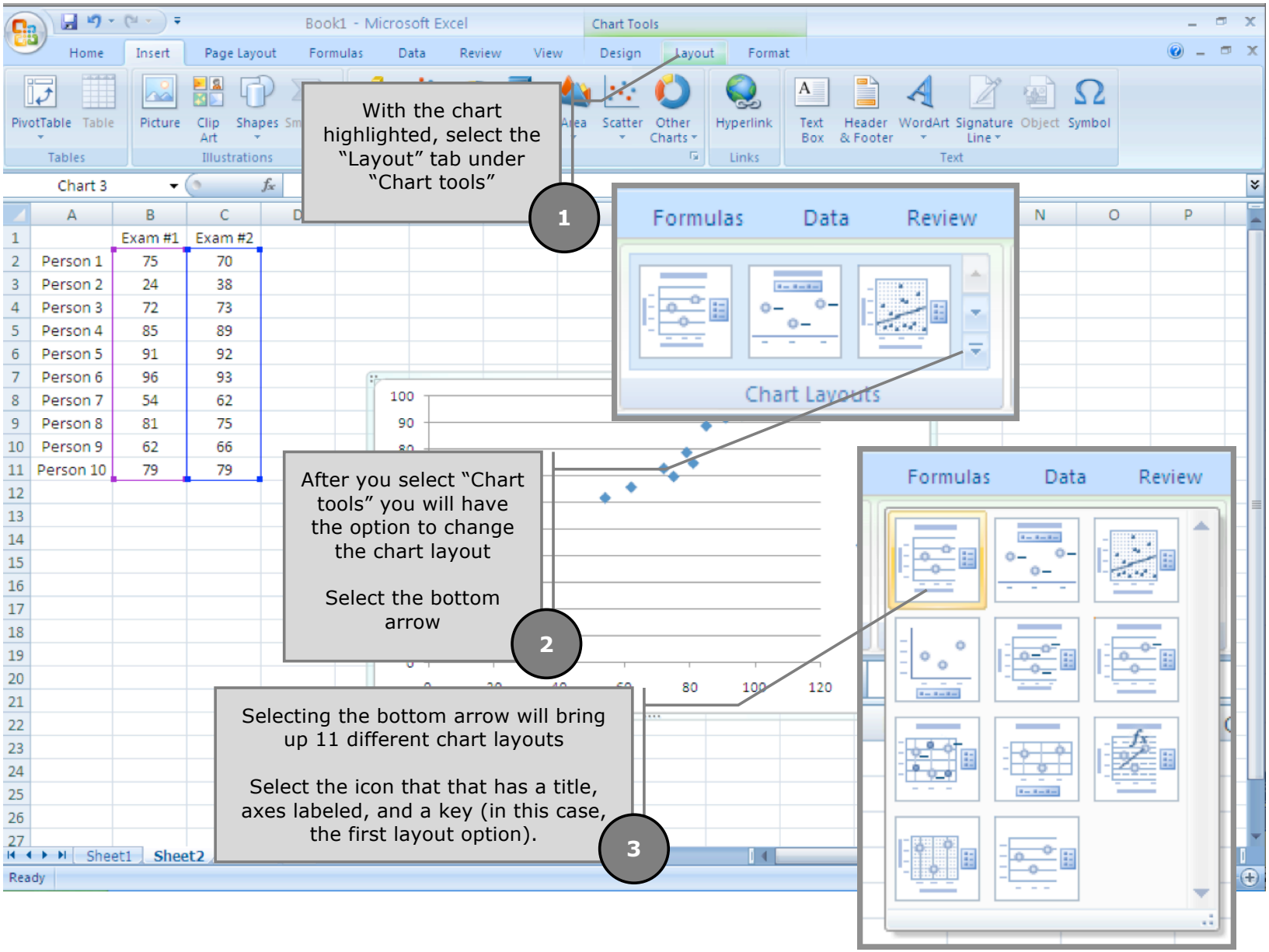
Click "OK"

