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INTRODUCTION

GRAPHICAL PRESENTATION OF DATA

1.1 PURPOSE AND INTENT OF GRAPHS ★

The principal purpose of a graph is to answer questions about data. Answers to the questions may then provide direction for additional analysis or convey information about the data to colleagues or students. The old adage "a picture is worth a thousand words" is especially applicable when working with large amounts of data. A graph summarizes a mass of data and is an excellent way to "make visible" answers to questions that may be hidden in the data. We may even say that graphs give "life" to the data.

The purpose of all statistical procedures is to make data understandable. Properly constructed graphs can do this in a very direct and straightforward way. In this book, each chapter presents questions concerning variables from many different databases. The proper SPSS graph is selected, built, and interpreted in a manner that answers those questions. Following this process you have made the data more understandable.

Whether you are reading a data report at work or conducting a cancer research project, it is a good idea to be able to interpret large amounts of numerical data. The interpretation of data can mean different things to different people. For this book, "interpretation of data" means that anyone reading the data is able to recognize and understand the *information* contained in the data. This information is then used to answer questions. Answering such

questions will then assist one in making a decision. One way to extract this information and make the data usable is to build a graph. A well-built graph will provide a clear visual representation of the data.

Numbers by themselves have meaning. But when they are used to measure and/or count something, they have more meaning. Throughout this book, the "meaning" may be thought of as information. The ultimate purpose of a graph is to make a "bunch of numbers" (the data) understandable. One way the graph accomplishes this is to extract *information* that is often hidden in the data. This information is then used to assist one in making a decision. Making an informed (educated) decision involves answering questions.

For example, a new professor designs her first statistics course so that her 90 students can each earn between 0 and 500 total points. At the end of her first semester of teaching, she questions the amount of material she attempted to cover in the class lectures. She wonders if she attempted to cover too much or perhaps too little material. One way to answer her question would be to analyze the data and determine the proportion of students scoring in various intervals that make up 0 to 500 points.

Let's say that she produces a graph known as a cumulative histogram. The graph reveals that 70 (78%) of the students earned between 200 and 240 total points. In other words, the graph revealed that more than three fourths of her students earned less than half of the possible points. Such a finding provides evidence that she might consider reducing the amount of material for the second semester of her teaching career. Perhaps, she might make a decision to present less material and to slow down, just a bit, with the intention that the students will increase their learning and therefore earn more total points.

The professor could have relied on basic descriptive statistical analysis to "interpret" or to extract this information from the data. As there are many statistical approaches designed to make data more understandable, for instance, she may have elected to organize the data into a table, determine percentile ranks, and calculate the mean and standard deviation.

This book is about graphs and how to use the graphing features found in the Statistical Package for the Social Sciences (SPSS) to make sense of data. This book is not about building tables or the calculation of numerous descriptive statistics. It is about the *how* and *when* to produce the appropriate graphical representation as a way to better understand data and answer pertinent questions. The actual "production" of the graph will be done by utilizing the power of the SPSS software. Much of this book is devoted to step-by-step procedures needed to build SPSS graphs. You are introduced to this aspect of our book in Section 1.5 of this chapter.

1.2 PROPORTIONAL THINKING AND GRAPH MAKING   ★

It should be obvious that data are usually collected with some purpose in mind. The purpose is that the data will possess the information needed to answer specific questions that will assist us in making a decision. Thus, one should always have a clear idea about the questions that we seek to answer by our graph making.

Often such questions revolve around the idea of percentages, proportions, and probability.[1] Let's use an example that places an emphasis on this aspect of a database. A young woman is trying to decide if she wants to attend a campus party. She hopes to meet a nice young man as a potential boyfriend. A basic question for this young lady is as follows: Given the gender makeup of the party, what is the probability of meeting a potential boyfriend?

She is able to look at the list of 100 names of those attending. She wants to use these data (the 100 names) to help decide whether to attend the party. Just looking at the list of names gives her some information about the proportion of males that will be at the party. She may have an intuitive feeling about the party's gender makeup but little understandable information.

Since the data are discrete (having the two categories of male and female), we could produce a bar graph to give us a clear picture of the proportion of males and females. Most would agree that the proportion of males attending the party would be something for this young woman to consider when deciding whether to go or not. For instance, the bar graph might show that there are 80 females and 20 males on the party list; therefore, there is a .80 probability that any encountered person would be female. We could also say that 80% of those people encountered at this party would be female. We could all agree that such information would be useful when one considers her purpose in attending the party. If her purpose is to meet a young man as a potential boyfriend, then perhaps, she should forget the party, stay at home, and study statistics.

