

Poker Chip People: Using Manipulatives in a College Level Statistics Course

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# Introduction

**Background Information**

Statistics is typically one of the most difficult courses for psychology majors to complete and for faculty to teach (Conners, McCown, & Roskos-Ewoldsen, 1998). Research indicates that one effective way to teach statistics is through the use of active learning strategies where students are tasked with actively applying their knowledge (e.g., Carlson & Winquist, 2011). In fact, a number of student-centered resources have been created to help students better learn the statistical concepts that underlie the field (e.g., Society for the Teaching of Psychology [STP] resources). However, many of these hands-on strategies are stand-alone activities that do not allow students to use the same problem or dataset to examine multiple statistical concepts, or they use objects to simulate data that do not correspond to the typical variables that psychologists tend to study.

The use of manipulatives (physical objects used to support hands-on learning) is a common tool used to teach math in the K-8 setting (Cain-Caston, 1996). In the education literature, manipulatives are thought to make abstract mathematical concepts more concrete (Cain-Caston, 1996). This same principle may also apply to the college student (Conners et al., 1998). In fact, the use of manipulatives is becoming more popular as a way to promote active learning in the higher education college classroom (e.g., Dunham, 2013). Several common statistics activities use manipulatives such as dice, poker chips, candy, and coins to demonstrate concepts such as sampling and the Central Limit Theorem. However, most of these manipulatives vary on only one dimension (e.g., color, date) and so do not reflect the types of data typically collected in the field of psychology.

**In-Class Activities**

This instructional resource consists of in-class activities using the same poker chips to demonstrate a variety of statistical concepts that are commonly covered in psychology courses including sampling and probability, probability and frequency distributions, descriptive statistics (i.e., frequency distributions, central tendency, variability), and inferential statistics (i.e., *z* test, *t* tests, Analysis of Variance, correlation, linear regression, and chi-square). These activities provide students with the ability to simulate real world data collection and subsequent statistical analyses using a very concrete and fun hands-on approach. This resource includes 12 activities using one population of Poker Chip People (*N* = 100). These activities can be easily completed through instructor demonstration or in small groups with each group having its own set of poker chip people.

**Poker Chips and Labels**

In order to simulate real people, these Poker Chip People differ on five variables: color (white, red, blue, green), gender (male, female), level of happiness (1-7), age (18-65), and income ($, $$, $$$, $$$$). The instructor will need to purchase 1.5 in. (2.54 cm) poker chips that come in at least four colors. This teaching resource is based on white, red, blue, and green poker chips.

The instructor will need to purchase 1 in. (2.54 cm) round labels (e.g., Avery® Removable Round Labels 6450) to place the additional four variables onto the front and back of the poker chips. The front label indicates two variables: gender (blue ink = male, pink ink = female) and happiness (facial expression ranging from extremely happy to extremely sad; adapted from Andrews & Withey, 1976). Each face will correspond with an overall happiness score (see Figure 1). The nose is the actual number to avoid confusion.



Figure 1. Adapted Faces Scale to indicate happiness.

The back label contains two additional variables: age (18-65) and household income ($, $$, $$$, $$$$).

The pdf label files are designed to work with the Avery Removable Round Labels 6450 template. These labels would correspond with the final 100 poker chip people data set (see Figure 2). Using the included IBM® SPSS® file with the entire population, print the front and back label sheets and adhere them to the appropriately colored poker chip so that the color, gender, happiness, age, and income match each person in the data file. The Microsoft Word® (.docx) files let the instructor easily modify the variables to change their distribution in the population.

****

Figure 2. 100 Poker Chip People Data Set

**Excel and SPSS Data Files**

A Microsoft Excel® file and an SPSS file of the final dataset of 100 Poker Chip People are included for the instructor’s use. The data file consists of the following variables that correspond to the printed labels for the poker chips: chip color (red, blue, white, green), age (18-65), gender (male, female), happiness (range 1-7), and income ($, $$, $$$, $$$$). Instructors should have their students create these files with their poker chips to provide practice with data input and manipulation using statistical software.

**Final Notes**

 Four of the variables are either nominal (gender, color) or ordinal (happiness, income) due to the difficulty in identifying appropriate interval and ratio variables that would easily fit on a poker chip. Thus, these four variables do not meet the assumptions of parametric statistical tests; however, this resource presents the opportunity for students to compare and contrast a parametric with its nonparametric equivalent. These activities are designed to be a fun way to help students practice their statistical calculations -- especially because students can keep generating new datasets by repeatedly picking different poker chips of different sample sizes. Instructors could consider adding new variables such as body mass index or IQ or, as suggested by an anonymous reviewer, use Popsicle sticks as a more cost-effective alternative to poker chips and labels.

