Middle Grades Statistics: Dealing with So Much Content in So Little Time!

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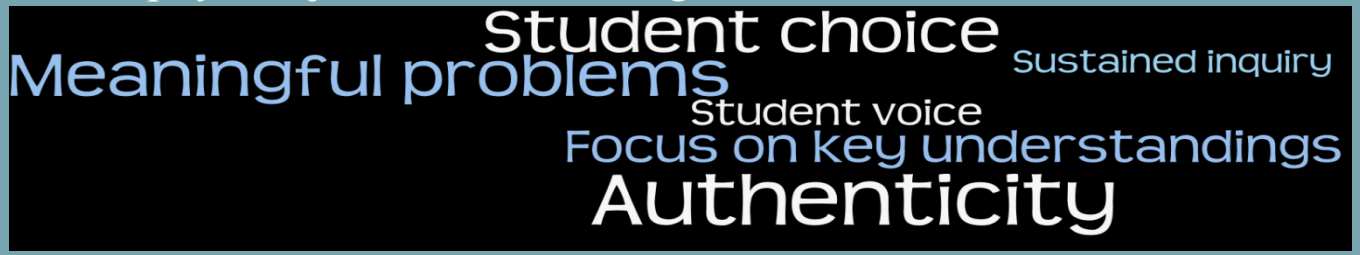
Our Statistics Unit

Five Years Ago

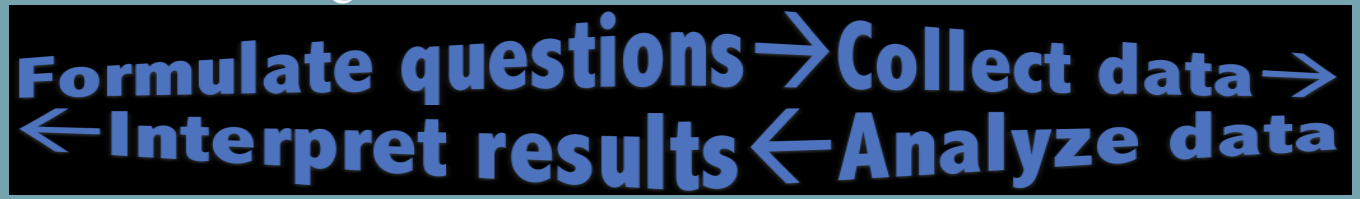
Now

Re-designed Statistics Unit: Three P's

- Placement
  - Project serves as introduction to unit
  - Project provides overarching theme and purpose for unit
- Philosophy: Project-based Learning



- Process of "Doing Statistics"



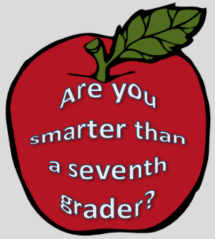
Current Context

- 20-day unit
- Seventh Grade

- Standards Clusters Addressed: Statistics and Probability
  - Use random sampling to draw inferences about a population.
  - Draw informal comparative inferences about two populations.

The Project: Design and Implement a Study.

1. Determine a topic.
2. Choose two populations or experimental/comparison groups.
3. Ask a statistical question and state a claim.
4. Use surveys, observations, or experiments to collect data.
5. Gather categorical and quantitative data to address claim.
6. Collect, organize, and analyze data.
7. Write up results.

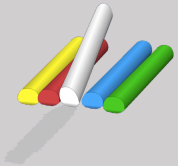


Question: Are seventh graders smarter than their parents?

Claim: Seventh graders are smarter than their parents.

Question: How do males and females deal with anxiety and depression?

Claim: Females deal with anxiety and depression differently than males.



Question: How many centimeters in length does Crayola sidewalk chalk decrease after 5 swatches compared to RoseArt?

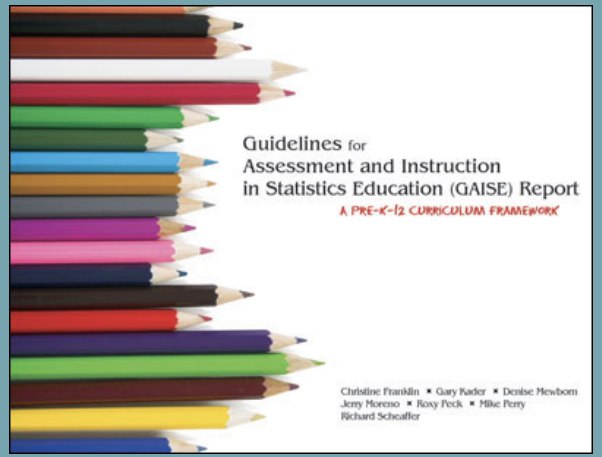
Claim: Crayola sidewalk chalk lasts longer than RoseArt sidewalk chalk.

Question: Do students that participate in extracurricular activities plan on attending college more than students who do not participate in extracurricular activities?

Claim: Students that participate in extracurricular activities plan on attending college more than students who do not participate in extracurricular activities.

Unit Structure:
Statistical Problem-solving Process

1. Formulate questions.
2. Collect data.
3. Analyze data.
4. Interpret results.



http://www.amstat.org/asa/files/pdfs/GAISE/GAISEPreK-12_Full.pdf

The Unit: Formulate Questions. (2 days)

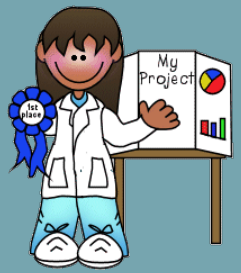
Day	Instructional and Project Foci
1	**Project** Share project description with students. Have students determine a topic they wish to study. Show previous student projects as samples.
2	**Instruction** Revisit statistical questions from grade 6. **Project** Establish a statistical question and claim for the identified topic. Determine the two populations or groups to be studied.

Project Description

Draw informal, comparative inferences about two populations or experimental/comparison groups.