Being able to visualize proportions (hence probabilities) as demonstrated in the party example represents only one of many graphing purposes. Another purpose for a graph might be that we wish to determine if a

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[1] Percentages, proportions, and probabilities may, in a general sense, be thought of as possessing the same type of information. Percentages use a base of 100, and therefore, any observed value represents a portion of 100 and can be expressed as a percentage of the total (100%). Probability uses a base of 1, and therefore, any observed value represents a portion of 1 and can be expressed as a decimal or fraction. The words proportion and probability actually convey the same information. Therefore, we say the proportion of females may be .80 or that the probability of a female is .80. Expressed as a percentage, we would say that 80% of the group is female.

distribution of continuous values are approximately normally distributed.[2] Or perhaps, we wish to see how two variables change together. We could also determine if the values of a variable change in some systematic manner over a period of time. These are only a few of the many uses of graphs. Later chapters will inform the reader as to the purpose of the graph and the type of graph required to answer the question at hand.

Proportional-type thinking is also related to inferential statistical concepts. When proportions are calculated on samples that were obtained through random techniques, another dimension is opened. In looking at the above party example, that new dimension is whether similar parties would be expected to have approximately the same proportion of females and males. If proper research practices were followed, then we can use the sample proportions to estimate the *likelihood* that those same proportions would exist at a similar party.

There are several considerations for the graph maker when deciding the best way to use the power of SPSS to answer questions about a database. This is the topic of the following section.

★   1.3 DECISIONS FOR THE GRAPH MAKER

What is the best approach when seeking to extract useful information from a large mass of data? What type of graph should be built to answer specific questions about the data? How can the extracted information be used to assist one in making decisions? What is the best way to organize data so as to answer specific questions? These are the types of questions about data answered in this section.

Since this book uses SPSS, the first step in understanding data is to make sure that its format is compatible with SPSS.[3] Once this is accomplished, we can let SPSS do the difficult and time-consuming work involved in producing a graph. Once SPSS has been selected as the software, there are other considerations before one attempts to produce a specific graph.

1.3.1 First Consideration: How Were the Variables Measured?

The first consideration when attempting to graph data is whether the measurement of the variable was discrete or continuous. When using SPSS, you

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[2]More details regarding the normal distribution are provided in Chapter 8 on histograms.

[3]For information on how data are inputted into the SPSS format (not required in this textbook) consult *Using SPSS: An Interactive Hands-On Approach* by Cunningham and Aldrich, 2011, Sage.

will *not* see data classified as discrete or continuous, but you will see a column heading called "Measure" in the "Variable View" Screen. Measure is short for "level of measurement." It is here that the person entering the data indicates how the data were measured. If you are entering the data into the SPSS software yourself, you must understand the meaning of "level of measurement" as it relates to the numerical values associated with your observations. The data used in this textbook already have these levels of measurement specified, so this point becomes academic.[4] When using this text, you will only have to decide if the data are discrete or continuous. The SPSS databases used in this text will have already specified the data as being measured at one of three levels of measurement (scale, ordinal, and nominal).[5] Those variables measured at the *scale* level are considered as continuous data. Variables specified as being measured at the *nominal* or *ordinal* level should be considered as discrete.

Variables measured at the continuous level are not based on distinct categories. Such variables can be recognized when an infinite number of points between each interval are possible. To understand the concept of infinite points, think of the variable of weight. If it was observed that an individual weighs 165 pounds, we can see that there are an infinite number of points between 165 and say 166. One could weigh 165.25 pounds or a more sensitive scale could record 165.2567 pounds and so on. One of the common methods used to understand a large database of continuous variables is to construct a histogram. SPSS constructs intervals for the continuous data and records these on the *x*-axis. Next it counts the number of observations within these intervals, which are read from the *y*-axis. Such graphs are distinct from the bar graph in that the intervals are connected on the *x*-axis and are not separate categories as with the bar graph.

Discrete variables are made up of separate and distinct categories. An example of a discrete variable is *gender* (nominal), where all observations must fall into one of two unique categories, male or female. Another example could be responses on a survey where one has several choices such as military ranks of general, colonel, captain, sergeant, and private. In this example, the respondent must fall in one of the five categories, which measure the level (amount) of military rank (ordinal). At this point, it is instructive to

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[4]If you wish to refresh yourself on the meaning of "levels of measurement," we refer you to *Using SPSS: An Interactive Hands-On Approach* by Cunningham and Aldrich.