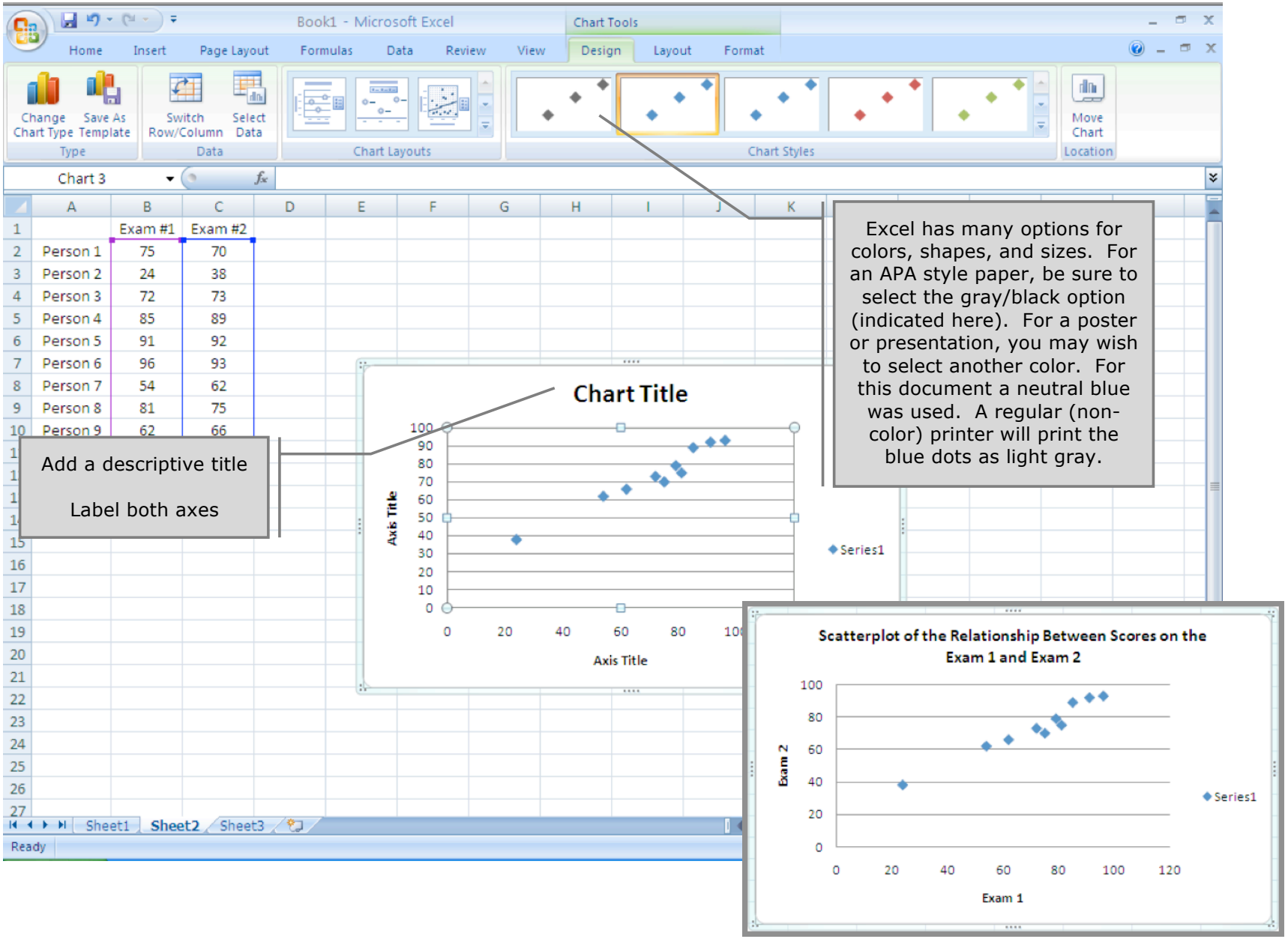

Scores on the First Statistics Exam
Frequency
0
2
4
6
8
10
12
14
24
31
38
45
52
59
66
73
80
87
94
101
Statistics Exam Scores