References

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# #1. Population vs. Sample (Sampling Techniques)

|  |  |
| --- | --- |
| **Learning Outcome**  | Students will be able to:* Conduct different sampling techniques and create a frequency table.
* Compare and contrast different sampling techniques to the original population.
* Compute basic probability of selecting a single person.
 |

1. **Population (*N* = 100)**
	1. Complete the top row of the table below by including the frequency and percentage of each color (red, white, blue, green) in your **population** of poker chips.
	2. Is color equally distributed in your population?
2. **Different types of sampling** – Complete the table below by including the frequencies (%) in the appropriate row for each type of sampling technique.
3. **Simple Random Sampling with Replacement (*n* = 15)**: Randomly choose 15 poker chips. Make sure to use ***sampling with replacement*** (each time you take a poker chip, put it back in the bag before you pick the next one).
4. **Simple Random Sampling without Replacement (*n* = 15)**: Randomly choose 15 poker chips. Make sure to use ***sampling without replacement*** (each time you take a poker chip, keep it out of the bag, but just choose one chip at a time).
5. **Simple Random Sampling with Replacement (*n* = 30)**: Randomly choose 30 poker chips. Make sure to use ***sampling with replacement*** (each time you take a poker chip, put it back in the bag before you pick the next one).
6. **Stratified Sampling (*n* = 20)**: Divide your poker chips by color. Randomly pick from red, white, blue, and green chips so that your final sample of 20 is color representative of your original population.
7. **Cluster Sampling**: Divide your poker chips by income level. Randomly choose an **income level ($, $$, $$$, or $$$$)** and those poker chip people now represent your sample. Record their color frequency and percentage in the table below.
8. **Convenience Sampling:** Grab a *small* handful (about 5) of the poker chips from the top of the bag.

**Sampling Techniques Table**

|  |  |  |
| --- | --- | --- |
|  | **Color** |  |
|  | **Red** | **White** | **Blue** | **Green** | **Total** |
| **Population** |  |  |  |  | 100 (100%) |
| **Simple Random Sampling (*n* = 15)***with replacement* |  |  |  |  | 15 (100%) |
| **Simple Random Sampling (*n* = 15)***w/o replacement* |  |  |  |  | 15 (100%) |
| **Simple Random Sampling (*n* = 30)***with replacement* |  |  |  |  | 30 (100%) |
| **Stratified Sampling** **(*n* = 20)** |  |  |  |  | 20 (100%) |
| **Cluster Sampling** |  |  |  |  |  |
| **Convenience Sampling** **(*n* = 5)** |  |  |  |  | 5 (100%) |

1. Which sampling techniques gave you the **most representative sample** (least biased) and the **least representative sample** (most bias) of the original population? Why?

**Probability of Picking a Single Score**

1. What is the probability of picking a female from your population?
2. What is the probability of picking a person with a happiness rating of 4 from your population?
3. What is the probability of picking a person between the ages of 20-25 from your population?

*Additional Practice*:

1. Repeat this activity, but instead use gender or income as your variable of interest.

Practice calculating the probability of picking a single person from your samples. How does that probability compare to the probability of picking that same person from the entire population? Please note this activity is based on “[Sampling Techniques-An Activity with Poker Chips](http://www.education.wichita.edu/alagic/grants/bridges/Sampling-PokerChips-NISOD.doc)” distributed by Donna Gorton (Butler County Community College).

# #2. Descriptive Statistics: Frequency Distributions and Histograms

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to:* Identify variables and their levels of measurement.
* Represent variable frequencies in a frequency table.
* Create a histogram and describe the shape of the distribution.
 |

**Variables and Level of Measurement:**

1. How many variables are represented on each poker chip person?
2. What is the level of measurement (nominal, ordinal, interval, or ratio) for each variable?

**Frequency Distribution Table**

1. Create an ungrouped frequency distribution table of happiness for your poker chip population.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Happiness Level** | **Frequency** | **Cumulative Frequency** | **Relative Frequency** | **Cumulative Relative Frequency** |
| X | *f* | *cf* | *rf* | *crf* |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| 7 |  |  |  |  |
| Total |  |  |  |  |

What happiness level is the most common?