[5]One note of caution is that the levels of measurement specified in the databases found in SPSS Sample files are not always correct. We will only use such databases when absolutely necessary and when it does not affect the graph building procedure. You should be alert to incorrect levels of measurement as you continue to develop your graph making skills and you explore other databases in the SPSS Sample files.

think in terms of a bar or pie graph when attempting to understand the distributions of discrete variables. With discrete data, each distinct bar or pie slice represents a category. Each category is represented either by a rectangular box or a slice of the pie. It must be mentioned that it is sometimes desirable to use a bar graph to represent continuous data. SPSS accomplishes this by organizing the continuous data into separate categories by specifying ranges. A bar graph can also be used to compare the means (continuous data) of a number of groups. An example would be to compare two university classes on the mean number of points earned on an exam. In spite of these exceptions, the primary use of the bar graph is to represent discrete data.

In many of the later chapters, you will learn to build graphs that use a combination of discrete and continuous data. At this time, we do not attempt to describe all the various combinations of discrete and continuous data and the appropriate graphs for these situations. You will learn these procedures when we describe the types of graphs and how they are used. Additional guidance in choosing the correct graph for various levels of measurement and to provide answers for specific questions is provided in Appendix D (Graph Selection: Type and Purpose).

To summarize this section: When one wishes to make a graph to discover information contained in a mass of data, it is necessary to first establish whether the data are discrete or continuous.

1.3.2 Second Consideration: What Are We Trying to Understand About the Data? What Is the Question? What Information Must the Graph Communicate?

When confronted with a large amount of data, we might be seeking information about a single variable. In this case, we are not concerned with how the values of one variable may relate to the values of other variables. In other words, we are concerned with what the distribution of values "looks like." If we have a discrete variable, such as the previously discussed gender variable, then "looks like" can refer to the number (or percentages) of males and females in the database. A bar graph would encourage thinking in a proportional way by drawing a graph, making it easy to visualize the relationship between the two categories for the single variable of gender. Another method might be to construct a pie graph. The pie graph is especially useful with more than two categories in that it makes it easier to see the proportions between the distinct categories and the whole. We will address such issues in greater detail when they are discussed in later chapters that describe how to produce such graphs.

If we are investigating a single continuous variable, we might choose to build a graph known as a histogram to see what the data "looks like."

The histogram could provide evidence as to whether the data approximates the normal distribution.[6] Such graphing of continuous data could also discover extreme values (outliers) that should be dealt with before additional statistical analysis is undertaken.

If the question we are seeking to answer involves two or more variables, we need a graph that depicts their relationship. With two variables, we need to display a bivariate relationship.[7] A scatter plot–type graph will enable the graph maker to display the relationship between two variables. In this application, the *x*-axis and *y*-axis both represent a value for each variable. Another example of graphing two variables would be putting the results of a 2×2 crosstab analysis into a stacked bar chart, making it easier, for most people, to visualize the proportions.

Another question might be the interpretation of the results of a multivariate analysis, where it is necessary to graph three or more variables. You will soon learn how to build a graph representing, say, two continuous and single discrete variables. Another use would be to use a line graph to display an interaction or lack of interaction between two independent variables.

Later chapters discuss all the above graphing possibilities (and more) with detailed guidelines as to which graphs answer specific questions about the data.

1.3.3 Third Consideration: Who Will Use the Information and What Is Their Level of Statistical Knowledge?

Another consideration would be the type of audience. By this we mean that graphs prepared for a meeting of members of the American Statistical Association might take on a different appearance than graphs prepared for an introductory course in statistics. Whoever the audience, graphs should always be clear and concise representations of the data and should be readily understandable.

1.3.4 Fourth Consideration: Is the Graph Intended to Guide Further Research or Will It Be Used for Presentation to Others?

If the intention of the graph builder is to use the graph to guide students or other users in the selection of further statistical approaches, then the use of

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[6]The normality aspect of continuous data is discussed in more detail in Chapter 8 on histograms.

[7]When graphing a bivariate relationship, we have a single point on the graph that represents two values, one for *x* and one for *y*.

the SPSS *Chart Editor* is not required. The basic graph produced by SPSS will usually provide the information required to answer their questions. On the other hand, a graph intended as part of a larger presentation to students and/ or colleagues would require one to "edit" the graph using the SPSS *Chart Editor*. The editing process, which uses the *Chart Editor*, is covered in detail in the later chapters.