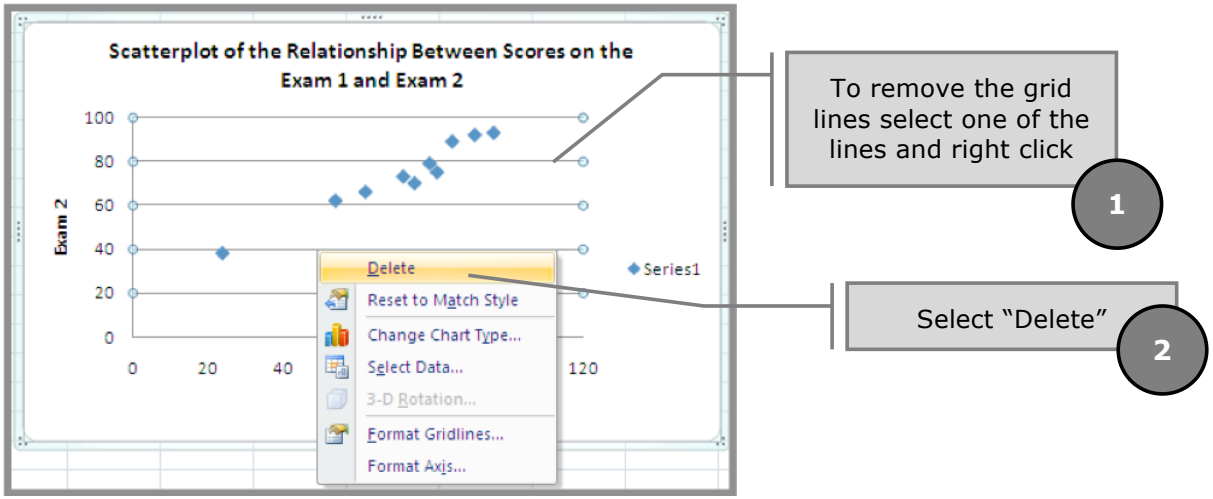
How to Create a Scatterplot

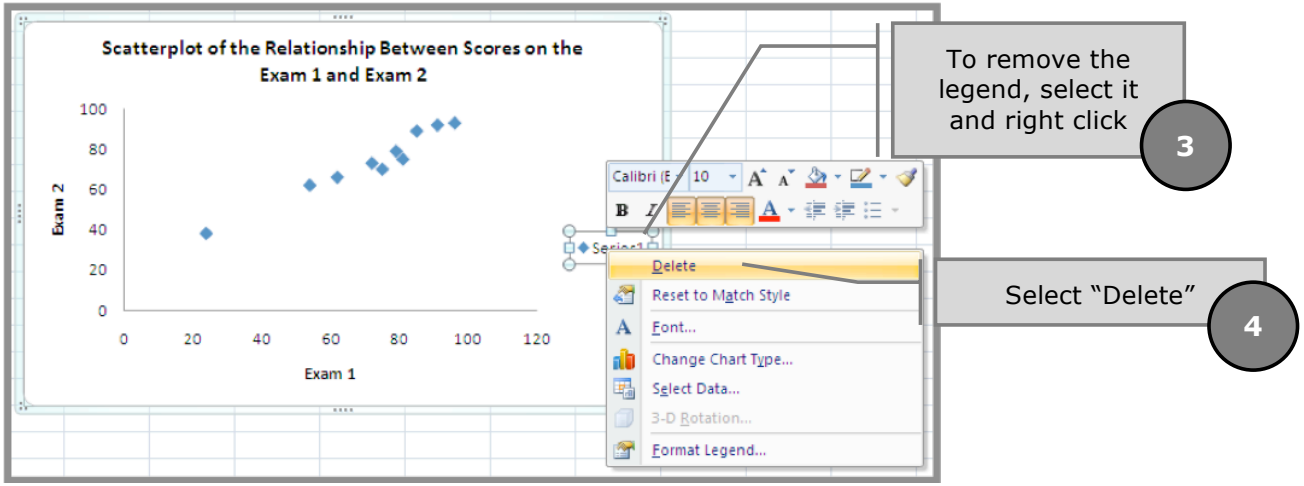


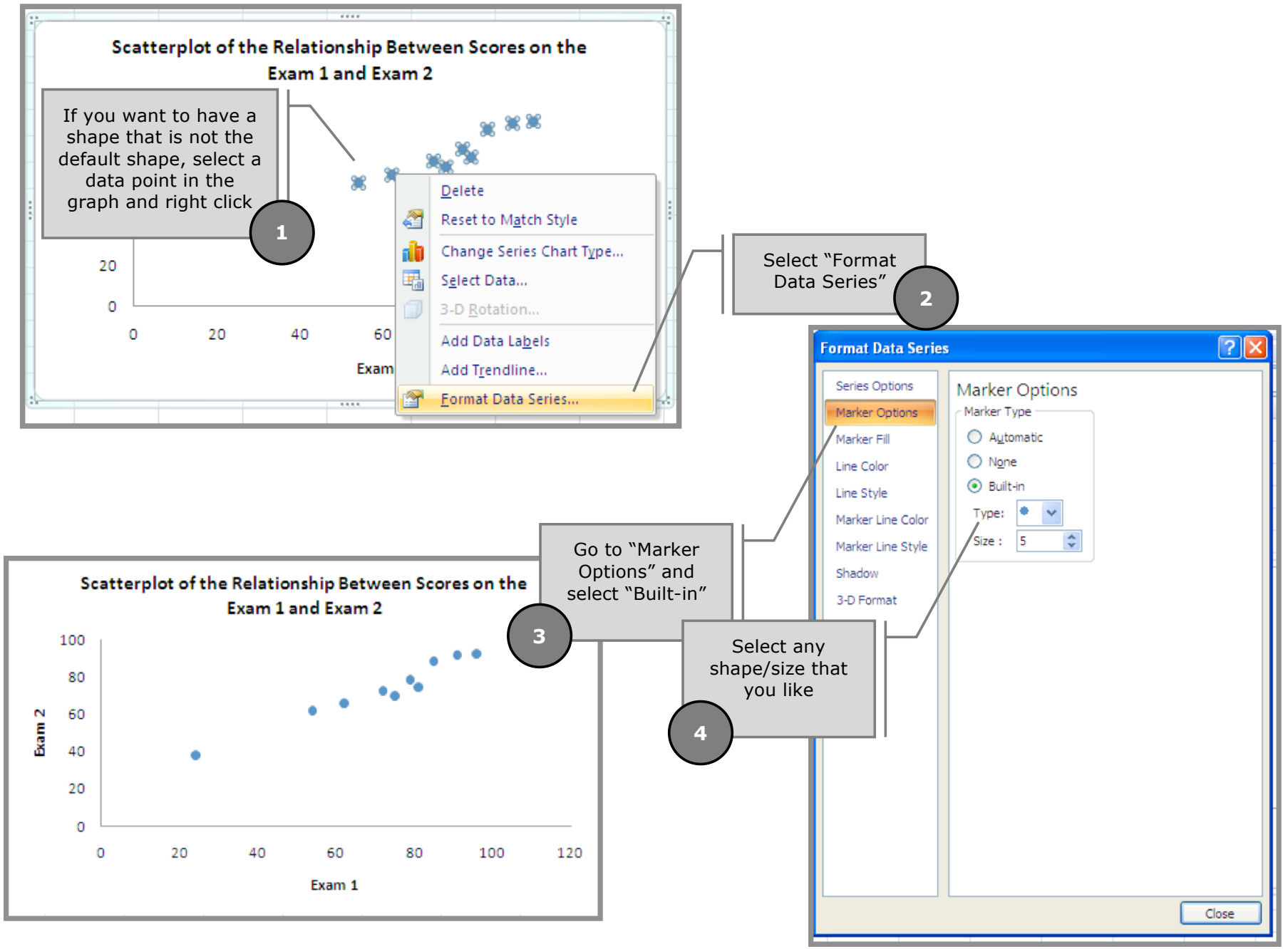

Book1 - Microsoft Excel
Home
Insert
Page Layout
Formulas
Data
Review
View
PivotTable
Table
Picture
Clip Art
Shapes
SmartArt
Column
Line
Pie
Bar
Area
Scatter
Other Charts
Hyperlink
Text Box
Header & Footer
WordArt
Signature Line
Object
Symbol
Tables
Illustrations
Charts
Text
Scatter
All Chart Types...
B2
75
Exam #1
Exam #2
Person 1 75 70
Person 2 24 38
Person 3 72 73
Person 4 85 89
Person 5 91 92
Person 6 96 93
Person 7 54 62
Person 8 81 75
Person 9 62 66
Person 10 79 79
With the data still highlighted, click the "Insert" tab
2
Highlight the two columns of data
1
Under "Scatter," select the image that shows individual dots (in this case, the first image).
3
This is the data for the graph
The order of the data does not matter but the data needs to be organized by PERSON
This is a good start but some things need to be added (i.e., a title, etc.)
Series1
Sheet1
Sheet2
Sheet3
Ready


Book1 - Microsoft Excel
Chart Tools
Home
Insert
Page Layout
Formulas
Data
Review
View
Design
Layout
Format
PivotTable
Table
Picture
Clip Art
Shapes
Area
Scatter
Other Charts
Hyperlink
Text Box
Header & Footer
WordArt
Signature Line
Object
Symbol
Tables
Illustrations
Links
Text
Chart 3
Exam #1
Exam #2
Person 1 75 70
Person 2 24 38
Person 3 72 73
Person 4 85 89
Person 5 91 92
Person 6 96 93
Person 7 54 62
Person 8 81 75
Person 9 62 66
Person 10 79 79
With the chart highlighted, select the "Layout" tab under "Chart tools"
1
Formulas
Data
Review
Chart Layouts
After you select "Chart tools" you will have the option to change the chart layout
Select the bottom arrow
2
Selecting the bottom arrow will bring up 11 different chart layouts
Select the icon that that has a title, axes labeled, and a key (in this case, the first layout option).
3
Sheet1
Sheet2
Ready