1. Create a grouped frequency distribution table of age for your poker chip population.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Class Intervals** | **Frequency** | **Cumulative Frequency** | **Relative Frequency** | **Cumulative Relative Frequency** |
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| Total |  |  |  |  |

Why would a grouped frequency distribution table be more appropriate for age compared to an ungrouped frequency distribution table?

**Histograms**

1. Create a histogram for happiness. How would you describe the shape of the distribution? What does the shape say about the overall happiness of your population?
2. Create a histogram for age based on the grouped frequency distribution. How would you describe the shape of the distribution? What does the shape say about the overall age of your population?

**Other Visual Representations of Data**

1. Visually represent the proportion of males and females in your population. Are males and females equally distributed?
2. Visually represent the color of your population. Is one color more common than the others?

*Additional Practice for students:*

1. Create a frequency distribution for color, gender, and income. How would you describe the population based on these distributions?
2. Besides using histograms, how else could you “visualize” the data?

*Additional Ideas for Instructors:*

1. Have students visualize the data in as many ways as possible. Some examples may include: stem-and-leaf plots, pie charts, bar graphs, and dot plots.

# #3. Descriptive Statistics: Central Tendency

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to:* Calculate the mean, median, and mode.
* Compare and contrast central tendency of a sample to the original population.
* Identify the best measure of central tendency given level of measurement.
 |

1. Calculate the mean, median, and mode for **happiness** for your population of poker chip people.
	1. Which measure is the “best”? Why?
	2. In words, how would you describe the happiness level of your population?
2. A researcher believes that males are happier than females. Based on measures of central tendency, would you agree?
3. Choose a sample of 20 poker chip people (use any sampling method).
	1. Recalculate the mean, median, and mode for happiness.
	2. How do these values compare to the population values?
4. What is the average age of the poker chip population?
	1. Suppose that an 85 year-old person joins your population. What happens to the average age? What happens to the median age?

*Additional practice:*

1. What is the best measure of central tendency to report for gender, color, and income for your population of poker chip people?
2. Choose samples of varying sizes and calculate central tendency for happiness. Compare and contrast these measures to the central tendency of the entire population. Are the larger samples more representative of the population?

# #4. Descriptive Statistics: Variability

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to:* Calculate the variance and standard variation for a population and sample.
* Explain the difference between population and sample variance.
 |

**Variability of Happiness Levels**

1. Calculate the range, variance, and standard deviation of happiness scores for your population of poker chip people.
2. Calculate the range, variance, and standard deviation for a **sample** of 25 poker chip people.
	1. How and why do the calculations for variance and standard deviation differ from the population formula?
	2. How do your measures of variability for your sample compare to the true population?

**Variability of Age**

1. Calculate the range, variance, and standard deviation of age for your population of poker chip people.
2. Calculate the range, variance, and standard deviation for a **sample** of 10 poker chip people.
	1. How do your measures of variability for your sample compare to the true population?

# #5. Probability and Sampling Distributions (Central Limit Theorem)

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| --- | --- |
| **Learning Outcome** | Students will be able to:* Construct a probability distribution.
* Construct a sampling distribution.
* Compare and contrast the probability and sampling distributions.
 |

Create a **probability distribution** of happiness level for your entire population of poker chip people.

Number of Poker Chip People

Happiness Level

Create a **sampling distribution** of happiness level based on the instructions on the following page.

Number of Samples with Mean

Mean Happiness Level

1. Pick a random sample (with replacement) of 10 poker chips and record the happiness level of each in the table below. Repeat this process 9 more times.
2. Calculate the mean happiness level of each sample.

|  |  |
| --- | --- |
|  | **Sample** |
|  **#1** | **#2** |  **#3** |  **#4** |  **#5** |  **#6** |  **#7** | **#8** |  **#9** | **#10** |
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| **Mean** |  |  |  |  |  |  |  |  |  |  |

1. Plot your 10 sample means on a histogram. This histogram is called a ***Sampling Distribution***.
2. How does the shape of the sampling distribution compare to your probability distribution? What shape would you expect if you took an infinite number of samples?
3. Calculate the mean of your sample means? How does it compare to the population mean? Is it closer to the population mean than each individual sample mean?