★   1.4 Databases Used in This Book

In all cases, the databases you will use to build the graphs are found in the SPSS Sample file that was downloaded with the software. In general, each database selected for use is briefly described when it is introduced. However additional information on specific databases is available by using the SPSS *Help* menu as follows:

- Open **SPSS**.
- Click **Help**, then click **Topics**, and type **sample files**.
- Click **list topics**, then click **sample files**.
- Click **Display**.

The data used to illustrate various graphs at the beginning of each chapter were obtained from the authors' years of teaching intermediate-level statistics classes. You are not required to have access to these data.

1.4.1 Access to Databases Used to Build Graphs

Before we can examine the major features of the *Chart Builder* in the next section, we must open a database. The procedure shown below will open one of the databases (**accidents.sav**) that was included with the SPSS software. You will use many of the databases that are found in the SPSS Sample files location. You should make a note to mark this page since you will use these procedures in almost every chapter.[8]

- Start **SPSS** if it is not already running.
- On the SPSS Menu, click **File**, select **Open**, and then click **Data**.

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[8]As you proceed through the chapters, you will be required to repeatedly use the same databases from the SPSS Sample files. You may wish to save the most used databases to your computer, making access much quicker. A chapter-by-chapter listing of all SPSS databases used in this book is given in Appendix C.

- In the *Open data* window, click the **down arrow** in the *Look in* box and scroll to and click the **C drive**.
- Double click **Program Files**.
- Scroll to **SPSSInc**, then double click **SPSSInc**.
- Double click **PASW Statistics 18** (currently Version 20 shows 18, and you may see other version numbers as well).
- Double click **Samples**.
- Double click **English**.
- A window opens in which you will see a long list of available files.
- Click **accidents.sav**.
- Click **Open** (*Data Editor* opens). We now have the required database and may open the *Chart Builder*.
- Click **Graphs**, and then click **Chart Builder**.
- *Chart Builder* window opens as shown in Figure 1.2. Make sure that **Gallery** is selected—if not, click **Gallery**.

Following the above procedures can sometimes be tricky. It may become necessary to exercise some patience, but we assure you that the procedure is the correct way to access SPSS Sample files. Be sure to double click on the files as specified.

## 1.5 SPSS GRAPH PRODUCTION: USING THE *CHART BUILDER* ★

The *Chart Builder* feature available in SPSS plays a major role in this book. Detailed procedures on building simple to complex graphs while using the *Chart Builder* are provided throughout this textbook. The purpose of this section is to provide you with a *basic* understanding about how to use the SPSS *Chart Builder*. Don't worry, you won't have to memorize everything in this section, as you are given step-by-step procedures when building graphs in the later chapters. We do, however, highly recommend that you take this time to become familiar with the *Chart Builder*. It won't be long before you will easily produce graphs to better understand large amounts of data. Let's proceed with the assumption that you have never used the SPSS *Chart Builder* feature.

When you click **Graphs** on the SPSS *Main Menu*, you are given three options for building a graph: (1) *Legacy Dialogs*, (2) *Graphboard Template Chooser*, and (3) *Chart Builder*. The *Legacy Dialogs* option is one of the first methods developed by SPSS, some people feel comfortable in using this earlier method. There is nothing wrong with the *Legacy* approach; however, it does take more statistical knowledge (and time) to use it correctly. The

next option *Graphboard Template Chooser* came along a few years later and offered more automatic steps in building a graph. The final option *Chart Builder* is the most recent version, and in the opinion of the authors, it is the most efficient. Therefore, we have chosen the *Chart Builder* as the option described in this book. Therefore, all step-by-step instructions in this book begin and end with the *Chart Builder*.

 Chart Builder is the first available option when clicking **Graphs** on the SPSS *Main Menu* (Figure 1.1). This is the option used in all chapters of this textbook.
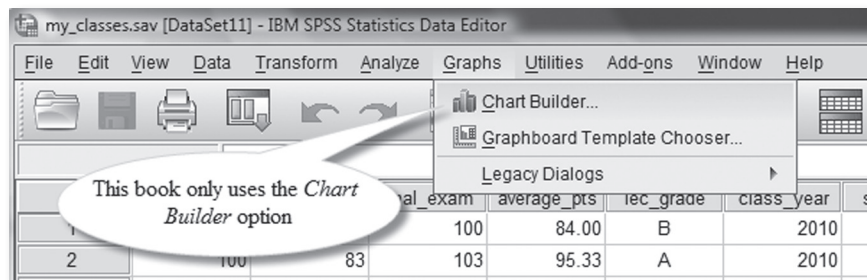
 The following section provides details on the *Chart Builder* window that opens once you click on *Chart Builder* in the drop-down menu as shown in Figure 1.1.

