CHAPTER 1

What Is a Number?
Is a Rose Always a Rose?

Remember when you first learned nursery rhymes such as *Three Blind Mice* or watched Count Dracula on *Sesame Street?* As a child, you probably helped the person reading to you count each of the three mice or followed the Count as he numbered everything in sight. You were learning numbers. Do you remember holding up your little fingers when someone asked you how old you were? At a very early age, you were expected to begin to understand numbers and what they meant. Numbers are a part of everyone's life. We all use them without thinking about their meaning. In this chapter, we're going to talk about types of numbers (or scales) and how they can be used in measurement. Measurement is a way to give meaning to numbers.

Numbers and Scales

First of all, in measurement numbers compose scales. There are four scales of measurement: nominal, ordinal, interval, and ratio (Stevens, 1946). Although each of these scales is represented by numbers, they are very different and cannot be used interchangeably. So it's very important that you understand these four measurement scales.

Nominal

Nominal measurement scales are used to name or label things or to depict categories. Nominal scales put things or people into categories. For example, when you responded to the latest U.S. census, you indicated your gender and

that placed you into a category—male or female. At this point you may be asking yourself, So what? In measurement, it is important to know characteristics of things or people. When trying to count the number of people in the United States, the government often wants to know how many men and women there are, not just the number of total citizens in the United States. Being able to examine citizens by gender allows you to get a more accurate picture of the people you are trying to measure. Other nominal categories that are frequently taken into consideration in measurement include categories such as race or ethnicity, marital status, or region of the United States.

Your social security number also names you. No other person has your number. It is uniquely yours. Similarly, universities use an identification (ID) number to represent you. When a faculty member needs to access your academic records, they look up your ID number. It is easier and more accurate to identify you by your ID number than your name (how many Mary Smiths are there anyway?). Both your social security number and your ID number are "shorthand" for you. Both are nominal-level data.

It is important to note that nominal scales cannot be added, subtracted, multiplied, or divided. You just cannot manipulate them mathematically. You can assign a value to categories, for example, 1 for men and 2 for women or vice versa. Regardless what number they are assigned, you cannot mathematically manipulate these numbers. For example, you cannot add a man and a woman or add social security numbers and get anything meaningful. Therefore, it is imperative that you remember that nominal scales only name things. Don't try to mess with them mathematically.

Ordinal

Ordinal scales order or rank things. Every child knows that it is better to be chosen first for a team than to be chosen sixth or tenth. Whoever is doing the choosing has made a judgment and ranked the other children by some trait or ability. In this case, the child chosen first was most likely perceived as the most skilled (or most liked?). In our society, we are taught to strive to be number one. We don't know how much better we are than number two, but we know we came in first. In measurement, an assigned rank given to a person or thing is an ordinal number.

While ordinal scales can be mathematically manipulated, special formulas are often required, and interpreting the findings is done with great care. One reason for this is that the differences between ranks can be very uneven. For example, let's pretend you are a fifth-grade teacher and you have to pick three students to compete in the school spelling bee. You have two dynamite spellers whom you quickly choose as your first and second choice—Nicole and Kevin. Sadly, the rest of your class is "spelling challenged." You pick the

01-Kurpius-4689.qxd 7/11/2005 7:44 PM Page 3

What Is a Number? Is a Rose Always a Rose?   **3**

Spelling				
Challenged	Sarah			Kevin Nicole
IIIIIIIIIIIII II II I_____I_____I_____I____				
				Best Spellers

best of this group, and Sarah becomes your third spelling bee contestant. While there is minimal difference between Nicole and Kevin, Sarah is a long way behind them. These differences are not reflected in their ranks of 1, 2, and 3. Therefore, when your measurement data are ordinal, make any interpretations cautiously.

Interval

The most commonly used scale in measurement in the social sciences is the *interval scale.* Interval measurement scales are based on a continuum where the interval (or distance) between any two numbers is always the same. The intervals are equal to each other. Intervals can be any size, but in measurement the interval often is set at the unit 1. For example, if we were to give Nicole, Kevin, and Sarah a 100-word spelling test and their scores were 98 for Nicole, 97 for Kevin, and 80 for Sarah, we can say exactly how much higher Nicole scored than did Kevin (1 point) and Sarah (18 points).