*Additional Ideas for Instructors*

1. Incorporate a discussion of the Central Limit Theorem and how sampling distributions will be normally distributed (depending on sample size, etc.) even though the probability distribution may not be normally distributed.

# #6. Hypothesis Testing: One-Sample *z* test vs. One-Sample *t* test

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to:* Compute a one-sample *z* test.
* Compute a one-sample *t* test.
* Compare and contrast the one-sample *z* test and *t* test.
 |

Assume that the happiness level of your population is normally distributed with an average of 4.45 and standard deviation of 1.76.

1. Are blue people significantly happier than the general population?
	1. Choose a random sample of 12 blue poker chips to answer this question using a one-sample *z* test.
	2. What if you didn’t know the population standard deviation (σ)? Using the same sample from above, conduct a one-sample *t* test to answer the question.
	3. Compare and contrast your results from the *z* test and the *t* test.
2. Are females happier than the general population?
	1. Choose a random sample of 10 female poker chips to answer this question using a one-sample *z* test.
	2. What if you didn’t know the population standard deviation (σ)? Using the same sample from above, conduct a one-sample *t* test to answer the question.
	3. Compare and contrast your results from the *z* test and the *t* test.
3. Are individuals in the lowest income bracket ($) sadder than the general population?
	1. Choose a random sample of 5 poker chips in the lowest income bracket ($) to answer this question using a one-sample *z* test.
	2. What if you didn’t know the population standard deviation (σ)? Using the same sample from above, conduct a one-sample *t* test to answer the question.
	3. Compare and contrast your results from the *z* test and the *t* test.

*Additional Ideas for Instructors*

1. Have students conduct the activity using different sampling methods (e.g., with and without replacement, convenient, clustered) or different sample sizes and compare their answers.
	1. How do different sampling techniques affect the results?
	2. How does the size of the sample affect the results?
2. Have students conduct the inferential tests as both one-tailed and two-tailed tests.
	1. Do the results change?
	2. How does a one-tailed or two-tailed test change the way an inferential test is conducted?
3. Given that happiness level is an ordinal variable, have students conduct a Wilcoxon one-sample Signed-Rank test (nonparametric equivalent of a one-sample *t* test). How do the results compare to the one-sample *t* test?

# #7. Hypothesis Testing: Independent Groups *t* test vs. Correlated Pairs *t* test

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to:* Calculate and interpret an independent groups *t* test.
* Calculate and interpret a correlated pairs *t* test.
* Create a bar graph of their findings.
 |

Answer the following questions using the appropriate *t* test.

1. Are men happier than women?
	1. Pick a sample of 16 poker chip people to determine whether men are significantly happier than women. Conduct an independent groups *t* test to answer this question.
		1. *Note*: With random sampling you may not get equal groups of males and females! What do you do if your groups are unequal? What type of sampling could you use to ensure that your groups are equal sizes?
	2. Create a bar graph of your results with gender on the x axis and mean happiness on the y axis.
	3. How do your results compare to the entire population of poker chip people? Would you have drawn the same conclusion if you had access to the entire population versus just the sample of 16?
2. Are husbands happier than their wives?
	1. Divide your population into males and females. For every male that you choose match him with a female. The male and female pair will represent the husband and wife in the pair. Conduct a correlated pairs *t* test to answer this question.
	2. Create a bar graph of your results with gender on the x axis and mean happiness on the y axis.

*Additional Practice:*

1. Are individuals in a higher income bracket happier than those in a lower income bracket? Combine income levels into two groups ($ & $$ = lower income; $$$ & $$$$ = higher income) and choose a sample to test this question.
2. Does happiness increase after winning the Powerball for individuals with a lower income? Choose a sample from the lower income brackets ($ & $$). Their happiness level represents their happiness at Time 1. Generate a happiness rating for Time 2 as if those individuals had just won the Powerball. Perform a correlated pairs *t* test to answer the question.

*Additional Ideas for Instructors:*

1. Given that happiness level is an ordinal variable, have students conduct the nonparametric equivalent to the independent samples *t* test (Wilcoxon Rank Sum test) and the correlated pairs *t* test (Wilcoxon Matched-Pairs Signed-Ranks test). How do the results compare to the *t* tests?

# #8. Hypothesis Testing: One-Way Between-Subjects Analysis of Variance (ANOVA)

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to * Conduct and interpret a one-way between-subjects ANOVA.
* Create a bar graph of their findings.
* Compare their sample results to the entire population.
 |

1. Does color affect your happiness level?
2. Pick a sample of 24 poker chip people to determine whether color is related to happiness level. Conduct a one-way between-subjects ANOVA with post hoc test (if appropriate) to answer this question.