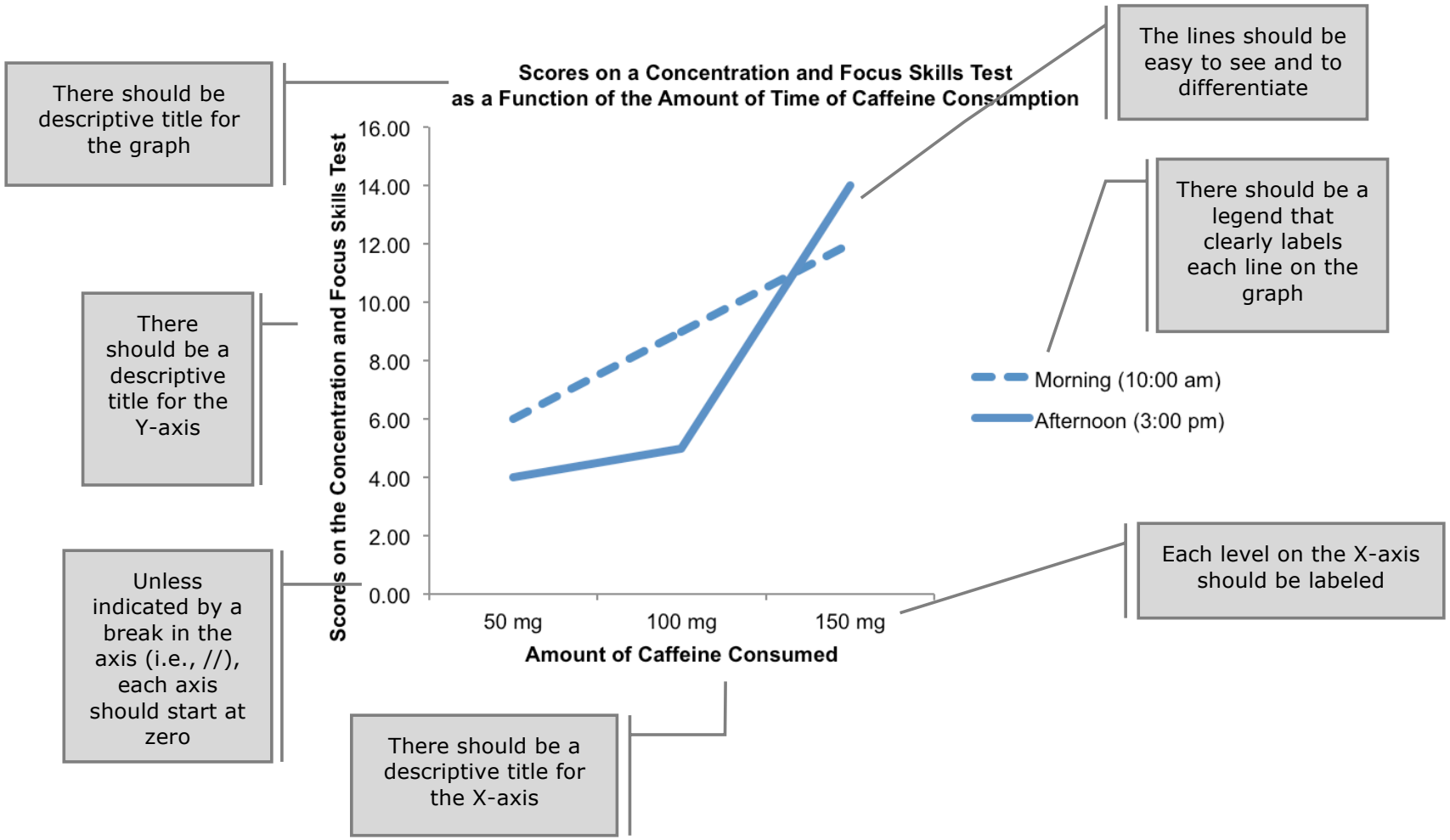

Book1 - Microsoft Excel
Chart Tools
Home
Insert
Page Layout
Formulas
Data
Review
View
Design
Layout
Format
Change Chart Type
Save As Template
Type
Switch Row/Column
Select Data
Data
Chart Layouts
Chart Styles
Move Chart
Location
Chart 3
Exam #1
Exam #2
Person 1 75 70
Person 2 24 38
Person 3 72 73
Person 4 85 89
Person 5 91 92
Person 6 96 93
Person 7 54 62
Person 8 81 75
Person 9 62 66
Add a descriptive title
Label both axes
Excel has many options for colors, shapes, and sizes. For an APA style paper, be sure to select the gray/black option (indicated here). For a poster or presentation, you may wish to select another color. For this document a neutral blue was used. A regular (non-color) printer will print the blue dots as light gray.
Chart Title
Axis Title
Axis Title
Series1
Sheet1
Sheet2
Sheet3
Ready
Scatterplot of the Relationship Between Scores on the Exam 1 and Exam 2
Exam 2
Exam 1
Series1

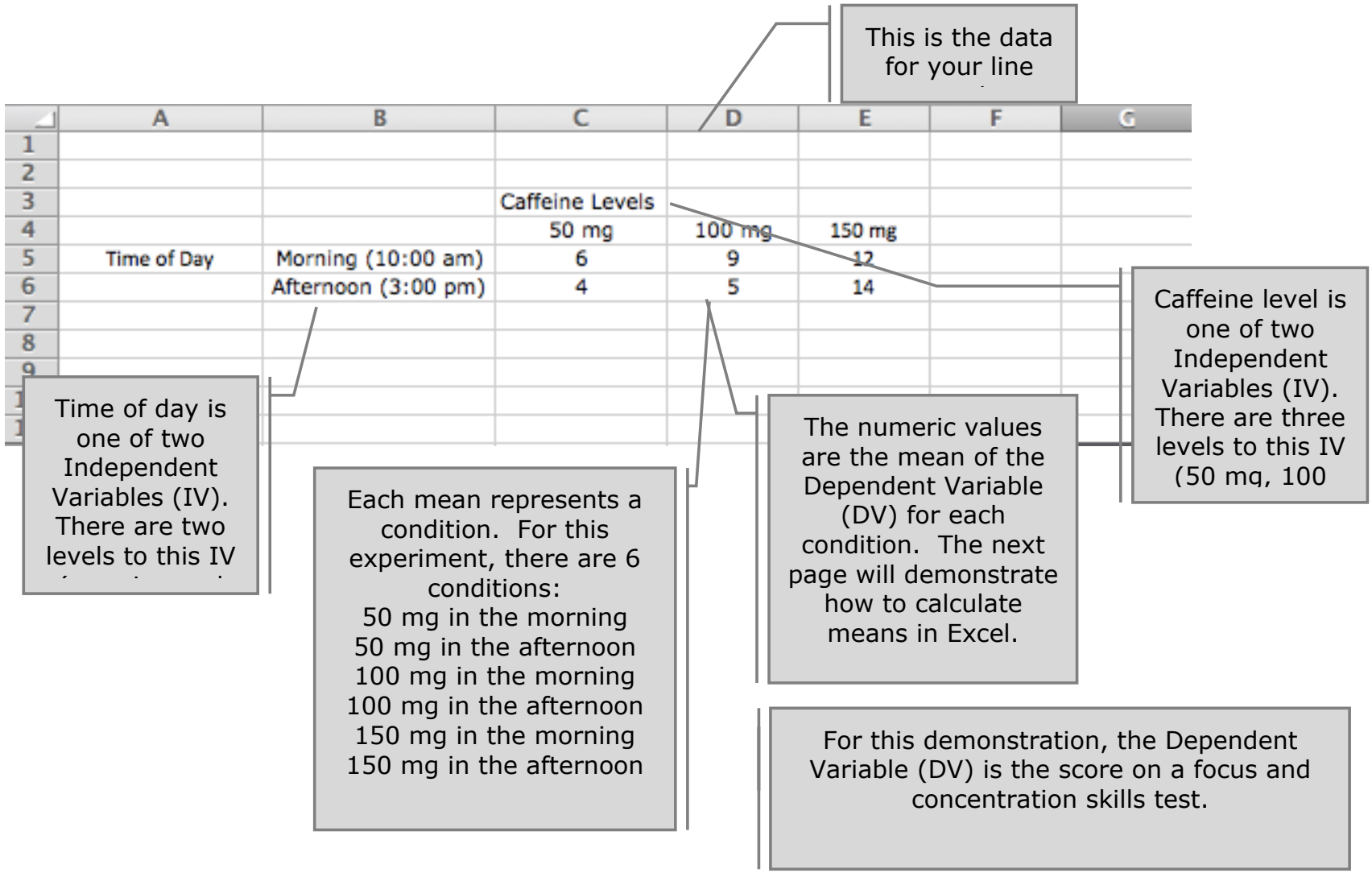

Scatterplot of the Relationship Between Scores on the Exam 1 and Exam 2
Exam 2
100
80
60
40
20
0
0
20
40
120
Series1
Delete
Reset to Match Style
Change Chart Type...
Select Data...
3-D Rotation...
Format Gridlines...
Format Axis...
To remove the grid lines select one of the lines and right click
1
Select "Delete"
2

