Consuming Cola

Nancy Sundheim
St. Cloud University
nksundheim@stcloudstate.edu

STatistics Education Web
STEW
online journal of K-12 statistics lesson plans

Published: July 2013

Overview of Lesson
Students will determine if drinking cola increases heart rate. The primary purpose of the lesson is to look for extraneous variables and try to control them through focusing on experimental design.

GAISE Components
This investigation follows the four components of statistical problem solving put forth in the *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report*. The four components are: formulate a question, design and implement a plan to collect data, analyze the data by measures and graphs, and interpret the results in the context of the original question. This is a GAISE Level B activity.

Common Core State Standards for Mathematical Practice
1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.

Common Core State Standards Grade Level Content (High School)
S-ID. 1. Represent data with plots on the real number line (dot plots, histograms, and boxplots).
S-ID. 2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
S-ID. 3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
S-IC. 1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
S-IC. 5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
S-IC. 6. Evaluate reports based on data.

NCTM Principles and Standards for School Mathematics
Data Analysis and Probability Standards for Grades 9-12
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them:

- understand the differences among various kinds of studies and which types of inferences can legitimately be drawn from each;
- know the characteristics of well-designed studies, including the role of randomization in surveys and experiments;
- understand the meaning of measurement data and categorical data, of univariate and bivariate data, and of the term variable;
- understand histograms, parallel box plots, and scatterplots and use them to display data;
- compute basic statistics and understand the distinction between a statistic and a parameter.

Select and use appropriate statistical methods to analyze data:

- for univariate measurement data, be able to display the distribution, describe its shape, and select and calculate summary statistics;
- display and discuss bivariate data where at least one variable is categorical.

Prerequisites
Students will have prior knowledge of calculating numeric summaries.
Students will have prior knowledge of constructing boxplots and histograms.
Students will have prior knowledge of developing a hypothesis.

Learning Targets
Students will be able to identify and construct methods for controlling extraneous variables in a simple experiment.
Students will be able to connect a real world problem with a hypothesis to be explored.
Students will be able to calculate numeric summaries and use these summaries to determine if there appears to be support for a hypothesis.
Students will be able to construct graphical tools (boxplots and/or histograms) and use these tools to determine if there appears to be support for a hypothesis.

Time Required
Two class periods (approximately 40 to 50 minutes each)
Recommended:

- one class period to discuss the question and carefully design the experiment
- one class period to collect the data, analyze it, and interpret the results

Materials Required
Activity worksheet (page 24)
Stopwatches
Cans of cola (or other caffeinated soft drink; may also need some decaffeinated soda)
Worksheet (given below)
Pencils

Instructional Lesson Plan

The GAISE Statistical Problem-Solving Procedure

I. Formulate Question(s)

Begin by discussing recent articles about energy drinks that mention the fact that they may be a health hazard. Some possible articles are:

1. MNU News, *Professor's Mission to Educate the Public about Energy Drink Dangers*, Feb 2013 https://www.mnu.edu/newsroom/article/professor-s-mission-to-educate-public-about-energy-drink-dangers/
2. Vavra, Shannon, The Tufts Daily, *Health Experts Assess Risks of Long-term Energy Drink Consumption*, Dec 2012. http://dl.tufts.edu/file_assets/tufts:UP029.033.067.00056.
3. Brody, Jane, The New York Times, *Scientists See Dangers in Energy Drinks*, Jan 2011 http://www.nytimes.com/2011/02/01/health/01brody.html?_r=0
4. Edney, Anna, Bloomberg, *Energy Drinks' Health Danger Being Probed by U.S.*, (Nov 2012) http://www.bloomberg.com/news/2012-11-27/energy-drinks-health-dangers-being-probed-by-u-s-regulators.html

Several of the articles above note that the primary concern is the amount of caffeine. Furthermore, a couple of the articles point out that the main short-term concern is the effect of caffeine on the heart rate. Since the safety of energy drinks is in question, this experiment will use soda instead of energy drinks to explore the effect of caffeine on the body. The main question is the effect of caffeine on heart rate. Some possible questions to ask:

1. What is the possible problem with energy drinks?
2. What ingredients are used in energy drinks to give that boost of energy?
3. Which ingredient seems to be the main concern? Why?
4. What can happen to some people when too much caffeine is ingested?
5. Is it likely that this can happen to all people or are there just a few that are more susceptible?
6. How does caffeine affect the body?
7. What other sources of caffeine are there in addition to energy drinks?
8. How could you explore the effect of caffeine on the body?

Tell students that they will need to identify the variables of interest in their experiment. They will also need to identify and then decide how to control any variables that are not of interest, but may affect results of the experiment. They will carry out their sampling plan, then analyze and interpret the data.

Define an extraneous variable.
Extraneous variable: a variable that is not of interest but can affect the results

Ask

1. What can be done about extraneous variables? *(take a really large sample to average out the effect of the variable (usually not the preferred method) or control those variables)*
2. What if an extraneous variable is not controlled? *(results are suspect because the response may be because of these variables rather than the variable of interest)*
3. Is it always possible to completely control an extraneous variable? *(no, sometimes extraneous variables are difficult to identify and sometimes they cannot be adequately controlled)*

II. Design and Implement a Plan to Collect the Data

Break students into groups of 3 to 4 students. Give students the activity worksheet and tell them they are to design an experiment that will account for and control the extraneous variables. The next day they will collect, analyze, and interpret the data. See the worksheet for some possible ideas to consider.

Circulate through the room and give some hints or suggestions to those that seem to be stuck.