1.5.1 A Description of the *Chart Builder* Window

Figure 1.2 shows the basic *Chart Builder* window that opens once *Chart Builder* is clicked. If the window you see is slightly different from the one shown in Figure 1.2, then look at the horizontal row of buttons in the middle of the window to make sure that *Gallery* is highlighted, which means it is active and does not need to be clicked. If one of the other buttons (*Basic Elements*, *Groups/Point ID*, and *Titles/Footnotes*) is highlighted, the window's appearance will not match the one shown in Figure 1.2, and you must then click the *Gallery* button.

 Let's go through some of the features and options available when you open the *Chart Builder* window. At this time, our intention is to only familiarize you with the major features available in the *Chart Builder* window. You will learn to build graphs, using the *Chart Builder* window, starting with the next chapter.

Figure 1.2   *Chart Builder* Window Showing Key Features and Control Points
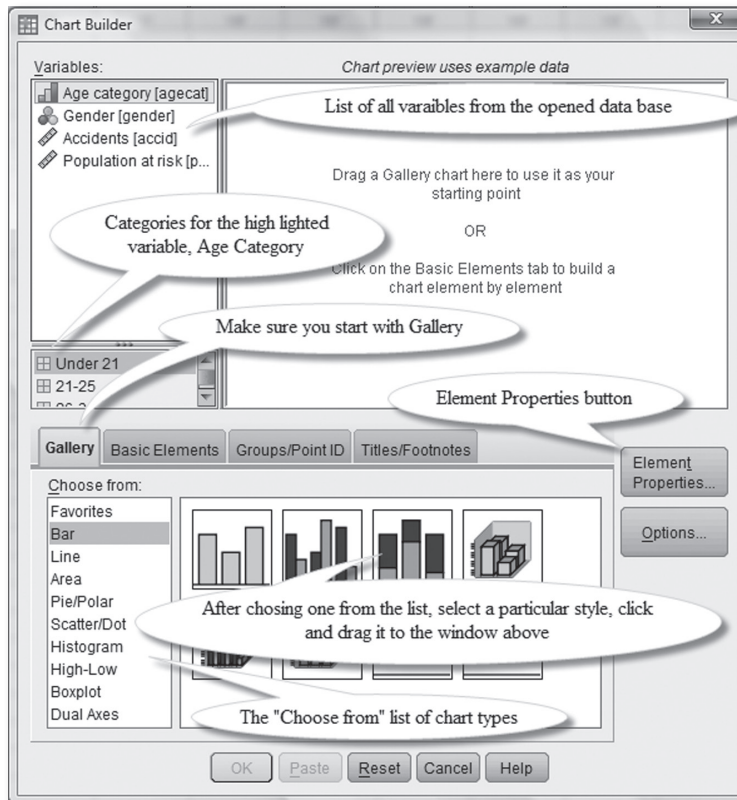
1.5.2 Panels in the *Chart Builder* Window

There are three major panels in the *Chart Builder* window titled as follows: (1) *Variables*, (2) *Chart preview uses example data*, and (3) *Choose from*. Let's examine each of these panels.

1. **The "Variables:" Panel:** The *Variables* panel provides a list of all the variables in the opened database. The level of measurement is also specified by the icon that precedes the variable's name. The first icon shown in the *Variables* panel is for *Age category*, and it represents data measured at the ordinal level. Therefore, if you select this variable for graphing you will only use graphing procedures appropriate for discrete data. The next variable, *Gender*, is represented by an icon resembling three balloons that denotes nominal data. Once again, for graphing procedures, one must consider this

as discrete data. The third variable in this panel, *Accidents*, is preceded by an icon looking like a small ruler. A variable shown with this SPSS icon indicates that it was measured at the scale level (interval and ratio). Data measured in this manner and accompanied by this icon are treated as continuous data for graphing purposes. We summarize our icon descriptions as follows:

- Icons for *discrete* variables are and
- Icon for a *continuous* variable is

The lower portion of the *Variables:* panel also provides a brief description of the categories for discrete (nominal and ordinal) data. You obtain these descriptions by clicking on each variable. This feature can be very useful when deciding on variables to include in your graph-building projects.

Figure 1.2 shows that the **accidents.sav** database has four variables available for graphing, two discrete (*Age category* and *Gender*) and two continuous (*Accidents* and *Population at risk*).