*Note*: With random sampling you may not get equal groups of each color! Plus, color is not equally distributed in the population. What do you do if your groups are unequal? What type of sampling could you use to ensure that your groups are equal sizes?

* 1. Create a bar graph of your results with color on the x axis and mean happiness on the y axis.
	2. How do your results compare to the entire population of poker chip people? Would you have drawn the same conclusion if you had access to the entire population versus just the sample of 24?
1. Is income level related to age?
	1. Pick a sample of 32 poker chip people to determine whether income level is related to age. Conduct a one-way between-subjects ANOVA with a post hoc test (if appropriate) to answer this question.
	2. Create a bar graph of your results with income on the x axis and mean age on the y axis.
	3. How do your results compare to the entire population of poker chip people? Would you have drawn the same conclusion if you had access to the entire population versus just the sample of 32?

*Additional Practice:*

1. Is income related to happiness?
2. Redo the above problems using a new sample or different sampling technique. Does your conclusion remain the same?
3. If your conclusions above were nonsignificant, create a new data set (or change some of your data points) to ensure a significant difference on mean happiness between your groups.

*Additional Ideas for Instructors*:

1. Are males happier than females? Using the data from the independent groups *t* test activity, recalculate your results using a between-subjects ANOVA. Does your conclusion change? What is the relationship between the *t* value and *F* value?
2. Given that happiness level is an ordinal variable, have students conduct the nonparametric equivalent to the one-way ANOVA (Kruskal-Wallis One-Way ANOVA). How do the results compare to the parametric version?

# #9. Hypothesis Testing: One-Way Repeated-Measures ANOVA

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| --- | --- |
| **Learning Outcome** | Students will be able to:* Conduct and interpret a one-way repeated-measures ANOVA.
* Create a line graph of their results.
 |

Does happiness level increase as we age?

1. A researcher assessed happiness levels once per year for four years for 10 people. Using a one-way repeated-measures ANOVA with post hoc tests (if appropriate), determine if happiness increased over time.
2. Because our poker chip people have only one assessment of happiness, we’ll have to be creative in generating a new repeated-measures dataset to answer this question.
	1. One option is to pick an initial sample of 10 poker chips and record their happiness level as Time 1. Then find a “match” for each poker chip you had originally selected. A match could be based on the age, gender, income, or color of the poker chip. Repeat that process three times so that you now have four happiness ratings per poker chip person. Proceed with the hypothesis testing.
	2. If you want to ensure a certain result (i.e., significant or nonsignificant), you can generate fake data based on your initial set of 10 poker chips. What would a dataset look like if happiness levels did significantly increase over time? What would a dataset look like if happiness levels **did not** significantly increase over time?
3. Create a line graph of your results with time on the x axis and mean happiness on the y axis.

 *Additional Ideas for Instructors*:

1. Websites, Excel® tutorials, and SPSS syntax (among other options) are readily available to generate fake or simulated data. Instead of having students generate data, have them use one of these programs to generate data.
2. Given that happiness level is an ordinal variable, have students conduct the nonparametric equivalent test (Friedman’s Rank Test for *k* Correlated Samples). How do the results compare to the parametric version?

# #10. Hypothesis Testing: Two-Way Between-Subjects Analysis of Variance

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to:* Conduct and interpret a two-way between-subjects ANOVA.
* Compare sample results to the entire population.
* Create a line graph to depict the interaction term.
 |

Is the relationship between age and happiness the same for males and females?

1. Divide the poker chips into two groups based on their age (18-40 & 41 and older). Now randomly choose eight males and eight females from each age group to be in your sample (*n* = 32). This process is to ensure equal groups. Conduct a two-way between-subjects (ANOVA) to determine whether there is a significant interaction between age group and gender on happiness level.

|  |  |
| --- | --- |
| **Younger** | **Older** |
| **Male** | **Female** | **Male** | **Female** |
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* 1. Create a line graph to visually depict your interaction effect.
	2. How do your sample results compare to the entire population?

*Additional Practice:*

Is the relationship between income and happiness the same for males and females?

Choose a sample of 30 poker chip people. Combine income levels into two groups ($ & $$ = lower income; $$$ & $$$$ = higher income). Conduct a two-way between-subjects (ANOVA) to determine whether there is a significant interaction between income bracket and gender on happiness level.