Other times, however, the interval is set to include smaller pieces of information. Everyone knows that 1 inch contains smaller measurements, such as 1/2 inch, 1/4 inch, or 1/8 inch. All of us report our height in feet and inches and often in parts of inches. On a spelling test, however, you can't get half a word right. But, if you are taking an essay test, your professor may award you part of a point for getting close to the answer (at least we hope professors look on your ideas with a generous spirit).

Interval measurement scales can be manipulated mathematically to produce meaningful results. For example, in this class you're going to take a couple of tests, at least a midterm and a final. Your professor can calculate the average for the midterm and for the final for the entire class and compare your midterm and final scores to the class average for each test. Your professor also can calculate your average across the two tests. Each of these resulting numbers has meaning. Let's say you got 78 out of 100 possible points on your midterm. The mean for the class was 82. Realizing you needed to study harder, you pulled 92 out of 100 possible points on your final, and the class average for the final was 86 (we assumed almost everyone studied harder). You scored 4 points below the class average on the midterm ($82 - 78 = 4$) and 6 points above the class average on the final ($92 - 86 = 6$). The class average across the two tests was 84 [$(82 + 86)/2 = 84$] and your average was 85 [(78 +

92)/2 = 85]. Your average score was only 1 point (85 – 84 = 1) above the class average for the course.

As you can see, interval scores make sense when they are added, subtracted, multiplied, or divided. Knowing this, please, please study harder for your midterm.

Ratio

The most advanced, the most sophisticated, the most precise measurement scale is the *ratio scale.* The ratio measurement scale is distinguished from the interval measurement scale by the fact that it has an absolute, true zero that has meaning. An absolute zero means there is nothing present of the variable that is being measured. Death is the absolute absence of a life force. It is a true zero, even though Billy Crystal in *The Princess Bride* proclaimed the hero as "mostly dead." Other than death when studying people, it is rare to have an absolute zero in the social sciences.

Less interesting (we think) textbooks provide examples of zero-degree temperature and zero distance as absolute zeros on temperature and distance scales. We offer the example of a 100-word vocabulary assignment, and you have not learned one word. This is an absolute zero *with respect to the assignment* (and may reflect your grade if you don't get going). In the ratio scale, every measurement unit is equal. So if you learn the meaning of 50 words, you're halfway there.

The social sciences seldom use ratio scales since an absolute zero is so difficult to define. As Salkind (2004) pointed out, "Even if you score a 0 on that spelling test or miss every item on an IQ test (in Russian), it does not mean that you have no spelling ability or no intelligence" (p. 277). Similarly, even if you score 0 on the vocabulary test, this doesn't mean you have no vocabulary.

Like interval scales, ratio measurement scales can be mathematically manipulated and yield meaningful results. Using the vocabulary assignment above, you ended up memorizing 81 words and five of your classmates each memorized 100 words, and one person didn't do the assignment (absolute zero). The class memorized an average of 83 words [(81 + 100 + 100 + 100 + 100 + 100 + 0)/7 = 83]. The person who didn't do the assignment lowered the class average. The real advantage of a ratio scale is that you can accurately say things such as something is "twice as much" or "half as much."

Some Final Thoughts About Scales of Measurement

Scales of measurement are not all the same. They vary from simply naming a variable (nominal scales) to being able to provide information (interval and ratio scales) that can be mathematically manipulated. We use nominal

01-Kurpius-4689.qxd 7/11/2005 7:44 PM Page 5

What Is a Number? Is a Rose Always a Rose? **5**

scales to label people or things. In the behavioral or social sciences we most frequently use interval and ordinal measurement scales, because they are a good fit for the kind of information or numbers (also called *data*) that are used in the behavioral or social sciences. Ratio scales have a very stringent requirement—they must have a true zero. Even though we used exam scores as one of our examples to explain ratio scales, having absolutely no knowledge of what is being tested would be most unusual. Knowing absolutely nothing would be a true zero only with respect to this one test. In some ways, we have created an artificial "true" zero. (Can you really create something that's artificially true? As we said in our introduction, we're the good witches, so we have this power.)