2. **The "Chart preview uses example data" Panel:** SPSS uses the words "uses example data" to emphasize that the graph shown in the panel, during the graph-building process, does not represent your data. It is only a very rough approximation of what your finished graph will look like. In later chapters, we shorten this panel's name to "*Chart preview.*"

It is in this panel that much of your basic chart building takes place. At this time, we do not attempt to show the many different appearances of this panel. Basically, this panel provides a template for various types and styles of graphs that are selected from the third panel ("*Choose from:*" panel). Briefly, the procedure is to select a graph and style from the *Choose from* panel, drag it to the *Chart preview* panel, then drag appropriate variables onto the shown graph. The procedures for using this panel, as they relate to specific graph-building projects, are detailed in all the later chapters.

3. **The "Choose from:" Panel:** Direct your attention to the *Choose from:* panel in Figure 1.2. Notice that "Bar" has been highlighted; this was accomplished by clicking on "Bar." When the word "Bar" is clicked, a specific set of bar styles appears to the right. If a different graph type had been clicked (highlighted), then you would see different set of graph styles to choose from. Clicking the Bar graph gives you eight style choices. Notice that some are hidden by our informational balloon. It is from these eight different styles that you choose one and then click and drag it to the *Chart preview* panel directly above. Later chapters will show styles appropriate for answering specific questions about a particular database. Once the style has been moved to the *Chart preview* panel, you will then drag variables onto various places on the graph to continue the graph-building process.

1.5.3 *Element Properties* Window

The *Element Properties* button is located in the center-right portion of the window shown in Figure 1.2. Clicking this button opens the *Elements Properties* window (Figure 1.3), which provides many ways to make changes during the graph-building process. The use of the features accessed through the *Element Properties* window will be illustrated as the need arises. In most cases, this window opens automatically when performing operations in the *Chart Builder* window. If it does not open automatically, then clicking the *Element Properties* button in the *Chart Builder* window offers an alternative way to gain access to its features.

Once you have made changes to your graph from the *Element Properties* window, remember to click the **Apply** button as shown in Figure 1.3. Clicking the **Apply** button takes you back to the *Chart preview* panel that incorporates your changes.
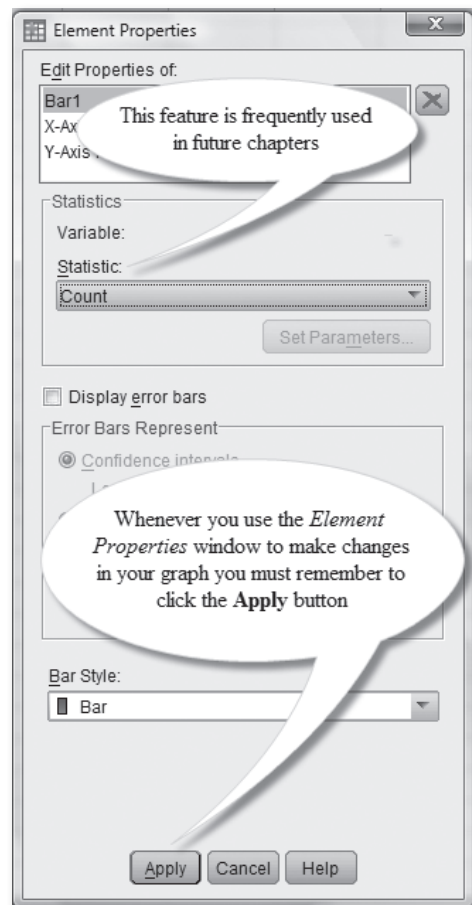
Figure 1.3   *Element Properties Window*

1.5.4 Final Stages When Using the *Chart Builder*

In the row of buttons at the bottom of the *Chart Builder* window, you will most frequently use **OK** and **Reset**. Clicking **OK** causes all previous instructions to be incorporated into the graph and immediately produces the finished basic graph that appears in the *Output Viewer* of SPSS. If the *Output Viewer* does not appear on the screen after clicking **OK**, then click **Output** found on the *Task* bar at the bottom of your computer screen.

Once your graph appears in the *Output Viewer*, there is an opportunity to further modify this basic graph. We refer to this graph as "basic" since there are many ways it can be embellished and improved by using the *Chart Editor* as described in the following section.