# #11. Hypothesis Testing: Pearson Correlation and Linear Regression

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| --- | --- |
| **Learning Outcome** | Students will be able to:* Conduct and interpret a Pearson correlation.
* Create a scatterplot of two variables.
* Conduct a linear regression and use it to predict an outcome.
 |

1. Do we get happier the older we get?
	1. Pick a sample of 12 poker chip people to determine whether age is significantly related to happiness. Conduct a Pearson correlation to answer this question.
	2. Create a scatterplot of your results with age on the x axis and happiness on the y axis.
	3. How do your results compare to the entire population of poker chip people? Would you have drawn the same conclusion if you had access to the entire population versus just the sample of 12?
2. What happiness level would you predict for a person that was 47 years old?
	1. Calculate the linear regression line for your sample of 12 to use for your prediction.
	2. If your Pearson correlation was not significant, what is your best prediction of happiness for a 47 year old?

*Additional Ideas for Instructors:*

Because happiness level is technically an ordinal variable, have students conduct a Spearman correlation (nonparametric equivalent) to determine if there is a significant association between age and happiness. How do the results compare to the Pearson correlation?

# #12. Hypothesis Testing: Chi-Square Goodness of Fit vs. Chi-Square Test of Independence

|  |  |
| --- | --- |
| **Learning Outcome** | Students will be able to:* Conduct and interpret a Chi-Square Goodness of Fit test.
* Conduct and interpret a Chi-Square Test of Independence.
* Compare their sample findings to the entire population.
 |

1. Are males and females equally distributed in your population?
	1. Choose a sample of 14 poker chips and determine if there are more males or females than would be expected if gender was equally distributed in your population. Perform a chi-square goodness of fit test to answer this question.
	2. How do your results compare to the entire poker chip population? Would you have drawn the same conclusion if you had access to the entire population versus just the sample of 12?
2. Recent reports concerning income distribution suggested that about 6% of people are considered rich, 42% are considered middle class, 40% are considered working class, and 12% are considered poor.
	1. Choose 26 poker chip people to determine if that income distribution holds true for your sample. Perform a chi-square goodness of fit test to answer this question.

|  |  |  |  |
| --- | --- | --- | --- |
| **Poor ($)** | **Working Class ($$)** | **Middle Class ($$$)** | **Rich ($$$$)** |
|  |  |  |  |

* 1. How do your results compare to the entire poker chip population? Would you have drawn the same conclusion if you had access to the entire population versus just the sample of 26?
1. Is gender related to income?
	1. Choose a sample of 50 poker chips to determine if gender is related to income level. Perform a chi-square test of independence to answer this question.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Poor ($)** | **Working Class ($$)** | **Middle Class ($$$)** | **Rich ($$$$)** |
| **Male** |  |  |  |  |
| **Female** |  |  |  |  |

b. How do your results compare to the entire poker chip population? Would you have drawn the same conclusion if you had access to the entire population versus just the sample of 50?

*Additional Practice:*

1. Are there more younger than older individuals in your sample? Categorize your sample into younger (18-49) and older (50+) categories (or any age grouping that you’d like!). Perform a chi-square goodness of fit test to answer the question.
2. Is age related to happiness level? Using your same age brackets, divide your sample based on their happiness level (happy = 5-7, neutral = 4, sad = 1-3). Perform a chi-cquare test of independence to answer the question.

# Statistical Software

If your course includes instruction using statistical software consider having students perform all of these activities using a statistical software program as well.

1. Data Management
	1. Setting up variables (naming, value labels, variable labels, etc.)
	2. Entering each poker chip into the data file
	3. Checking for errors
2. Importing/Exporting Data (e.g., Excel 🡪 SPSS)
3. Choosing a Random Sample
4. Conducting Descriptive Statistics
	1. Frequency tables
	2. Central tendency
	3. Variability
5. Visualizing Data
	1. Bar graphs
	2. Line graphs
	3. Histograms
	4. Scatterplots
	5. Pie charts
6. Conducting Inferential Statistics
	1. Parametric tests – *t* tests, ANOVAs, correlations, and regression
	2. Nonparametric tests – chi-square
7. Using code/syntax to conduct statistical analyses

A number of textbooks, websites, and YouTube channels are devoted to teaching students how to conduct statistical analyses in a variety of programs.