To help you remember these four measurement scales, let's consider the following example. As a student you have a very limited budget. But you and your roommate eat peanut-butter-and-jelly sandwiches for a semester so you can go to Europe for 1 month during the summer. You buy a travel guidebook that classifies restaurants as $ (Cheap), $$ (Moderate), or $$$ (Expensive). This is ordinal level data and gives you a general idea of cost. Common sense tells you that you'll probably get your best meals at a $$$ restaurant, next best at $$ restaurant, and stave off hunger at the $ restaurant. Quality of meal is also ordinal data. Since you have to budget your money, it would be much more helpful if the guidebook had given actual prices (interval or ratio data) for each of these three classifications. If you spend no money on food, you automatically have a true zero (and will probably starve). Considering that the monetary unit (e.g., Euros) is a counting unit with equal intervals between amounts, you can divide your money so that you can eat at both cheap and expensive restaurants. Because money is a ratio scale, you can mathematically manipulate it.

Let's Check Your Understanding

Before we introduce you to response formats, let's make sure you're getting the hang of this.

1. What is a nominal scale?

   _____

   _____

2. What is an ordinal scale?

   _____

   _____

3. What is an interval scale?

    _____

    _____

4. What is a ratio scale?

    _____

    _____

5. Which of these scales cannot be manipulated mathematically?

    _____

    _____

Our Model Answers

1. What is a nominal scale?
    A nominal scale is used to name or label things or categories.

2. What is an ordinal scale?
    An ordinal scale orders or ranks things.

3. What is an interval scale?
    An interval scale presents a continuum of numbers where the interval between each number is equal.

4. What is a ratio scale?
    A ratio scale is an interval scale with an absolute true zero.

5. Which of these scales cannot be manipulated mathematically?
    You cannot meaningfully mathematically manipulate nominal-level scales.

Numbers and Response Formats

When we're gathering measurement data, we ask questions and get answers. What types of answers are possible reflects a format for responding. For example, sometimes when we measure variables, we ask people to respond in their own words. We call these responses open-ended because people can say anything they wish to answer the question. Other times, we

want specific answers, so we provide a series of possible answers for them to choose from. When we limit response options, the response formats are dichotomous or continuous. This allows us to mathematically manipulate their responses in order to understand patterns of responding across people.

Dichotomous Responses

Sometimes we like to corner people and ask them to make a choice between yes or no, black or white, good or bad, like me or not like me, or to report whether something is true about them. When we do this, the response format is *dichotomous*. There are only two choices. There is no middle ground.

Let's look at the following example to illustrate our point. An instrument frequently used to measure stress asks whether specific events have been experienced in the past month. Some of the events include having a flat tire, breaking up with a boy- or girlfriend, or visiting a doctor. Ryan, a college freshman who has had difficulty adjusting to college life and is thinking about quitting, goes to the student counseling center. He takes an academic stress scale and has to respond "yes" or "no" to each statement. Each item has a truly natural dichotomous response format because the event either did or didn't happen to Ryan in the past month.

Other tests also use a dichotomous response format, but the response options are not natural dichotomies; they are forced-choice dichotomies. For example, a well-known social support instrument asks questions such as "I rely on my friends for emotional support" and "My friends seek me out for companionship." The only response options you have to these two statements are "yes" or "no." In reality, more accurate responses would reflect gray areas between yes and no. Ryan tells his counselor that he relies on friends for emotional support sometimes but not always. Further-more, some of his friends are fickle and may ask someone else to go out with them. The yes-or-no-response format doesn't allow for his friends' inconsistencies.