- Determine a topic that you would like to research further.
- Choose two populations or comparison groups that you can use to make comparisons about the topic.
    - The populations or experimental/comparison groups should be diverse such as males and females, adults and children, basic dart paper airplanes and winged paper airplanes, etc.
- Ask a statistical question and create a claim based on the topic and the populations or groups.
    - The claim should be controversial in the sense that people will not tend to all agree with the claim.
- Using surveys, observations, or experiments, determine how to collect data that should be representative of each population or that should minimize bias in results.
- Gather categorical and quantitative data to fully address the claim.
    - Ask multiple questions on your survey or collect data on multiple variables to provide strong evidence for your claim.
    - Collect data from 25 or more subjects, observations, or trials for each population or group.
- Collect, organize, and analyze your data.
    - Include frequency tables, graphs, and statistics measures to display data and use in your analysis.
    - At least one graph should compare data from your two populations or experimental/comparison groups.

Formulate Questions: Choice, Meaning, and Authenticity



- Resources
  - Science Fair Projects: https://www.education.com/science-fair/psychology-and-sociology
  - Statistics Projects: https://acrhs.buncombeschools.org/common/pages/UserFile.aspx?fileId-4047725
  - Previous years' student projects
- Potential Obstacles
  - Questions too general to be answered by a single survey, observational study, or experiment
  - Claims of little interest to others or not "controversial"
  - Categorical and quantitative data

Sample Questions and Claims

Example 1

- Question: Do students that participate in extracurricular activities plan on attending college more than students who do not participate in extracurricular activities?
- Claim: Students that participate in extracurricular activities plan on attending college more than students who do not participate in extracurricular activities.

Example 2

- Question: How many centimeters in length does Crayola sidewalk chalk decrease after 5 swatches compared to RoseArt?
- Claim: Crayola sidewalk chalk lasts longer than RoseArt sidewalk chalk.

The Unit: Collect Data. (7 days)

Day	Instructional and Project Foci
3-4	**Instruction** Investigate different types of sampling (convenience [biased], random, systematic, stratified) and the advantages and disadvantages of each. Review psychological experiments to consider the types of conclusions possible from experiments. **Project** Begin to think about the types of questions (survey) or data (observational study or experiment) that are needed to answer the statistical question and to determine the claim's validity.

Surveying, Sampling, and Experimenting

- Census and Sampling & Samples and Surveys videos from Against All Odds series: https://www.learner.org/courses/againstallodds/unitpages/index.html
- Validity of Claims: https://www.khanacademy.org/commoncore/grade-7-SP
- Designing Experiments video from Against All Odds series: https://www.learner.org/courses/againstallodds/unitpages/unit15.html
- Example psychology experiments: https://www.verywellmind.com/psychology-experiment-ideas-2795669

The Unit: Collect Data.

Day	Instructional and Project Foci
5	**Project** Develop survey questions or observational or experimental protocol. Create surveys; identify needed materials and develop instructions for conducting observational studies or experiments.
6	**Instruction** Investigate random sampling, focusing on the effects of sample size. **Project** Post surveys, observational studies, and experiments for review.
7	**Instruction** Explore methods to collect random samples using graphing calculators, spreadsheets, and slips of paper.

Survey and Study Development

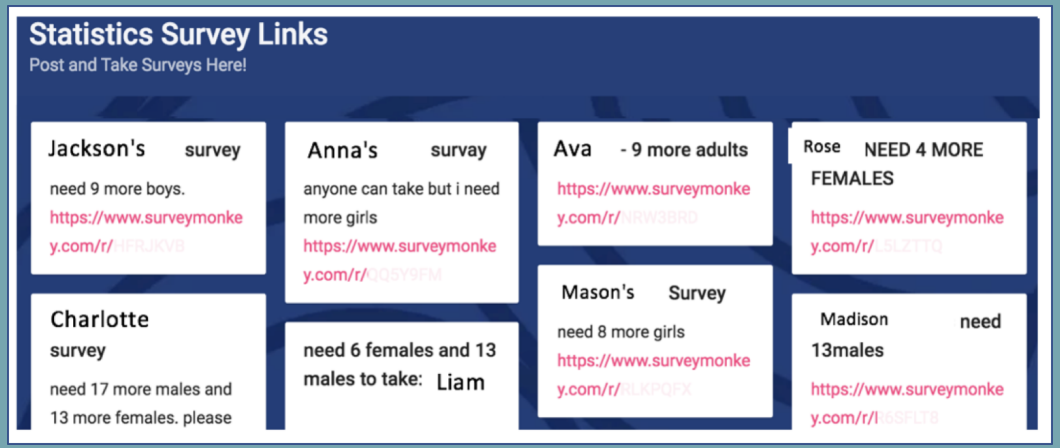
- Surveying
  - SurveyMonkey: www.surveymonkey.com
  - Google forms: https://www.google.com/forms/about/
- Posting for review
  - Padlet: https://padlet.com/
  - Weebly: https://www.weebly.com/ **(spencermath7.weebly.com)**

The Unit: Collect Data.

Day	Instructional and Project Foci
8-9	**Project** Begin collecting data in class or work on projects. 1. Visit sixth grade classes and have sixth graders complete surveys and participate in observational studies or experiments. 2. Complete surveys and participate in observational studies or experiments. 3. Work on other aspects of project such as determining sampling scheme.

Data Collection: Building Community

- Collect data from sixth grade classes during class time.
- Collect data from larger student body and school personnel.
- Collect data from parents and community members using social media.
- Collect data from classes of students in other schools.



The Unit: Analyze data and interpret results. (11 days)

