Teaching Statistics and Research Methods:
A Collection of Hands-on Activities and Demonstrations

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Overview

Many educators advocate the incorporation of more active learning techniques into the traditional lecture; for instance the use of hands-on activities (Wenglinsky, 2000), cooperative learning assignments (Gokhale, 1995), and student projects (Chance, 1999) represent several innovative strategies for enhancing student motivation and performance. Specifically, hands-on activities and demonstrations allow students to construct their own understanding of statistics concepts by actively engaging the course material.

This resource outlines 9 stand-alone activities and demonstrations that can be used in relatively small (i.e., less than 50 students) introductory statistics and research methods courses. For each activity, we provide its purpose, a summary of the critical procedural steps, the estimated time needed to complete the activity, and a list of materials needed. For a few of the activities, we provide a worksheet for students to complete alone or in groups.

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References

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Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education, 7*(1), 22-30.

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ACTIVITY 1. A Tale of a Population and Two Samples

Summary:

This hands-on activity enables students to grasp the relationship between a population and a sample.

Courses:

Introductory statistics, research methods, and introduction to psychology courses.

Class Time Involved:

Approximately 40 min to complete and discussion the activity.

Materials Needed:

A table of random numbers

Set-up:

Prior to the activity, have students take a short quiz. One of our favorite quizzes uses questions from the popular show "Are You Smarter than a Fifth Grader?" Score each paper and compute the population mean for use during the next class period.

Procedure:

Step 1: On the day of the activity, return the scored quiz papers and write the population mean on the board. Next, tell students that you will randomly select, from the members of the class, two samples comprised of five individuals each. Assign each student a number from 1 to *N* (e.g., if there are 30 students in the class, assign the numbers 1-30). Beginning anywhere in a table of random numbers, move down two digits at a time (because *N* is a two-digit number). Record the first 10 nonrepeating numbers that correspond to a number assigned to students in the class, skipping numbers that do not correspond to a number from 1 to *N*. For example:

Random numbers

<u>26</u>	<u>28</u>	<u>30</u>	44	<u>25</u>	<u>01</u>	72	85	93	<u>05</u>	<u>09</u>	57
98	<u>27</u>	68	87	60	80	51	88	<u>12</u>	97	<u>26</u>	

Sample 1	Sample 2
26, 28, 30, 25, 01	05, 09, 27, 12, 26

Step 2: Collect the quiz papers from the members of the two samples and place the data on the board. Have the class compute the sample means for these data.

Step 3: End this activity with a discussion of concepts related to a population and a sample. For example, discuss the difference between a population of scores and a sample of scores; the relationship between a population and a parameter, and a sample and a statistic; the distinction between a constant and a variable; and the relationship between a random sample and a representative sample.

ACTIVITY 2. Read All About It

Summary:

This activity facilitates student understanding of the different levels of measurement.

Courses:

Introductory statistics and research methods courses.

Class Time Involved:

Approximately 30 min.

Procedure:

Ask students to bring a magazine or newspaper to class. Popular magazines such as *People*, *Newsweek*, and *Time* work well. Explain that they are to peruse their reading material, paying special attention to examples of the different levels of measurement presented in the magazine or newspaper. Have students identify and briefly discuss at least one example of nominal, ordinal, interval, and ratio scales. End this activity with a discussion of student examples.

ACTIVITY 3. Music and Memory

Summary:

This activity is designed to help students understand the major components of a true experiment.

Courses:

Research methods, introduction to psychology, and introductory statistics courses.

Class Time Involved:

Approximately 50 min.

Material Needed:

A list of 10 words, two selections of music from different genres (e.g., classical music and country music), a CD, Cassette player, or computer that plays music files, a stopwatch, and a table of random numbers

Procedure:

Step1: Tell the class that they will participate in a mini-experiment. Pose the following question: “Does listening to classical music improve memory?” Briefly discuss the “Mozart Effect” and the contradictory findings regarding the link between music and memory.

Step 2: Inform students that you will randomly select from the members of the class two samples of five individuals each; one group will listen to a selection of classical music, and the other group will listen to a selection of country music.

Step 3: Assign each student a number from 1 to *N* (e.g., if there are 30 students in the class, assign the numbers 1-30). Beginning anywhere in the table, move down two digits at a time (because *N* is a two-digit number). Record each nonrepeating number that corresponds to the number of students in the class, skipping numbers that do not correspond to a number from 1 to *N*. For example:

Random numbers

26	28	30	44	25	01	72	85	93	05	09	57
98	27	68	87	60	80	51	88	12	97	26	

Sample

26, 28, 30, 25, 01, 05, 09, 27, 12, 26

Step 4: To assign randomly the 10 individuals to either the classical music group (assign this group a value of 1) or the country music group (assign this group a value of 2) again, use a table of random numbers. Find a starting point on the table. Record digits of 1 and 2 in blocks of two, ignoring digits that already appear in the block. Continue this process until five blocks of two are complete. Next, assign the individuals who comprise the sample to one of the two groups. For example:

Random Numbers

75	40	19	15	11	17	53	48	13	90	18	10
10	42	82	70	66	42	79	15	93	81	36	42
77	91	33	78	41	94	38	98	03	06	13	32
57	53	32	48	45	63	51					

Blocks of two digits

1 2; 2 1; 1 2; 1 2; 2 1

Group assignments

26(1), 28(2), 30(2), 25(1), 01(1), 05(2), 09(1), 27(2), 12(2), 26(1)

Step 5: After assigning individuals to the two groups, have the classical music group wait in the hall until called. Read the following instructions to the country music group:

To test the hypothesis that students who listen to classical music will recall more words on a memory task than students who listen to country music, I will read to you a list of 10 words. While I am reading these words, you are not to write anything. After I have finished reading the 10 words, you will listen to 2 min of a classical song. After the 2 min, write down as many words as you can remember from the list of 10 words read to you. You will then count the number of words you were able to remember from the list.

Step 6: After reading the instructions, read the list of 10 words, approximately one per second.

Step 7: Play a 2-min selection from a country song.

Step 8: Prompt students to write down as many words as they can recall. Allow approximately 3 min to complete this task.

Step 9: Have students who did not participate in the study score the papers of the country music group. Re-read the list of 10 words and ask students to tally the number of words correctly recalled. Place these data on the board.

Step 10: Call the classical music group in from the hall. Repeat steps 5-9 with the classical music group.

Step 11: Distribute the following worksheet for students to complete alone or in pairs.

End the activity with a discussion of the worksheet.

Music and Memory Worksheet

1. State the hypothesis.

2. Why is random sampling important in an experiment?

3. Why is random assignment necessary in experimental research?

4. What was the independent variable in this study?

5. What was the dependent variable in this study?

6. Is the independent variable discrete or continuous?

7. Is the dependent variable discrete or continuous?

8. On what scale of measurement is the independent variable measured?

9. On what scale of measurement is the dependent variable measured?

10. List two variables that were held constant. Why is this important in experimental research?

11. Compute the mean for the classical music group.

12. Compute the mean for the country music group.

13. Discuss your findings in a few sentences.

14. Discuss possible alternative explanations for the findings.

Alternative Assessment: You could assigned a lab report consisting of a brief introduction, method, results, and conclusion.

ACTIVITY 4. Graphing It

Summary:

This activity is designed to help students understand different methods for displaying data.

Courses:

Introductory statistics and introduction to psychology courses.

Class Time Involved:

Approximately 40 min.

Set-up:

Prepare a data sheet consisting of data from topics that have widespread appeal and represent various scales of measurement. Examples include the number of gold, silver and bronze medals won by the United States during the last Olympic games; a distribution of test scores, or campus crime statistics.

Procedure:

After a brief class discussion of frequency distributions and graphs, distribute the data sheet. Encourage students to think about when it is appropriate to use each type of graph to summarize and organize data. Next, have students create a graph to summarize the data. Finally, have students read and interpret each graph. For example, you could distribute the following data table and ask, “What percentage of the medals won were silver?”

Medals Won by the United States during the Last Olympic Games		
Gold	Silver	Bronze
36	38	36

ACTIVITY 5. The Dating Survey

Summary:

This activity is designed to help students understand the purpose and function of the different measures of central tendency and variability.

Courses:

Introductory statistics and research methods courses.

Class Time Involved:

Approximately 30 min to brainstorm and generate a brief survey and 30 min to complete the activity.

Set-up:

Depending on your school's policies, you may need to get approval from your university's Institutional Review Board before you collect data. Alternatively, students can obtain data from class members

Procedure:

Brainstorm with students several questions related to dating. Then generate survey items that would address those questions. Survey items we have used are "The guy should always pay for the first date," "It is appropriate to go to your date's room or apartment on the first date," and "It is acceptable to date multiple people at the same time as long as all parties are aware of it." Have each student distribute the survey to 2-3 individuals and bring the completed surveys to class the following class period. Create a spreadsheet of the raw data and compute a total score for each respondent. Higher scores represent more liberal views on dating, whereas lower scores represent more conservative views. End the activity with a discussion of the following items:

1. Discuss the appropriateness of each measure of central tendency
2. Compute the mean, median and mode for the total score as well as for each item.
3. Which measure of central tendency is most appropriate given the data above? Explain your answer.
4. Compute SS, variance, and standard deviation for the total score and for each item.

Alternative Assessment: To make this activity more relevant to a research methods class, select a random sample of surveys and discuss issues related to sampling bias, representative samples, and so on. Instructors can also discuss survey research and the importance of effective survey construction.

ACTIVITY 6. Are You Ready for Some Football?

Summary:

This activity is designed to facilitate students' understanding of the concept of variability, in particular standard deviation. This particular activity may not appeal to all students, but instructors can substitute some other data set.

Courses:

Introductory statistics, research methods, and introduction to psychology courses.

Class Time Involved:

Approximately 40 min.

Materials Needed:

Quarterback data sheet (sample appears on the next page).