Continuous Responses (Likert Scales and Their Cousins)

In its simplest form, *continuous responses* allow for three or more choices that increase in value. Now, back to Ryan . . . Let's say you're still trying to pin Ryan down about his friends, but he is faster afoot than you are. You demand, "Do your friends seek you out for companionship?" Ryan says,

"Some of the time." While this response is not as clean as "yes" or "no," it gives us more information about Ryan's social support system. The response "Some of the time" is only one of multiple choices when a *Likert-type response format* is used.

Likert-type scales allow for a continuum of responses. Typically, they allow for five, seven, or nine responses. For example, you may be asked to what extent you agree with the statement, "It has been difficult for me to meet and make friends with other students." The five-point response format would range from:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

It is also possible that the five-point response format could range from:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4

Both of these examples, regardless of the numerical values assigned, depict five-point Likert-type response formats.

The two end points are called anchors. The seven-point and nine-point response formats would have the same anchors, but the middle points frequently are not labeled. Other common anchors are "Not at all" and "Completely"; "Not at all" and "A great deal"; and "Never" and "All of the time." Sometimes the numerical values assigned to the responses range from 1 to 7 or 0 to 6 for a seven-point Likert-type scale. When a nine-point scale is used, the range may be 0 to 8 or 1 to 9. There is no rule about assigning of numerical values except that the numbers must be in the numerical order that produces a continuum and are ordinal-level data. Remember the goal is to make sense of the numbers.

Likert scale cousins typically leave out the middle choice, thus forming a forced-choice response. For example, the Rosenberg Self-Esteem Scale (1979) uses a four-point response format. The response options are:

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

If our good friend, Ryan, was also taking this test, he would have to choose among these four answers. No middle-of-the-road cop-outs would be allowed!

Some Final Thoughts About Response Formats

Response formats for assessment instruments typically take three forms: open-ended, dichotomous, and continuous. We are most interested in the latter two.

Snapshots

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Figure 1.1   Response Formats

- Dichotomous responses have only two options. "Open wide! It's your tooth or your pain" is a natural dichotomy even though you are forced to make a choice between your tooth and your pain. If you don't answer, the dentist may ask, "How bad is your pain anyway?" Your response, "On a scale of 1 to 7, my pain is about 5," reflects a continuous response format.

- Continuous responses add texture and allow shades of gray interpretations.
- Both dichotomous and continuous responses can be mathematically manipulated to yield interesting information about people or things being measured.

Let's Check Your Understanding

1. Dichotomous response format allows for _____ response options.

2. The two types of dichotomous response formats are _____ and _____.

3. A response format that allows for more than two choices is _____.

4. A Likert-type response format is a _____ response format.

5. The most typical number of Likert response options are _____, _____, and _____.

6. A typical set of anchors for Likert response options might be _____ and _____.

Our Model Answers

1. Dichotomous response format allows for **two** response options.

2. The two types of dichotomous response formats are **natural dichotomies** and **forced dichotomies.**

3. A response format that allows for more than two choices is **continuous.**

4. A Likert-type response format is a **continuous** response format.

5. The most typical number of Likert response options are **5, 7, and 9.**

6. A typical set of anchors for Likert response options might be **strongly disagree and strongly agree. Other anchor pairs might include "not at all" to "completely"; "never" to "all the time"; or "not at all" to "a great deal."**

01-Kurpius-4689.qxd 7/11/2005 7:44 PM Page 11

What Is a Number? Is a Rose Always a Rose?   **11**

Numbers and Test Scores—How Do They Relate?

In case you weren't paying attention when you read "A Note to Students" at the beginning of this book, let's review what a test is. A *test* is a sample of behavior or characteristic at a given point in time. For the purposes of this book, we are interested in measurement concepts related to test scores that are numerical. Measurement of open-ended responses presents a completely different set of issues beyond the scope of this book. Sorry, but we won't be discussing them even though they can be very enlightening.

It's time to tie the ideas in this chapter together to solidify your understanding. These ideas are the building blocks for the rest of this book. First, when taking a test, people are expected to respond in some way. While we are interested in dichotomous or continuous response formats, we are absolutely fascinated with total test scores and their characteristics. You're probably thinking right now, "They need to get a life!"