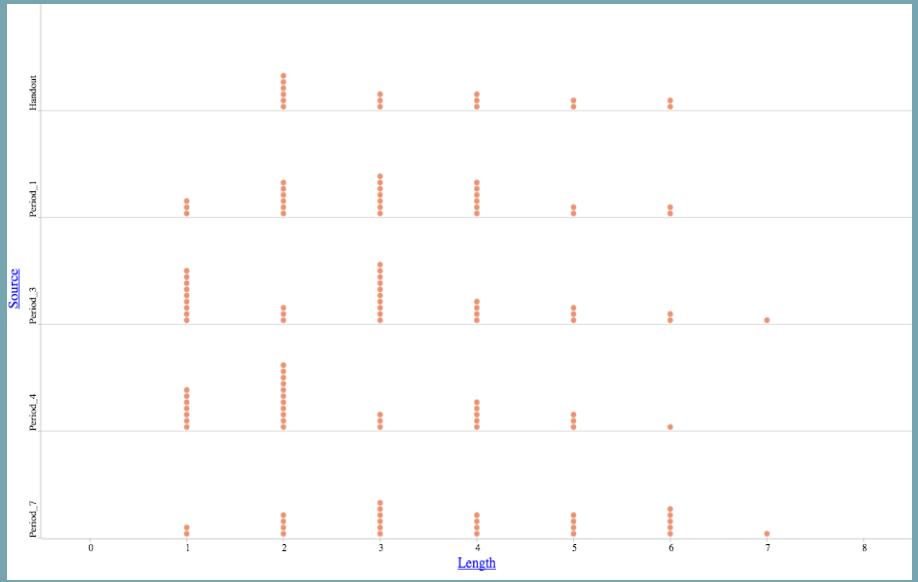
Day	Instructional and Project Foci
10-11	**Instruction** Make statistical inferences about a population using data from a sample or group. Use graphs and measures of center and variability to explore distributions. **Project** Continue collecting data outside of class.

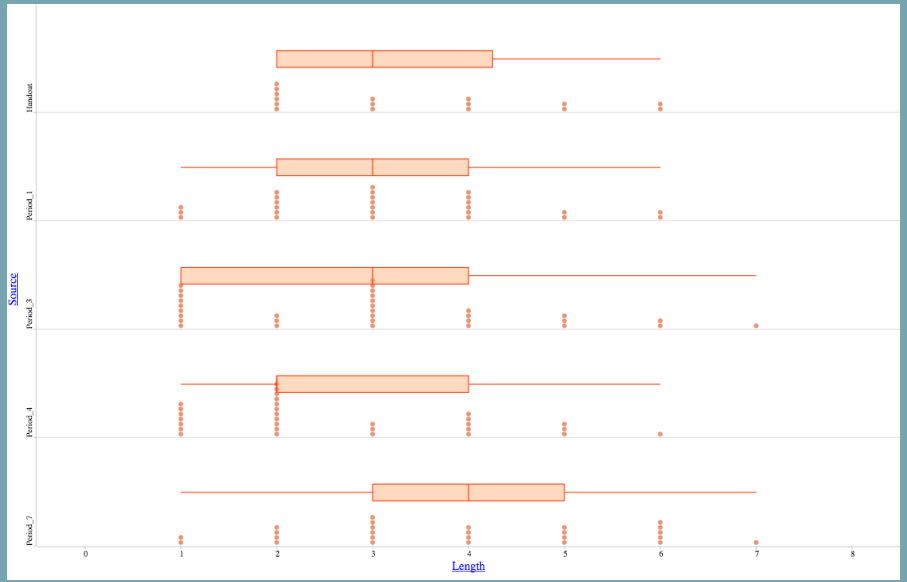
Analyzing Data: Use real data.

# words	Frequency Handout	Frequency 1st period	Frequency 3rd period	Frequency 4th period	Frequency 7th period
1	0	3	9	7	2
2	6	6	3	11	4
3	3	7	10	3	6
4	3	6	4	5	4
5	2	2	3	3	4
6	2	2	2	1	5
7	0	0	1	0	1

Length of Book Titles

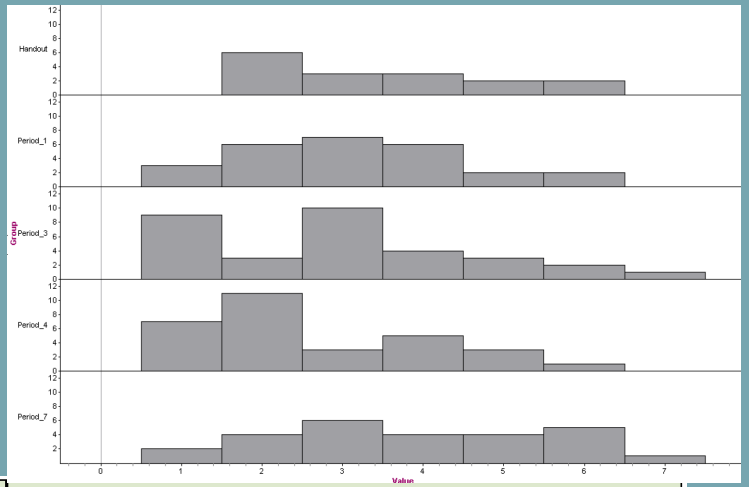
Analyzing Data: Interpret representations Quantitative Data





CODAP: https://codap.concord.org/

Analyzing Data: Interpret representations
Quantitative Data

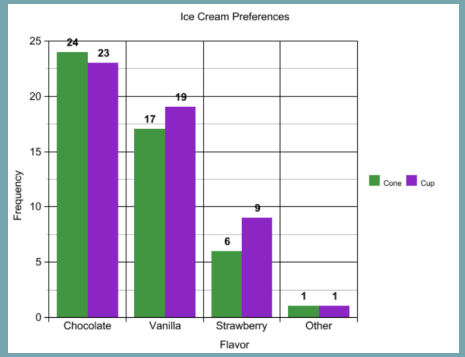


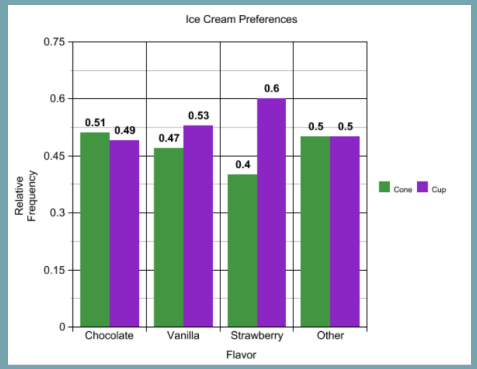
	Group				
	Handout	Period_1	Period_3	Period_4	Period_7
Value	3.4375	3.15385	2.96875	2.63333	3.88462
	1.45917	1.40548	1.6941	1.44993	1.70474
	2	1	1	1	1
	2	2	1	2	3
	3	3	3	2	4
	4.5	4	4	4	5
	6	6	7	6	7