Before leaving the *Chart Builder*, we describe the use of the *Reset* button found at the bottom of the *Chart Builder* window. This handy feature clears all prior work from the *Chart preview* panel

(Figure 1.2). We recommend this, unless you are building another graph of the same type and style as the one you may have just built.
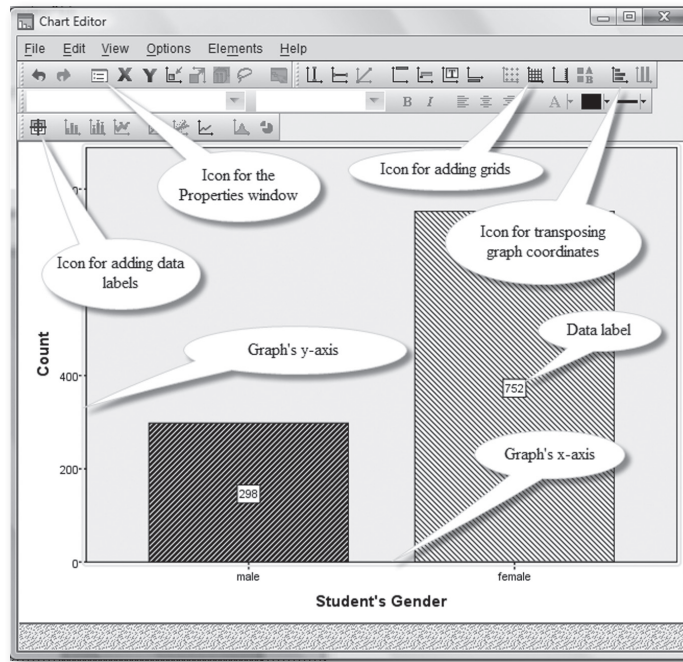
1.5.5 *Chart Editor* and *Properties* Window

The *Chart Editor* window is key when building clear and concise graphs that effectively communicate the information needed to understand the data. The *Chart Editor* window (see Figure 1.4) opens when you double click the basic graph in the *Output Viewer*.

In this section, our intention is to briefly introduce you to some of the editing features made possible by using the *Chart Editor*. Specific instructions on how to use the *Chart Editor* are provided in later graph-building exercises. You will utilize features of the *Chart Editor* and its associated *Properties* window (see Figure 1.5) to make changes that you see immediately as you continue with your graph-building project.

Figure 1.4 shows the *Chart Editor* window with a few of the key features and control points emphasized with information bubbles. As before, our

Figure 1.4   *Chart Editor* Window With Some Useful Points Tagged

intention here is to only familiarize you with the *Chart Editor* window. You will learn much more about its use as you progress through various graph-building procedures.

Figure 1.5 shows the *Properties* window (not to be confused with the *Element Properties* window shown in Figure 1.3). Normally the *Properties* window opens with the *Chart Editor*. If it does not, then click the *Properties* icon as shown in Figure 1.4. Depending on the particular graph-building project and the request you make by clicking items in the *Chart Editor*, the

Figure 1.5 *Properties* Window Showing the *Categories* Tab Clicked
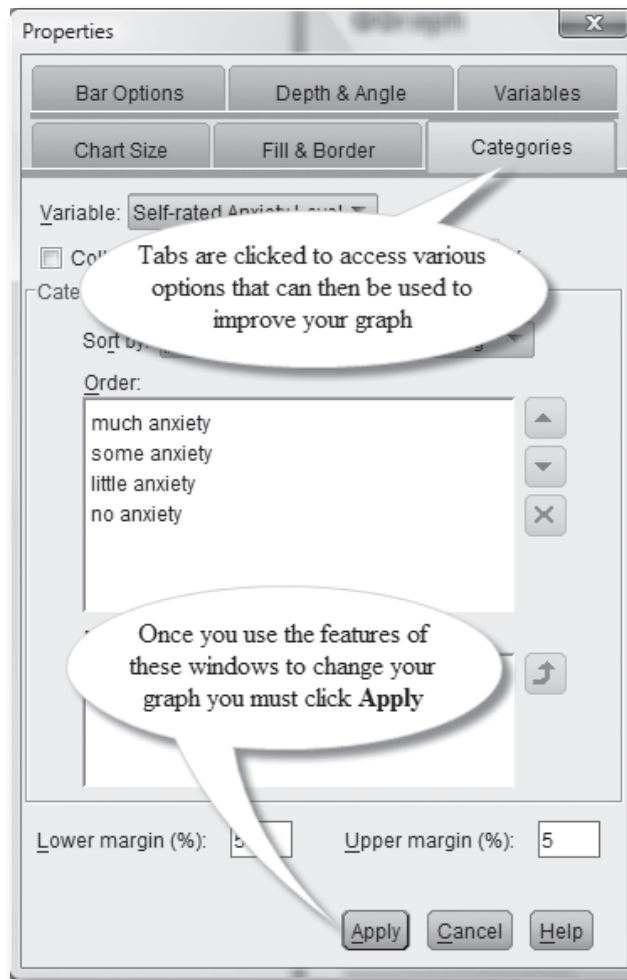
Properties window takes on many different appearances. You will be directed on a case-by-case basis to click various tabs, which then provide access to the features needed to make the desired changes.