To prove to you how interesting total test scores can be, let's revisit Ryan. A counselor at the student counseling center gave Ryan an instrument to measure stress. He had to respond "yes" (scored 1) or "no" (scored 0) to each statement on the instrument. When all his "yes" responses are added, his total score, which is interval-level data, is a reflection of the accumulation of stressful events in Ryan's life. Theory tells us the more stressful events that occur in a short time period, the more likely the individual, in this case Ryan, is to report feeling stressed. Being caring, empathic people, of course we are concerned about our friend Ryan feeling stressed and we don't want him to quit school. The counselor can look at Ryan's total stress score and then at individual items to target areas to help Ryan cope with college life better.

Ryan also took a social support instrument that had a forced dichotomy response format. In spite of the response format being forced, Ryan's total score reflects his perceptions of social support. This total score is interval-level data that can be mathematically played with and tells the counselor whether Ryan needs to work on expanding his social network.

Total scores from the social support and stress instruments are interval-level data. Even if someone answered "no" to every item on each test, this would not be interpreted as an absolute absence of social support or stress. On both tests, scores of 0 do NOT reflect an absolute zero with respect to the constructs stress and social support.

See, we told you total test scores could be interesting. Hopefully, by the end of this class, you too will be interested in test scores and their measurement. A few of you may even become fascinated.☺

Some Final Thoughts About Measurement Scales and Response Formats

Test responses can form nominal, ordinal, interval, or, on rare occasion, ratio scales. Depending on what you're trying to find out, you will choose questions or tests that give you the type of data that best answers your questions. Remember the U.S. census? If you wanted to know the racial or ethnic minority population in the United States, what type of scale do you want? THAT'S RIGHT—Nominal! Next, if you wanted to rank racial or ethnic minority groups from the largest to the smallest, what type of scale do you want? Before you jump to an answer, look at the question again. The key words are *largest* and *smallest*. These words key you that we are going to look at order; therefore, you want an ordinal scale. Finally, if you wanted to know the actual numerical size of the largest and smallest racial or ethnic minority group, what type of scale do you want? Hint: Two answers are possible. Both interval and ratio level scales would provide you with meaningful numbers that would allow you to give exact sizes. You could even calculate the difference in number of people between the largest and smallest racial or ethnic minority groups (as well as all of the groups between the largest and smallest). As an aside, ratio would be the best answer if every single racial or ethnic minority person in the United States had completed the census, since that would allow us an absolute zero. Being realists, we realize that not everyone completed the census. Therefore, the most appropriate scale is interval.

For each of the three census questions above, we used numbers and scales to arrive at meaningful answers. That is what testing is all about—using numbers that are appropriate for the issues being addressed to arrive at information that can guide our decisions and behaviors. Knowing that this information is actually going to impact your decisions and what you do, you want these numbers to be as accurate and truthful as possible.

Key Terms

To help you review the information presented in this chapter, you need to understand and be able to explain the following concepts. If you are not sure, look back and reread.

- Test
- Measurement scales
  - Nominal scale
  - Ordinal scale
  - Interval scale
  - Ratio scale

01-Kurpius-4689.qxd 7/11/2005 7:44 PM Page 13

What Is a Number? Is a Rose Always a Rose?   **13**

- Response format
  - Dichotomous response format (natural or forced)
  - Continuous response format
- Anchors
- Total score

Models and Self-instructional Exercises

Our goal is to have you master the concepts we presented and to use the concepts appropriately in answering questions or solving problems related to measurement. In this chapter, which presented some basic measurement concepts, we gave you lots of examples to illustrate these concepts. Before we see what you've learned, we're going to model for you how to use the concepts we just introduced and then give you a chance to practice. When reading our model, try to answer the questions before you look at our answers.

Our Model

The process of transitioning from high school to college is difficult for many students. One factor that eases this transition is becoming involved on campus. As a student affairs employee at ABC University, you are charged with finding out why some students dropped out (nonpersisters) and some stayed enrolled (persisters).