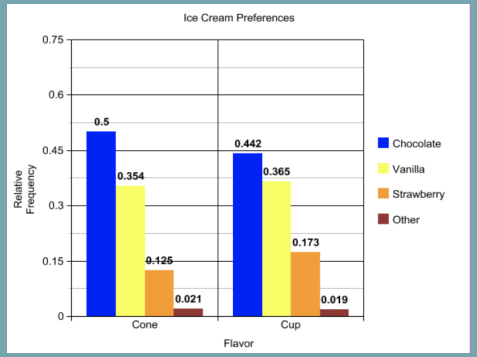
S1 = mean ( )
S2 = stdDev ( )
S3 = min ( )
S4 = Q1 ( )
S5 = median ( )
S6 = Q3 ( )
S7 = max ( )

Analyzing Data: Interpret representations
Categorical Data

Ice Cream Preference	Cone	Cup
Chocolate	24	23
Vanilla	17	19
Strawberry	6	9
Other	1	1







CreateAGraph: https://nces.ed.gov/nceskids/createagraph/

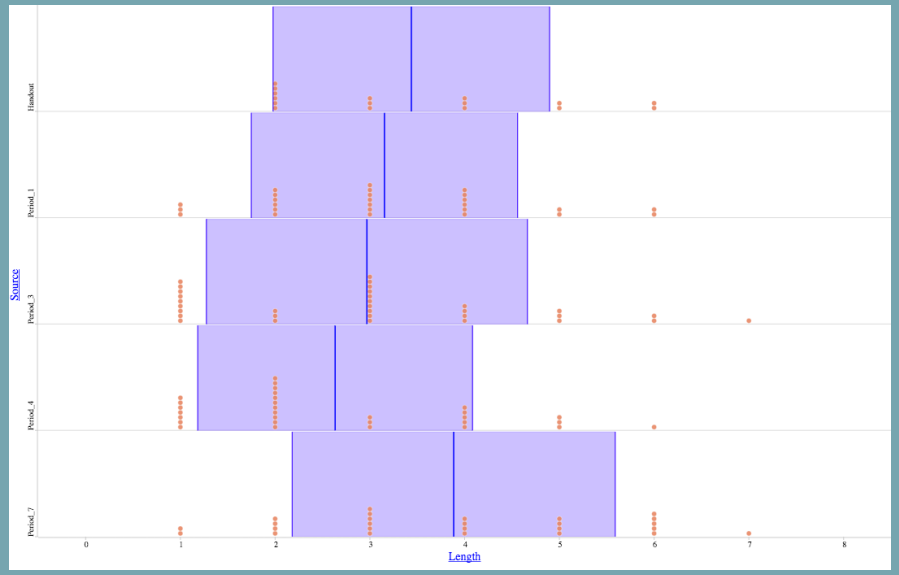
Analyzing Data

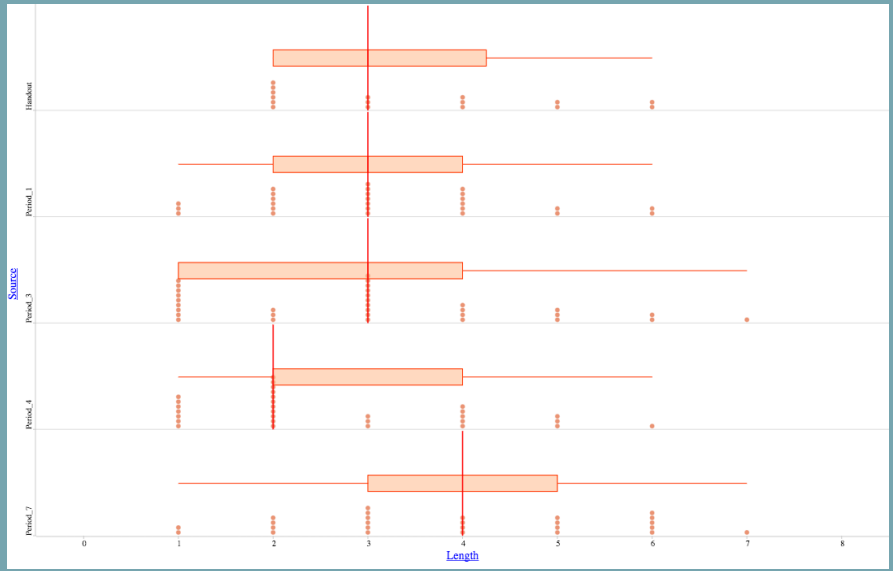
- Graphing resources
  - CODAP: https://codap.concord.org/releases/latest/static/dg/en/cert/index.html
  - CreateAGraph: https://nces.ed.gov/nceskids/createagraph/
  - Meta-Chart: https://www.meta-chart.com/box-and-whisker#/display
  - GeoGebra: https://www.geogebra.org/m/BxqJ4Vag
  - Histogram Maker: http://www.socscistatistics.com/descriptive/Default.aspx
- Video tutorials for using resources
  - Weebly: http://spencermath7.weebly.com/statistics.html

The Unit: Analyze data & Interpret results.

Day	Instructional and Project Foci
12-14	**Instruction** Use graphs and measures of center and variability to compare distributions and draw inferences about populations or groups. **Project** Continue collecting data outside of class.