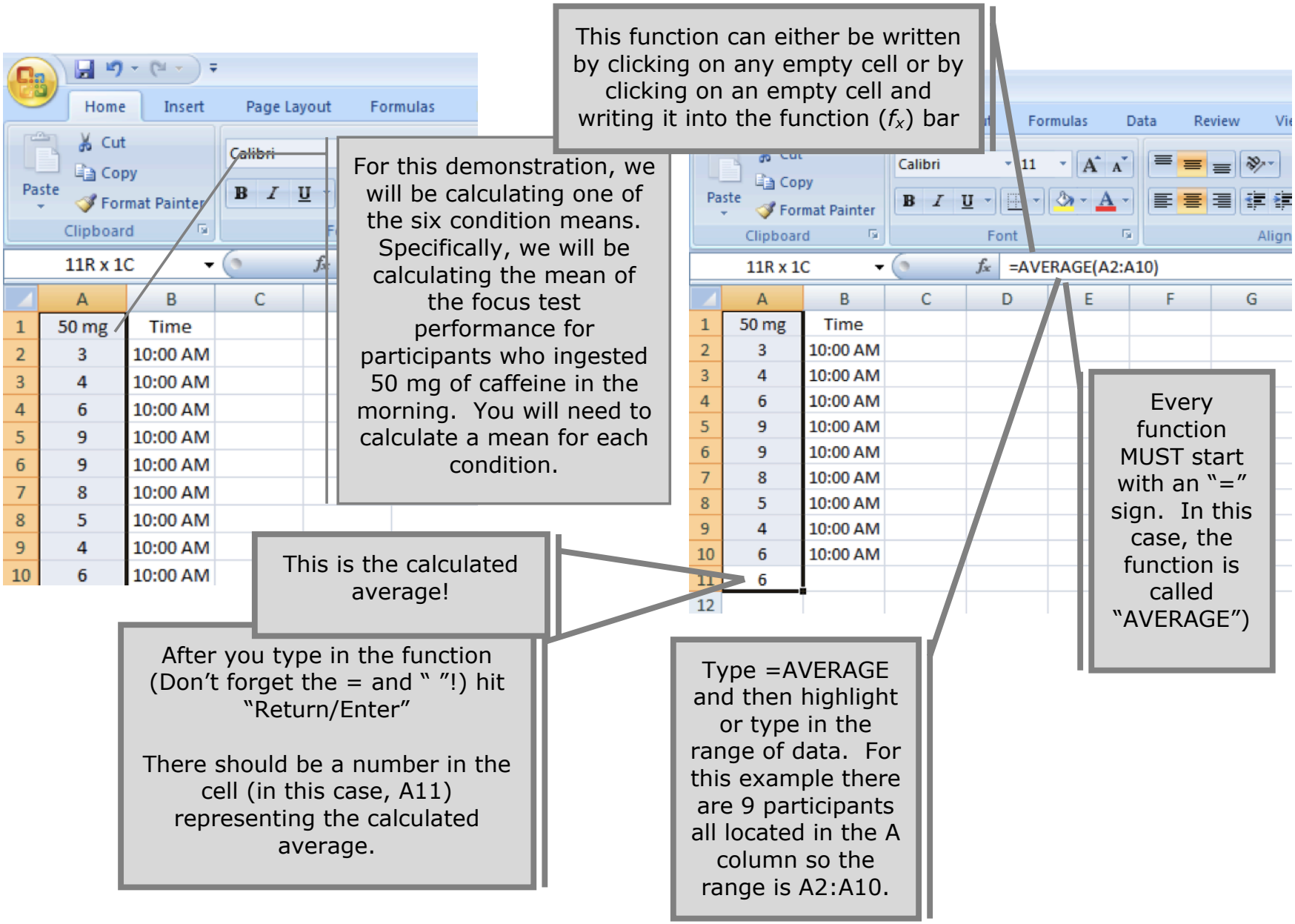

Scatterplot of the Relationship Between Scores on the Exam 1 and Exam 2
Exam 2
100
80
60
40
20
0
0
20
40
60
80
100
120
Exam 1
Delete
Reset to Match Style
Font...
Change Chart Type...
Select Data...
3-D Rotation...
Format Legend...
To remove the legend, select it and right click
3
Select "Delete"
4