1. If you grouped students by their persistence, what kind of scale have you created?

   _____
   _____

2. If you asked them whether they lived on-campus, off-campus, or with family, what kind of scale would you have?

   _____
   _____

3. You asked them whether or not they had joined a variety of activities on campus, and they answered yes ("1") or no ("0").
   a. What kind of response format is this?

      _____
      _____

   b. When you add up their responses, what kind of scale are you creating?

      _____
      _____

4. If you have them respond on a five-point Likert scale as to how involved they are in each activity they belong to, what kind of scale are you creating?

_____

_____

Our Model Answers

1. If you grouped students by their persistence, what kind of scale have you created?

   You have created a nominal scale with two categories: persisters and nonpersisters.

2. If you asked them whether they live on-campus, off-campus, or with family, what kind of scale would you have?

   Surprise, you still have a nominal scale—with three categories this time.

3. You asked them whether or not they had joined a variety of activities on campus, and they answered yes ("1") or no ("0").
   a. What kind of response format is this?

   This is a dichotomous response format.

   b. When you add up their responses, what kind of scale are you creating?

   You are creating a ratio scale, because there is a true zero if they belong to no campus activities.

4. If you have them respond on a five-point Likert scale as to how involved they are in each activity they belong to, what kind of scale are you creating?

   You are creating an ordinal scale.

Now It's Your Turn

Too many American children are becoming addicted to tobacco at an early age. National data tell us that age of first experimentation with cigarettes is between 9 and 11 years old. This is a grave concern because earlier initial use is directly linked to stronger addiction and serious health complications as adults. As measurement specialists, you are asked to assess cigarette use in a large metropolitan school district (they will even pay you). You decide to administer the Adolescent At-Risk Behaviors Inventory (Robinson, 1992), not only to look at tobacco use but also to provide the school district with information about other at-risk behaviors. One series of questions asks the students whether they have tried tobacco or cigarettes, alcohol, and/or other drugs. A second series of questions asks about

01-Kurpius-4689.qxd 7/11/2005 7:44 PM Page 15

What Is a Number? Is a Rose Always a Rose?   **15**

frequency of use, with response choices being never, sometimes, often, and frequently. A third set of questions asks students to indicate how many cigarettes they smoke each day and each week. They were given six response options ranging from no cigarettes per day, 1 to 4 cigarettes per day, 5 to 8, 9 to 12, 13 to 16, and 17 to a full pack (20 cigarettes) per day. This question is paralleled with questions about drug and alcohol use. Based on these test questions, you are able to classify kids as smokers or nonsmokers, alcohol users or nonusers, and drug users or nonusers.

1. When students indicate whether or not they use tobacco or cigarettes (or alcohol or drugs):
   a. What type of response format is being used?

   _____

   _____

   b. Why would you choose to use this response format?

   _____

   _____

   c. What type of measurement scale is being used?

   _____

   _____

2. You would also like to be able to determine whether or not each student is "at-risk" for substance use. Substance use is defined as use of tobacco or cigarettes and/or alcohol and/or drugs.
   a. How would you go about creating dichotomous categories for substance use?

   _____

   _____

   b. Is this a natural or forced dichotomy and why?

   _____

   _____

3. Although in reality use of tobacco or cigarettes, alcohol, and drugs is not equivalent in terms of at-risk behaviors, for the sake of our measurement questions, let's pretend it is. Using this assumption,
   a. How would you create a scale that would rank order at-risk behaviors from "not at risk" to "high risk"? (Here is a hint: The lowest rank, "not at risk," would reflect no at-risk behaviors related to substance use.)

_____

_____

    b. What type of measurement scale have you created?

_____

_____

4. The second series of questions about frequency of use has
    a. What type of response format?

_____

_____

    b. This response format reflects what type of measurement scale?

_____

_____

5. If we assigned a 0 to "never," a 1 to "sometimes," a 2 to "often," and a 3 to "frequently," we have created what kind of measurement scale?

_____

_____

6. The most specific data are provided in the questions asking how many cigarettes they smoke each day and each week. Using these questions,
    a. What type of response format is used?

_____

_____

    b. What kind of measurement scale was created?