Analyzing Data: Compare distributions
Quantitative Data

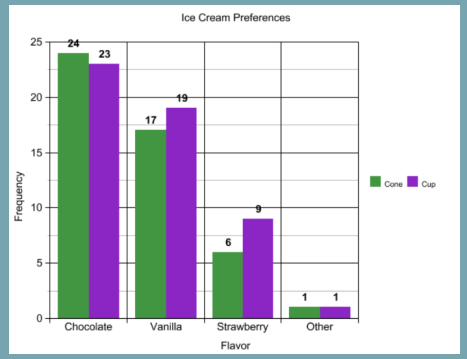


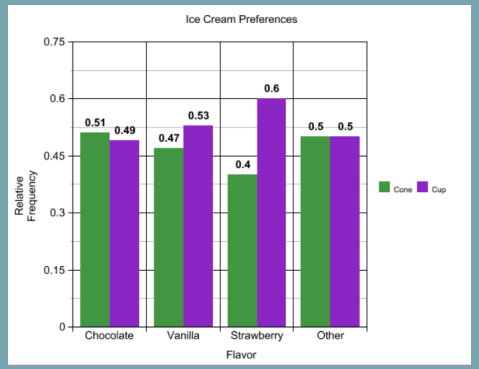


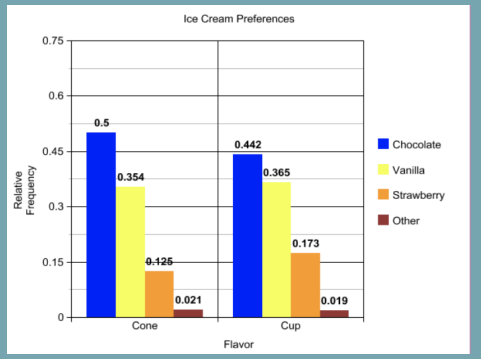
CODAP: https://codap.concord.org/

Analyzing Data: Compare distributions
Categorical Data

Ice Cream Preference	Cone	Cup
Chocolate	24	23
Vanilla	17	19
Strawberry	6	9
Other	1	1





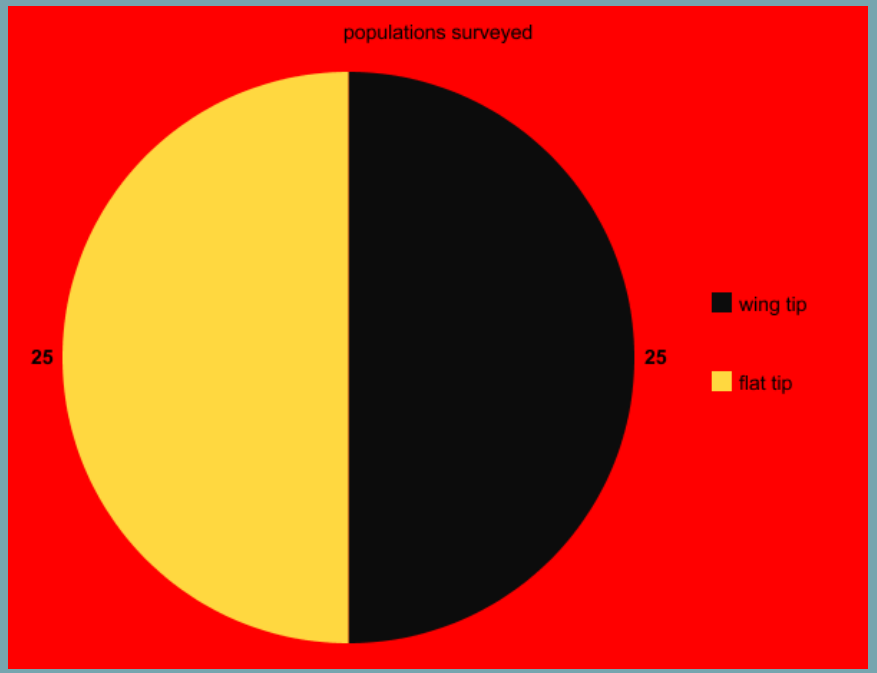


CreateAGraph: https://nces.ed.gov/nceskids/createagraph/

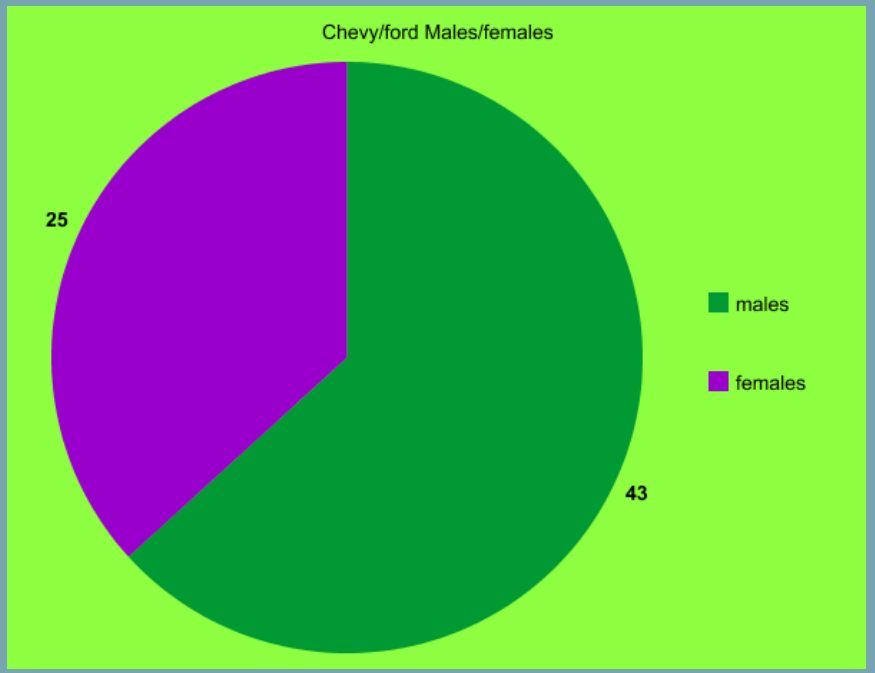
The Unit: Analyze data & Interpret results.

Day	Instructional and Project Foci
15-16	**Project** Organize data. Organize categorical data into frequency tables and bar graphs. Organize quantitative data into graphical displays such as histograms, dotplots, or boxplots. Create comparative graphs.
17-18	**Project** Calculate measures of center and variability. Analyze data to compare distributions and draw inferences. Interpret results in the context of the data.
19-20	**Project** Use paper outline to organize analyses and complete report. Reflect on the project.

Student Samples: Circle Graphs



Statistical Question: Is there a difference in how far different types of paper airplanes will go?



Claim: More guys like Chevy than girls.