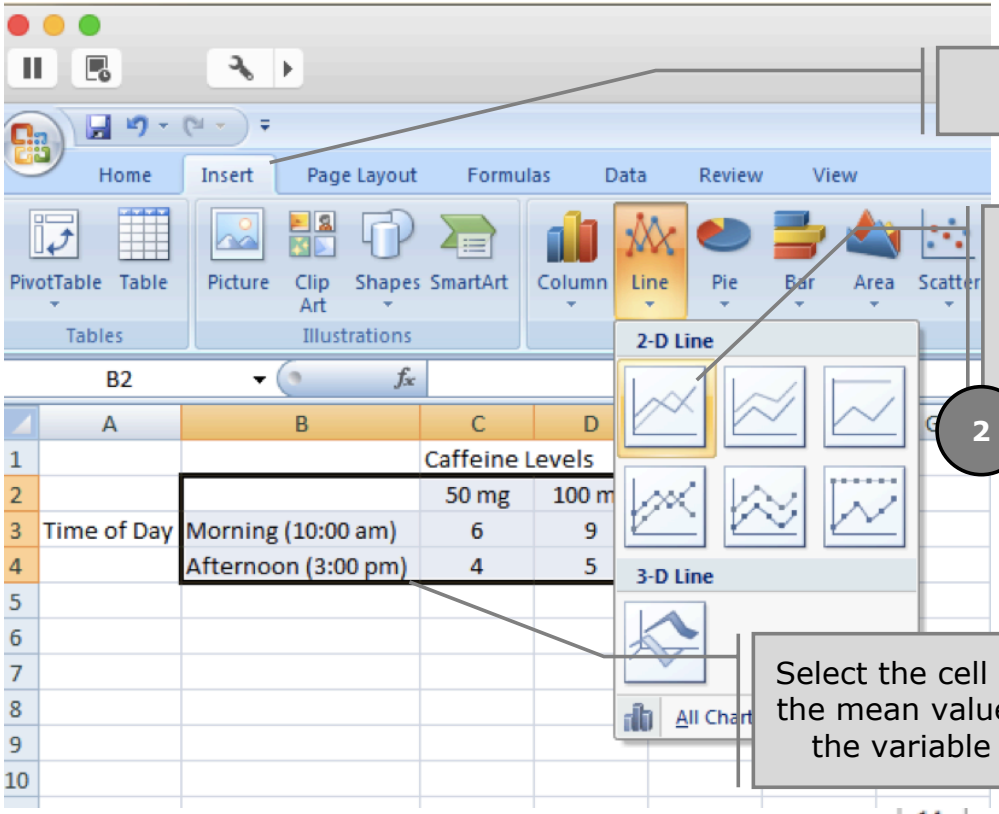

Scatterplot of the Relationship Between Scores on the Exam 1 and Exam 2
If you want to have a shape that is not the default shape, select a data point in the graph and right click
1
Delete
Reset to Match Style
Change Series Chart Type...
Select Data...
3-D Rotation...
Add Data Labels
Add Trendline...
Format Data Series...
Select "Format Data Series"
2
Format Data Series
Series Options
Marker Options
Marker Fill
Line Color
Line Style
Marker Line Color
Marker Line Style
Shadow
3-D Format
Marker Options
Marker Type
Automatic
None
Built-in
Type:
Size :
5
Close
Go to "Marker Options" and select "Built-in"
3
Select any shape/size that you like
4
Scatterplot of the Relationship Between Scores on the Exam 1 and Exam 2
Exam 2
Exam 1
0
20
40
60
80
100
120

How to Create a Line Graph




This is the data for your line
Caffeine Levels
50 mg
100 mg
150 mg
Time of Day
Morning (10:00 am)
Afternoon (3:00 pm)
6
9
12
4
5
14
Caffeine level is one of two Independent Variables (IV). There are three levels to this IV (50 mg, 100
Time of day is one of two Independent Variables (IV). There are two levels to this IV
Each mean represents a condition. For this experiment, there are 6 conditions:
50 mg in the morning
50 mg in the afternoon
100 mg in the morning
100 mg in the afternoon
150 mg in the morning
150 mg in the afternoon
The numeric values are the mean of the Dependent Variable (DV) for each condition. The next page will demonstrate how to calculate means in Excel.
For this demonstration, the Dependent Variable (DV) is the score on a focus and concentration skills test.


This function can either be written by clicking on any empty cell or by clicking on an empty cell and writing it into the function (f_x) bar
For this demonstration, we will be calculating one of the six condition means. Specifically, we will be calculating the mean of the focus test performance for participants who ingested 50 mg of caffeine in the morning. You will need to calculate a mean for each condition.
Every function MUST start with an "=" sign. In this case, the function is called "AVERAGE")
This is the calculated average!
After you type in the function (Don't forget the = and " "!) hit "Return/Enter"
There should be a number in the cell (in this case, A11) representing the calculated average.
Type =AVERAGE and then highlight or type in the range of data. For this example there are 9 participants all located in the A column so the range is A2:A10.
Home
Insert
Page Layout
Formulas
Data
Review
Paste
Cut
Copy
Format Painter
Clipboard
Font
Calibri
11R x 1C
=AVERAGE(A2:A10)
50 mg
Time
10:00 AM

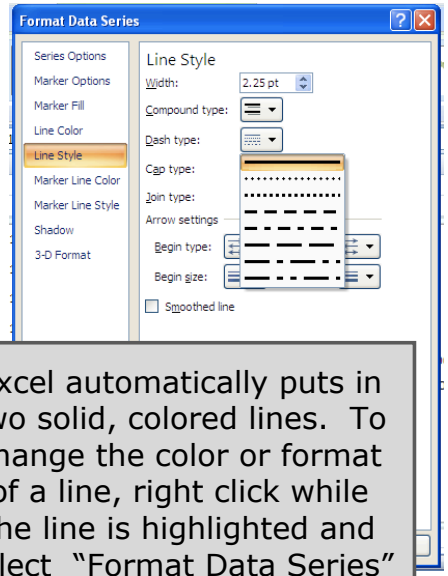


Click the "Insert" tab

1

Select the graph icon with the two crossing lines under the "2-D Line" options. In this case, it is the first icon.

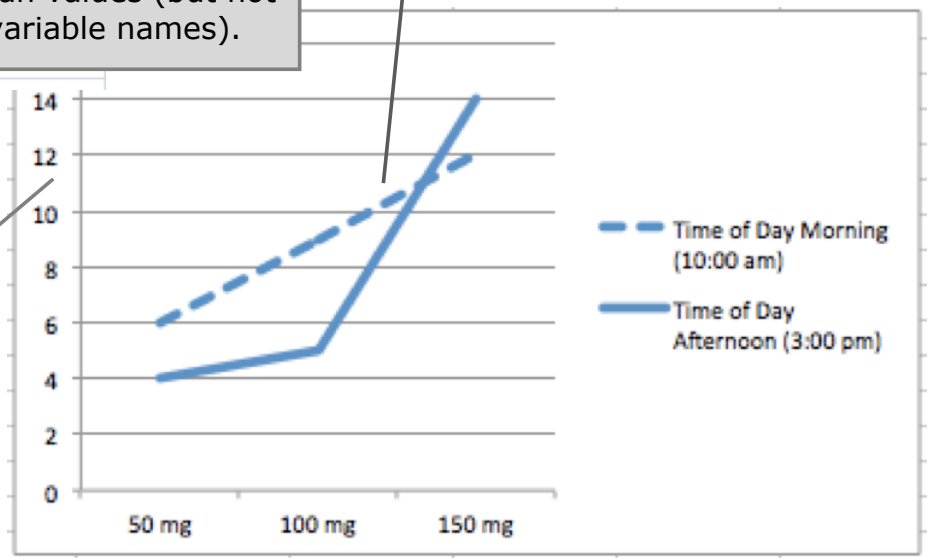
2



Excel automatically puts in two solid, colored lines. To change the color or format of a line, right click while the line is highlighted and select "Format Data Series"