_____

_____

Our Model Answers

Now it is time to see if you have started thinking like measurement specialists. Come on now, that's not a bad thing. Below are model answers to each of the questions we asked you to solve. Compare your answers to ours and pat yourself on the back when you are right. Don't feel

01-Kurpius-4689.qxd 7/11/2005 7:44 PM Page 17

What Is a Number? Is a Rose Always a Rose?   **17**

badly if you aren't right. This is still a learning experience. Look at our answer and modify your thinking, so next time you'll arrive at the correct answer too.

1. When students indicate whether or not they use tobacco or cigarettes (or alcohol or drugs):
    a. What type of response format is being used?
        Dichotomous response format is being used.
    b. Why would you choose to use this response format?
        A dichotomous response format was chosen because we were only interested in whether tobacco or cigarettes were used (yes) or not (no). Similarly, we are only interested in whether or not alcohol or drugs were used.
    c. What type of measurement scale is being used?
        A nominal measurement scale is being used because we are categorizing students as smokers or nonsmokers (or alcohol users or nonusers, or drug users or nonusers). We have named them.

2. You would also like to be able to determine whether or not each student is "at-risk" for substance use. *Substance use* is defined as use of tobacco or cigarettes and/or alcohol and/or drugs.
    a. How would you go about creating dichotomous categories for substance use?
        First, you want to create two categories. For clarity name them "substance use" and "substance nonuse." Then, if a student answered "yes" to any of the questions that asked whether or not they used tobacco or cigarettes, alcohol, or drugs, the student will be placed in the "substance use" category. If they answered "no" to all three questions, they are placed in the "substance nonuse" category.
    b. Is this a natural or forced dichotomy and why?
        This is a forced dichotomy because whether the student used just one substance or two substances or all three, he or she was placed in the "substance use" category.

3. Although in reality use of tobacco or cigarettes, alcohol, and drugs is not equivalent in terms of at-risk behaviors, for the sake of our measurement questions, let's pretend it is. Using this assumption,
    a. How would you create a scale that would rank order at-risk behaviors from "not at risk" to "high risk"? Here is a hint: The lowest rank, "not at risk," would reflect no at-risk behaviors related to substance use.
        First, to answer this question you have to look at the response options for each of the three substances. If students answer "no" to all three questions about whether they use each substance, they would be placed in the "not at risk" category. If they reported using

18   TESTING AND MEASUREMENT

one of the three substances, they would be placed in a next higher category, which might be labeled "somewhat at risk." If they reported using two of the three substances, they would be placed in an even higher category, which might be labeled "moderately at risk." Finally, if they reported using all three substances, they would be placed in the highest at-risk category, labeled "high risk." Voila, you have successfully created graduated categories of substance use.

b. What type of measurement scale have you created?

The measurement scale is ordinal because it is on a continuum of increased usage without the amount of usage being taken into consideration.

4. The second series of questions about frequency of use has
   a. What type of response format?

   This is a continuous response format because there are four response options that fall along a continuum from never to frequently.

   b. This response format reflects what type of measurement scale?

   This reflects an ordinal measurement scale because it reflects qualitative differences in frequency of use but does not specify exact differences between the four response options.

5. If we assigned a 0 to "never," a 1 to "sometimes," a 2 to "often," and a 3 to "frequently," we have created what kind of measurement scale?

   We have created a Likert-type scale with the assumption of *interval* equivalence for both labels and their assigned numbers.

6. The most specific data are provided in the questions asking how many cigarettes they smoke each day and each week. Using these questions,
   a. What type of response format is used?

   Students were given six response options ranging from no cigarettes each day to up to 17 to 20 cigarettes per day. These response options reflect a Likert-type (continuous) response format.

   b. What kind of measurement scale was created?

   Because some students smoke no cigarettes (absolute zero) and because the other responses are continuous, the measurement scale is ratio level.

Words of Encouragement

Phew!!! What a challenge that was! But by now you are experts on response formats and measurement scales. And even more important, you've started to use this knowledge to address measurement problems. Congratulations!! You've come a long way in a short time period.☺