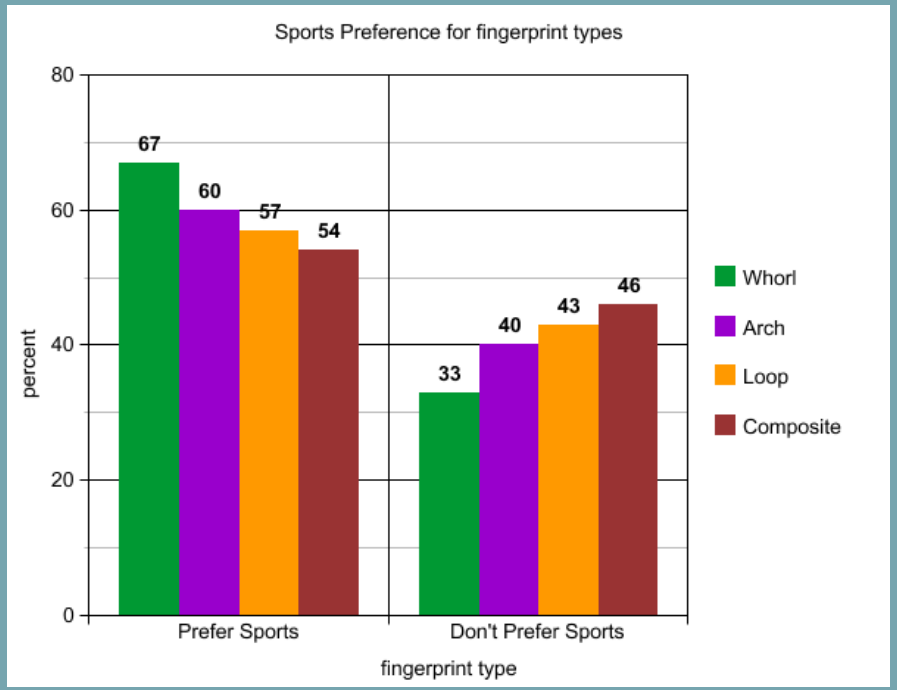
Student Samples: Frequency Tables

Hearing Ranges of Middle Schoolers		
Range	**Males**	**Females**
1-10	**0**	**2**
11-20	**2**	**1**
21-30	**10**	**15**
31-40	**11**	**7**
41-50	**1**	**0**
51-60	**0**	**0**
61-70	**1**	**0**
Total	**25**	**25**

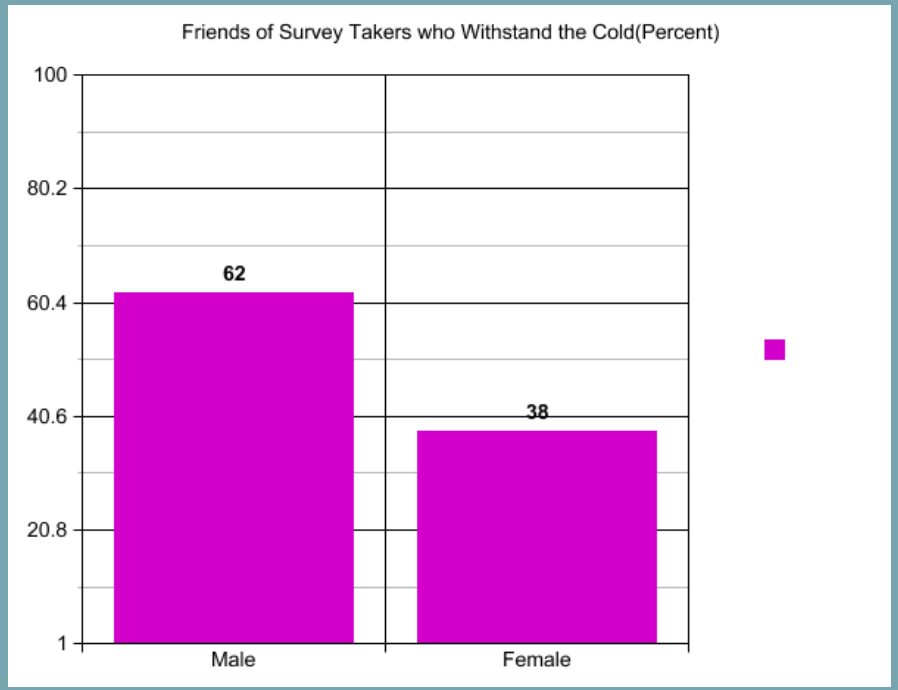
Claim: 7th grade girls hear better than 7th grade boys.

Females have better taste perception than males				
	Apple	Grape	Cranberry	Other
Females	12	1	1	11
Males	10	5	5	5

Student Samples: Comparative Bar Graphs



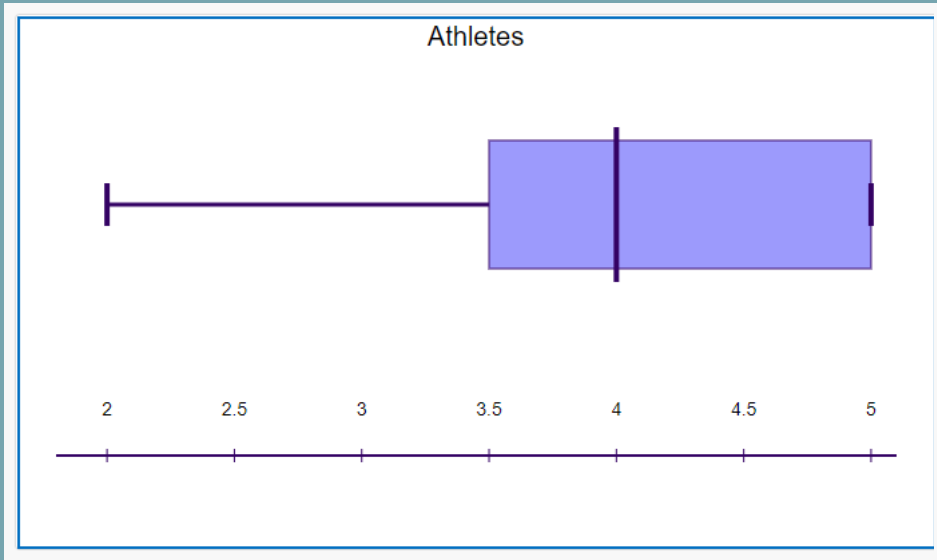
Claim: Fingerprint types affect personality traits.