Set-up:

Create a data sheet of football statistics for two NFL quarterbacks playing during the same time period. We have used the passing data of Donovan McNabb and Peyton Manning from 1999-2007.

Procedure:

Distribute a data sheet to each student. Tell students that this activity will facilitate their understanding of variability, in particular, standard deviation. Encourage students to respond to the following items:

1. Compute the average number of touchdown passes thrown by McNabb and Manning from 1999-2007.
2. Compute the standard deviation for touchdown passes thrown.
3. What does the standard deviation tell you about the spread of scores in the distribution for each quarterback?
4. In any given year, which quarterback can you count on to consistently throw passes close to his average, McNabb or Manning?

At the conclusion of this activity, discuss the answers as a class.

Data Sheet:

	Touchdown Passes Thrown	
Season	Donovan McNabb	Peyton Manning
2007	19	31
2006	18	31
2005	16	28
2004	31	49
2003	16	29
2002	17	27
2001	25	26
2000	21	33
1999	8	26

ACTIVITY 7. The Alphabet Game

Summary:

This activity is designed to help students understand the purpose and function of *z* scores.

Course:

Introductory statistics courses.

Class Time Involved:

Approximately 10 min to complete the activity and 40 min to complete and discuss answers related to *z*.

Procedure:

Tell students the activity will facilitate their understanding of *z* scores. Have students write the letters A through Z down the left of a blank sheet of paper. Instruct them to write down one psychologically related term, concept, or name for each letter of the alphabet. For example, A = Gordon Allport or altruism; B = Albert Bandura or behaviorist. At the end of 5 min, collect the papers and count the number of correct terms for each letter. Create and distribute a spreadsheet of the data during the next class period. Encourage students to provide answers to the following items:

1. Compute the mean and standard deviation for the distribution of scores.
2. Transform the distribution of scores into a *z*-score distribution.
3. Discuss the characteristics of a *z*-score distribution.
4. What is the mean of a z-score distribution?
5. What is the standard deviation of a *z*-score distribution?
6. Compute and interpret the *z score* for your raw score.

ACTIVITY 8. A Bag of Skittles™ and Probability

Summary:

This hands-on group activity is a fun way to introduce students to basic concepts related to probability.

Courses: Introductory statistics.

Time Involved: 40 min.

Materials needed:

A bag of Skittles candy for each group of 3-4 students.

Procedure:

After a brief lecture on probability, divide students into groups of 3-4. Provide each group with a bag of Skittles candy. Next, distribute a worksheet (see sample below) and have students, as a group, provide answers to questions related to probability. Discuss the answers.

Worksheet:

Probability Worksheet

Key Terms

Sample	Sampling with Replacement	Independence
Addition Rule	Sampling without Replacement	Mutually Exclusive
Population	Sample Space	
Random Sample	Multiplication Rule	

Using the concepts above, fill-in the blanks; all concepts will be used.

1. The entire bag of Skittles can be considered a ____________________ whereas the selection of one red Skittle would be the _______________.
2. That every Skittle in the bag has an equal chance of being selected is one requirement of a ____________. The second requirement, constant probability, demands _________________, which involves the replacement of each member of the sample back into the population before the next selection. For example, if you select one Skittle from the bag, you record the color and return the candy to the bag before making a second selection.
3. If you were interested in determining the probability of selecting a red Skittle or a yellow Skittle from the bag, you would use the ______________. Because a skittle cannot be both red and yellow, these events are said to be ___________.

Using your bag of Skittles, answer the following questions:

1. How many Skittles make up the population?
2. How many red, yellow, purple, etc. Skittles are in the bag?

3. What is the probability of selecting a Skittle that is not red?
4. What is the probability of selecting a yellow Skittle or a purple Skittle?
5. What is the probability of selecting three orange Skittles from the bag?

ACTIVITY 9. The Envelopes Please

Summary:

This activity facilitates understanding of concepts related to probability, especially randomness and sampling without replacement.

Materials Needed:

Five white envelopes, five blank pieces of paper about the same size as a dollar bill, an opaque bag.

Courses: Statistics courses.

Class Time Involved:

30 min.

Set-up:

Prior to the activity, write the words “dollar bill” and “gift card” on two of the blank pieces of paper. Insert these slips of paper into separate envelopes. Insert blank slips of paper in the three remaining envelopes. Place the five envelopes into the opaque bag.

Procedure:

Tell students that they will answer questions related to probability. Invite a student to select one of the five envelopes from the bag. Ask the class to determine the probability of selecting the following:

- The envelope containing the dollar bill.
- The envelope containing the gift card.
- The envelope containing neither the dollar bill nor the gift card.
- An envelope containing either the dollar bill or the gift card in one selection.
- On two successive selections, the dollar bill and the gift card (in either order).

Next, ask the student to open the envelope and display its contents. Invite a second student to select an envelope from the bag. Again, ask the class to state the probability of the student selecting the envelop containing the $1.00 bill (if not selected by student #1), the gift card (if not selected by student # 1); at least one of the prizes (if neither prize is selected by student #1). The point here is to discuss with students the concepts of randomness and sampling without replacement.