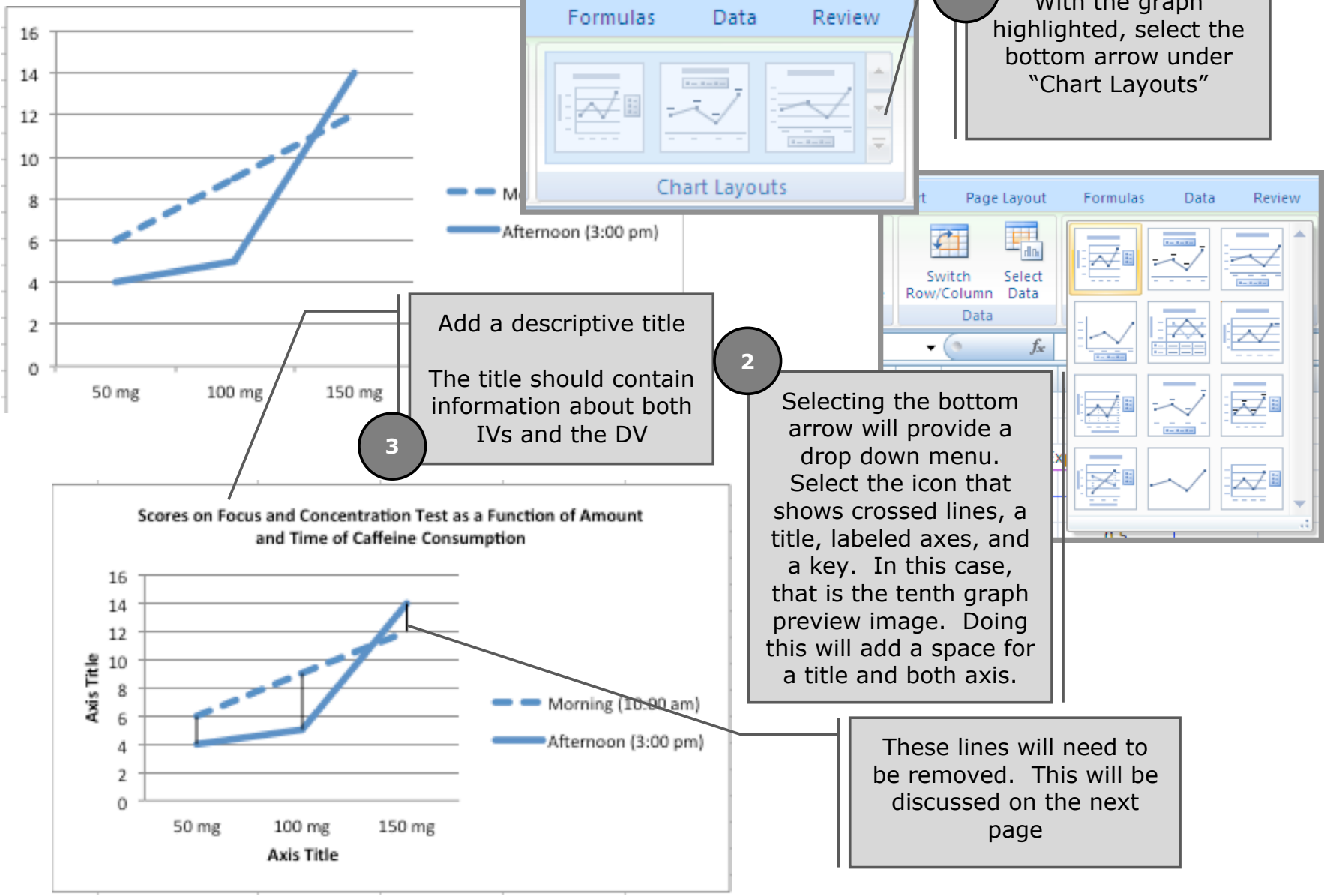
3

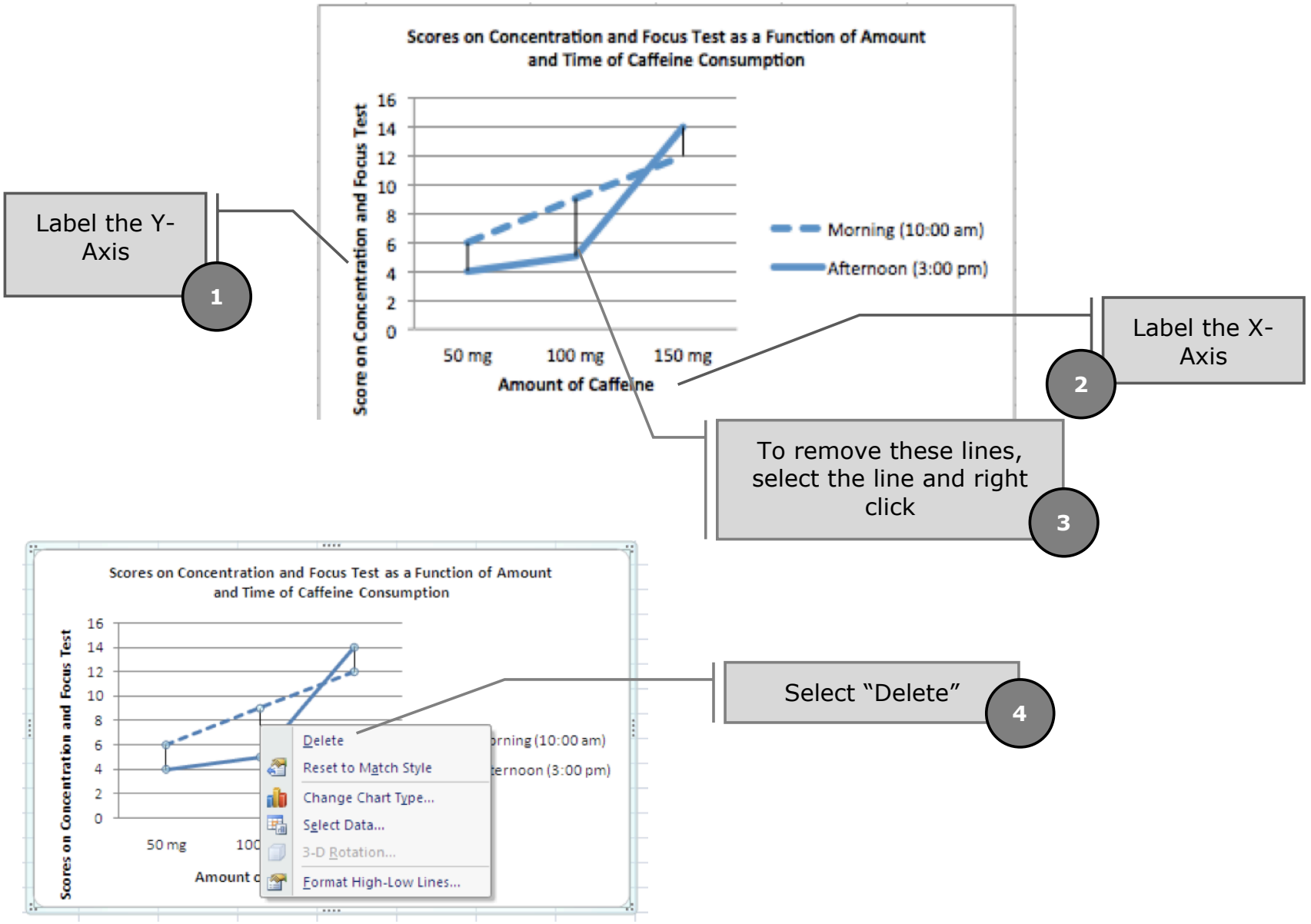
Select the cell labels AND the mean values (but not the variable names).