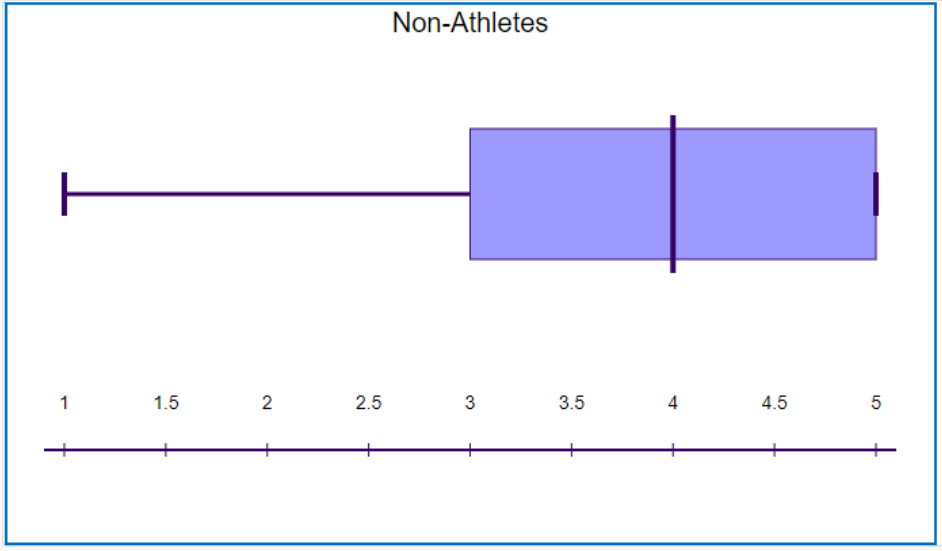


Claim: Males tolerate colder temperature better than females.

Student Samples: Box Plots

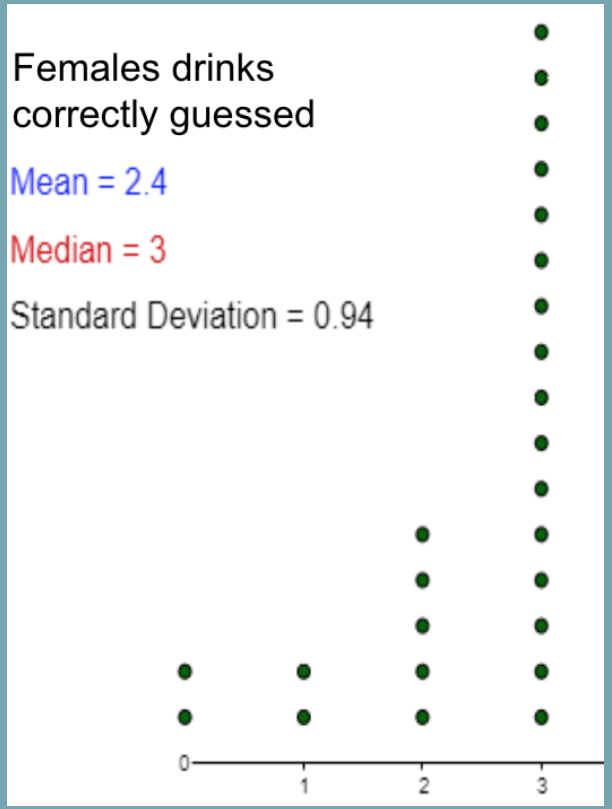
On a scale of 1-5, rate your grades (1 = poor, 5= excellent)

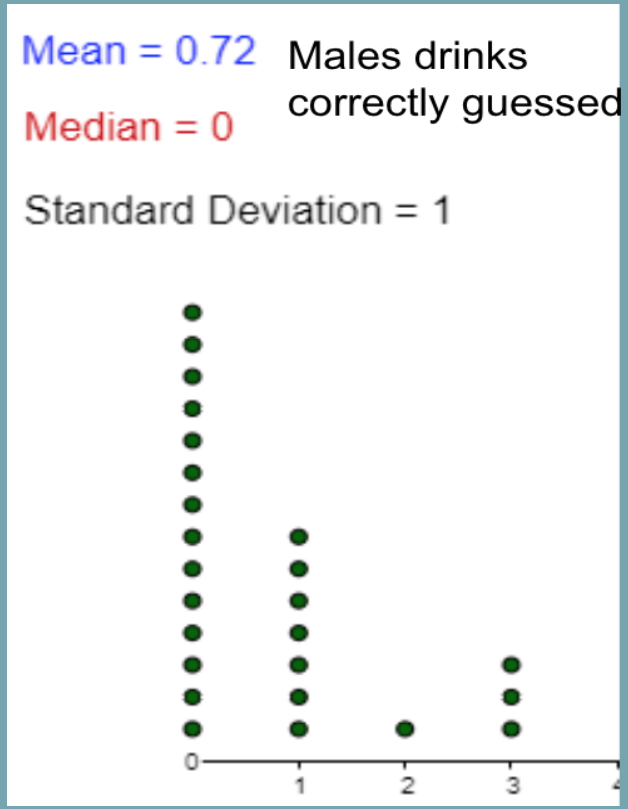




Claim: Athletes have better grades than non athletes.

Student Samples: Dot Plots





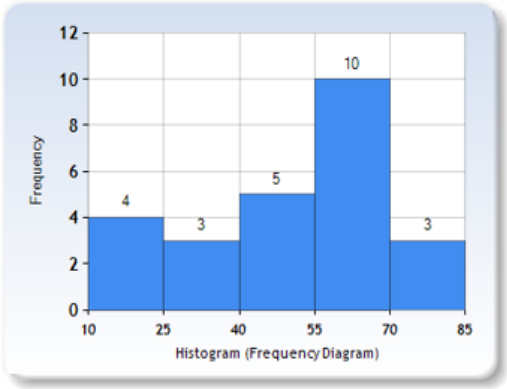
Claim: Females have a better perception of taste.