At this point, you may feel a little overwhelmed by the many details associated with graph building. However, we assure you that after making a few graphs as described in the following chapters, the process becomes very natural and intuitive—SPSS has done an excellent job in this regard.

★   ## 1.6 DEFINITION OF KEY TERMS AND CONCEPTS

Variable—A characteristic that describes some physical or mental aspect of the individual, group, or inanimate object. The key point is that variables can *vary* and can be expressed as a particular numerical value or as falling in a unique category. The following are some examples:

- *Gender* as the observed variable could vary in two ways: male or female (discrete).
- *Mental state* could be a variable and vary in five ways: very anxious, anxious, neutral, relaxed, and very relaxed (discrete).
- *Number of errors* on a written test can be considered as a variable. If there were 10 questions, then such a variable could vary from 0 to 10 errors (discrete).
- *Make of automobile* owned or leased can be considered as a variable (discrete).
- *Weight of an individual* can be considered as a variable (continuous).
- *Speed of an airplane* can be considered as a variable (continuous).
- *How high one can jump* can be considered as a variable (continuous).

Discrete Variable—A characteristic that describes some physical or mental aspect of the individual, group, or inanimate object that has been observed. The term *discrete* describes how the variable is measured or counted. Discrete variables vary in a manner so that the characteristics being measured fall in unique categories. Such categories must be *mutually exclusive*, which means that any observation must fall in one and only one category. The categories must also be *inclusive*, which means that there must be a category for every possible observation. Examples of discrete variables from the list above are *gender*, *mental state*, *number of errors*, and *make of automobile*.

Continuous Variable—A characteristic that describes some physical or mental aspect of the individual, group, or inanimate object that has been observed. The term *continuous* describes how the variable is measured. Continuous variables vary by taking on any one of a large number of measures (often infinite). Examples of continuous variables from the list above are *weight*, *speed*, and *how high one can jump*.

Category—A natural grouping of the characteristics of a discrete variable. Think of the type of automobile as a variable having categories such as Porsche, Ferrari, and Maserati. The automobile possessing "Porsche" characteristics is counted or placed in a category titled Porsche.

Continuous Distribution—Plainly speaking, a continuous distribution is just a "bunch of numbers" that resulted when something was measured at the continuous level. We use various types of statistical analysis, including graphs, to make sense of such distributions. Histogram and line graphs are the most commonly used graphing techniques to describe continuous distributions.

Discrete Distribution—Could also consist of a bunch of numbers, but the numbers take on a different meaning. Using the gender variable as an example, we could assign the value label of 1 to the male category and 2 to the female category. This being the case, you now have a column of numbers consisting of 1s and 2s that you are trying to understand. You could use SPSS to produce a bar graph.

Levels of Measurement—A classification method used to define how variables are measured. For most statistical work, there are four possible ways to measure variables: (1) nominal, (2) ordinal, (3) interval, and (4) ratio. When using SPSS, you will find that interval and ratio have been combined and are referred to as *scale*. For purposes of graph making, only two methods of measurement need to be distinguished: (1) continuous, which includes interval and ratio (SPSS's scale) and (2) discrete, which includes SPSS's nominal and ordinal levels of measurement.

Independent Variable—The independent variable is manipulated and has the freedom to take on different values. It is the presumed cause of change in the dependent variable in experimental work. In observational-type studies, it is often referred to as the predictor variable. This definition hinges on the idea that knowledge of the predictor variable will facilitate the successful estimation of the value for the dependent variable.

Dependent Variable—This variable can take on different values; however, these values are said to "depend" on the value of the independent variable. In experimental work, we test whether the manipulation of the independent variable results in a significant change in the dependent variable. In observational studies, the value of the dependent variable can be better predicted by knowledge of the value of the independent variable.

Horizontal Axis—In this book, the term horizontal axis is used infrequently, as the preferred terminology is the *x*-axis. Both these terms will always refer to the horizontal axis of the chart you are building. During certain SPSS operations, you will find that the vertical axis is referred to as the *x*-axis. When this happens, we revert to the term *horizontal axis* so as to avoid confusion.

Vertical Axis—The vertical axis rises perpendicular to the *x*-axis (horizontal) and is most frequently referred to as the *y*-axis.