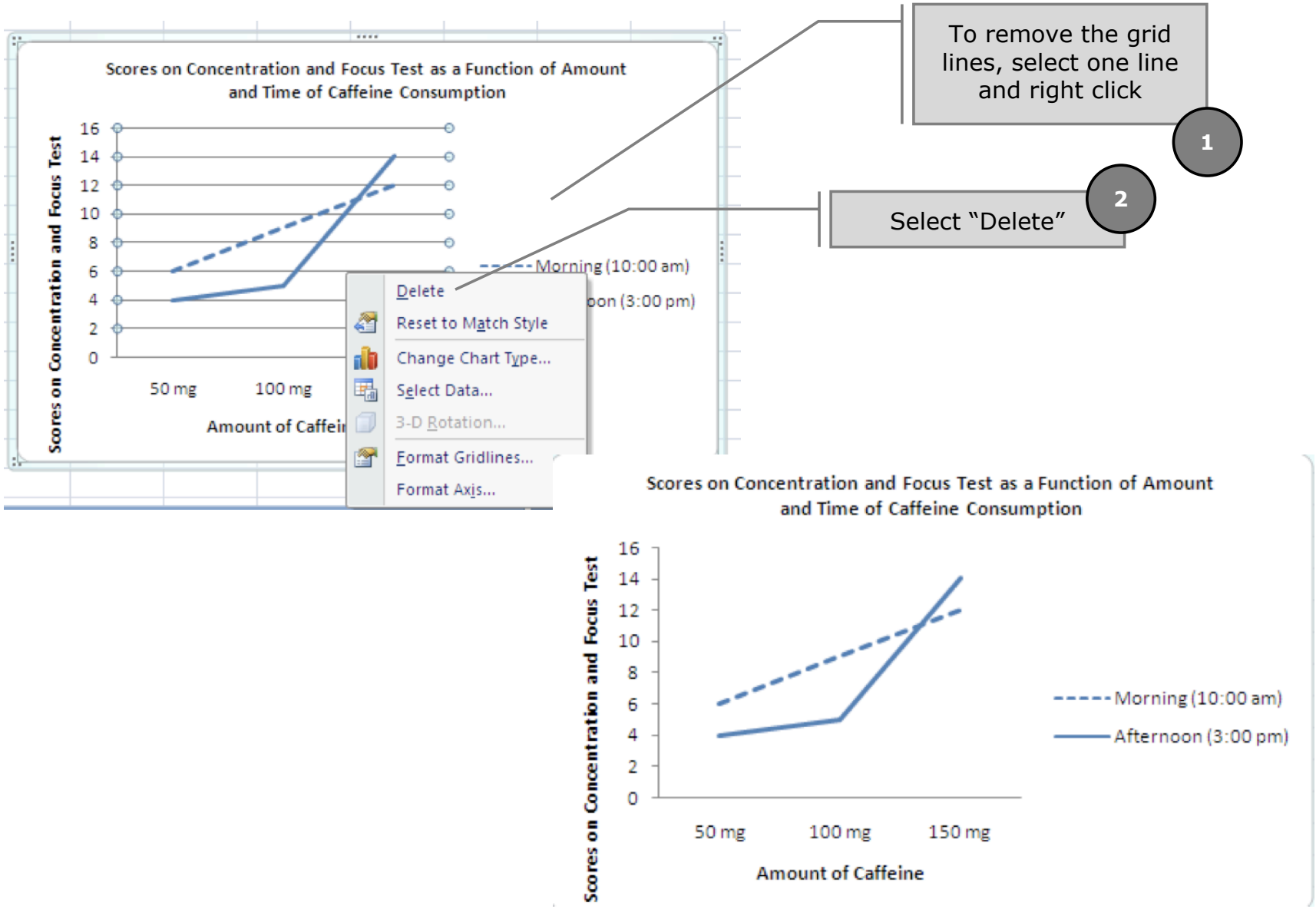


The resulting graph should look like this

It's a good start but some changes (i.e., adding a title, changing the lines, etc.) still need to be made


16
14
12
10
8
6
4
2
0
50 mg
100 mg
150 mg
Afternoon (3:00 pm)
Formulas
Data
Review
Chart Layouts
1
With the graph highlighted, select the bottom arrow under "Chart Layouts"
Page Layout
Formulas
Data
Review
Switch Row/Column
Select Data
Data
2
Selecting the bottom arrow will provide a drop down menu. Select the icon that shows crossed lines, a title, labeled axes, and a key. In this case, that is the tenth graph preview image. Doing this will add a space for a title and both axis.
3
Add a descriptive title
The title should contain information about both IVs and the DV
Scores on Focus and Concentration Test as a Function of Amount and Time of Caffeine Consumption
Axis Title
Morning (10:00 am)
Afternoon (3:00 pm)
Axis Title
These lines will need to be removed. This will be discussed on the next page


Scores on Concentration and Focus Test as a Function of Amount and Time of Caffeine Consumption
Score on Concentration and Focus Test
16
14
12
10
8
6
4
2
0
50 mg
100 mg
150 mg
Amount of Caffeine
Morning (10:00 am)
Afternoon (3:00 pm)
Label the Y-Axis
1
Label the X-Axis
2
To remove these lines, select the line and right click
3
Scores on Concentration and Focus Test as a Function of Amount and Time of Caffeine Consumption
Delete
Reset to Match Style
Change Chart Type...
Select Data...
3-D Rotation...
Format High-Low Lines...
Select "Delete"
4


Scores on Concentration and Focus Test as a Function of Amount and Time of Caffeine Consumption
Scores on Concentration and Focus Test
16
14
12
10
8
6
4
2
0
50 mg
100 mg
Amount of Caffei
Morning (10:00 am)
oon (3:00 pm)
Delete
Reset to Match Style
Change Chart Type...
Select Data...
3-D Rotation...
Format Gridlines...
Format Axis...
To remove the grid lines, select one line and right click
1
Select "Delete"
2
Scores on Concentration and Focus Test as a Function of Amount and Time of Caffeine Consumption
Scores on Concentration and Focus Test
16
14
12
10
8
6
4
2
0
50 mg
100 mg
150 mg
Amount of Caffeine
Morning (10:00 am)
Afternoon (3:00 pm)

Reference

Pagano, R. R. (2007). *Understanding statistics in the behavioral sciences* (8th ed.). Belmont, CA: Wadsworth.