Student Samples: Histograms

Boys Perception of 1 minute

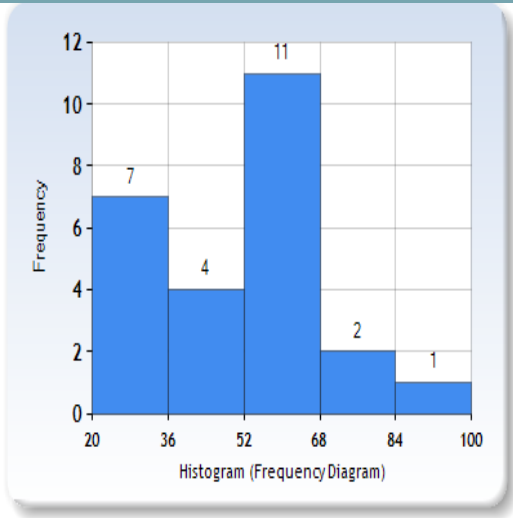
Frequency Table	
Class	*Count*
10-24	4
25-39	3
40-54	5
55-69	10
70-84	3

Your Histogram	
Mean	49
Standard Deviation (s)	19.13113
Lowest Score	15
Highest Score	80
Distribution Range	65
Total Number of Scores	25
Number of Distinct Scores	20
Lowest Class Value	10
Highest Class Value	84
Number of Classes	5
Class Range	15



Frequency Table	
Class	*Count*
20-35	7
36-51	4
52-67	11
68-83	2
84-99	1

Your Histogram	
Mean	52.36
Standard Deviation (s)	17.48781
Lowest Score	23
Highest Score	94
Distribution Range	71
Total Number of Scores	25
Number of Distinct Scores	18
Lowest Class Value	20
Highest Class Value	99
Number of Classes	5
Class Range	16



Girls Perception of 1 minute

Girls have a better perception of time than males.

Project Reports

Paragraph 1 – Introduction

- State your statistical question and your claim and why you chose that claim.
- State your populations or experimental/comparison groups and why you chose those populations/groups.

Student Example

My statistical question is how does your gender impact your emotions? My claim is that females are more positive than males. I chose this claim because it seems that girls are more positive than males. My populations are males and females. I chose these populations because I wanted to compare males and females.

Project Reports

Paragraph 2 – Sample

- Include the sample size for each of your samples/groups.
- How did you sample from your populations (random, convenience) or collect data for your observational/ experimental study?
- What biases, if any, occurred in your sampling or observational/experimental data collection?
- How might biased samples or processes impact your overall results?

Student Example

My sample sizes were 25 boys and 25 girls. I used random sampling for this test. There may have been a slight bias due to the fact that mostly 7th graders took any of the surveys.These may have affected my overall results because people of different ages generally don’t all know the same things.

Project Reports

Paragraph 3 – Survey or Observation/Experiment

- What were your survey questions or what observational/experimental process did you follow?
- How did your questions or processes help to support your claim?
- Were any of your survey questions or observational/experimental processes biased? How?

Example: Females have more desire to travel than males.

My survey questions were ‘Are you male or female?’, ‘On a scale of 1-5, how much do you like the idea of travel?’, and ‘Have you traveled outside of your home-state?’. My questions help support my claim by giving me opinions and experience of travel from the populations i’m using, therefore giving me the desire of travel from each population so i can see which one is greatest. None of my survey questions were biased.

Project Reports

Paragraph 4 – Analysis of Data

- Using the data, what were your results? (Embed your graphs/charts and measures here.)
  - For numerical data, what were the measures of central tendency (mean, median, mode) and measures of variability (interquartile range, MAD) for each sample's/group's data?
  - For your numerical data, use a dot plot, box plot, or histogram to display your data.
  - For categorical data, include a frequency table and a bar graph or circle graph to display your data.
- Did the data support your claim? State your conclusion, and explain how you came to your conclusion. Refer to your graphs and measures in your explanation.

Example: Adults are more stressed than students.

According to my results, the measures of central tendency for “on the scale of 1-10, how stressed are you” adults are, the mean- 6.71, the median- 7, the mode- 7, and range- 5. Also the measure of variability (MAD) for adults is 1.2. The measures of central tendency for students are, the mean- 4.03, the median- 4, the mode- 1, and the range- 5. Also the measure of variability (MAD) is 2.7. There was enough evidence to support my claim. The adults on average were more stressed.

Project Reports

Paragraph 4 – Analysis of Data (cont).

- State generalizations about your populations or groups. Include answers to questions such as these in your generalizations: What were the outcomes of the majority? Were there any outliers that may have affected your results? Were there any other factors that affected your results?
- State conclusions about your populations or groups. Include answers to questions such as these in your conclusions: What did you learn based on the data? How did what you originally thought compare to what actually happened? Did the results change your beliefs about your populations?
- Make inferences. Include answers to questions such as these in your inferences: What inferences can you make about even larger populations or groups? What factors might impact your inferences?

Females are smarter than males.

According to my populations, the outcomes of the majority were the chances males will answer a math problem correctly. There weren't any outliers that may have affected my results. The fact that more males have actually taken my survey probably affected my results. Luckily, I was able to fix that problem by getting rid of four responses from the males. I learned that even though they don't mature quickly, males are able to use their senses to solve even the toughest problems. How I thought of was completely the opposite. The results did help me change the way I look at the knowledge of males. Yet I still believe that females are just as smart. I can infer that maybe it is more likely to find a male be able to handle such tough scenarios and are better at problem-solving. Male students at schools worldwide are more likely to get math problems answered correctly. I could be incorrect though, considering that I see girls more likely work with problems like this.

Project Reports

Paragraph 5 – Reflection & Conclusion

- What did you learn from conducting this statistics project?
- How can you connect this research to real-world situations/scenarios?
- How did the data you collected affect your opinion of your original claim?
- What would you do differently if you were to conduct this research again?
- How did this project help you to better understand statistics?

Example: Females are happier after listening to music than males.

I learned from conducting this project that people are different and may not choose what you want them to pick. I also learned how to find MAD (Mean Absolute Deviation) and reviewed how to find mean, median, and mode. I can connect this research to the real-world because if I were to become an entrepreneur I would want to survey people to see if my product would be successful or a flop. The data I collected did not affect my opinion of my original claim. If I were to do this research again (I will in college more than likely) I would plan ahead more and make sure I post the right link to the web page so I can get more responses. This project better helped me understand statistics by showing me how to make charts, graphs, and surveys. This project also taught me how to find the MAD and how to use it. This project was really fun and I really enjoyed the four weeks we spent on this project.

Questions?

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