The emphasis of this lesson is on identifying and controlling extraneous variables.

After each group has completed the worksheet, direct a whole-class discussion of the proposed plans. Then select a method that ALL groups will use the next day so that all data is consistent. Things to prepare for:

1. Be sure all know how to use the stopwatch correctly.
2. Train all to take the pulse in the same manner.
3. If caffeinated and de-caffeinated cola will be used, then plans need to be made as to how to randomly select which students will get the caffeine and who won't and how this will be kept secret (this must also be done if a "drink" and "no drink" design is used).

On the second day any student who forgot and had caffeine within the 10 hours before the class needs to not participate.

Each group will proceed with data collection as planned.

[Design A]

If the class decided to control for fitness level and/or individual physiological differences by taking the pulse before and after, then use data collection sheets A (page 26). In this design all students will be drinking the caffeinated cola. *This is a matched pairs design* and the appropriate value to analyze is the difference in the pulse rate (after – before).

[Design B]

If the class decided to have some drink caffeinated cola and some drink decaffeinated cola, use data collection sheets B (page 27). (In this case they are assuming random assignment to the caffeinated and decaffeinated groups will assure fitness levels are equally distributed in the two groups.) In this scenario the appropriate analysis will be to compare the differences in pulse rates of the two groups. *This is an independent samples design.*

[Note: while drinking the cola the students can participate in a discussion of how they plan to analyze the data collected. However, they need to be sure they are accurate in the waiting time after finishing the cola and taking their pulse.]

III. Analyze the Data

The main objective of the experiment is to determine if caffeine increases the heart rate. Ask students what numbers can be calculated or what graphs can be drawn in order to help make this determination. This will depend on which design is selected (matched pairs or independent).

Design A:

Matched Pairs (take pulse before and after)

- Could look at the mean difference and the five-number summary of the differences. Depending on the background, a paired t-test can be performed. A histogram and boxplot of the differences could be helpful.

- Here is an example data set from this design along with results:

Table 1. Example Class Data – Matched Pairs.

(Difference in Heart Rate, After – Before)

After - Before	After - Before	After - Before	After - Before
12	2	3	5
6	5	3	9
3	6	10	8
9	-1	5	4
6	6	6	6
3	5	6	8
8	2	2	

- Have students calculate the mean and the five-number summary.
- Have students construct a boxplot from the five-number summary.
- Have students construct a histogram.

Table 2. Example Results from Class Data – Matched Pairs.

	Mean	Minimum	1st Quartile	Median	3rd Quartile	Maximum
After – Before	5.44	– 1	3	6	8	12

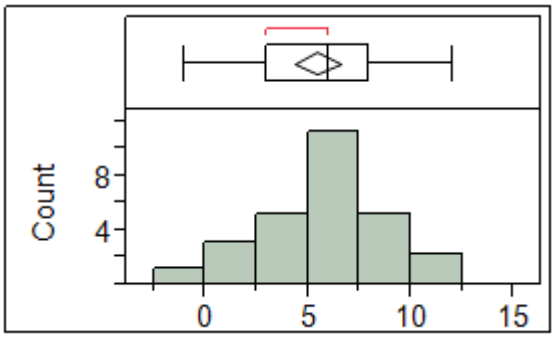


Figure 1. Example Graphs from Class Data – Matched Pairs.

Design B: Independent Samples (caffeinated and decaffeinated groups)

- Could compare the overall means for the two different groups and the five-number summaries. Comparative boxplots would be useful.

- Here is an example data set from this scenario along with results:

Table 3. Example Class Data – Independent Groups.

(Difference in Heart Rate, After – Before)

Caffeinated	
2	10
13	6
5	12
6	5
0	6
– 1	9
5	1

Decaffeinated	
3	4
0	1
– 3	2
– 1	5
4	– 2
1	4
– 2	– 1

- Have students calculate the means and the five-number summaries.
- Have students construct boxplots from the five-number summaries.
- Have students construct histograms.

Table 4. Example Results from Class Data – Independent Groups.

	Mean	Minimum	1st Quartile	Median	3rd Quartile	Maximum
Caffeinated	5.64	– 1	2	5.5	9	13
Decaffeinated	1.07	– 3	–1	1	4	5

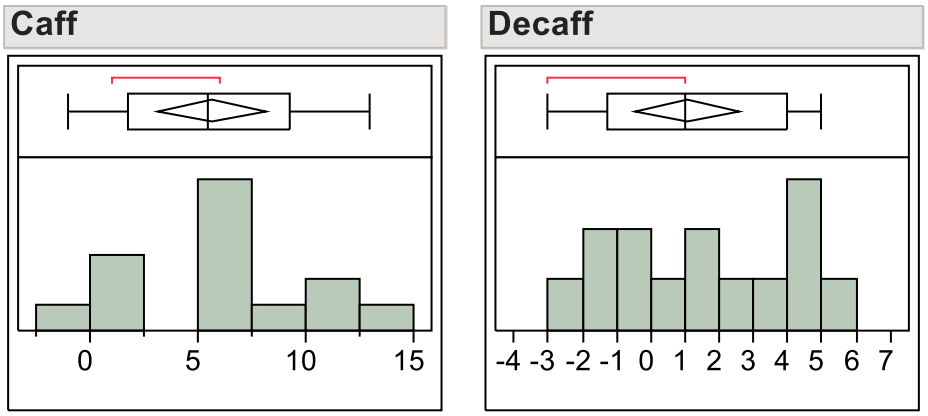


Figure 2. Example Graphs from Class Data – Independent Groups.

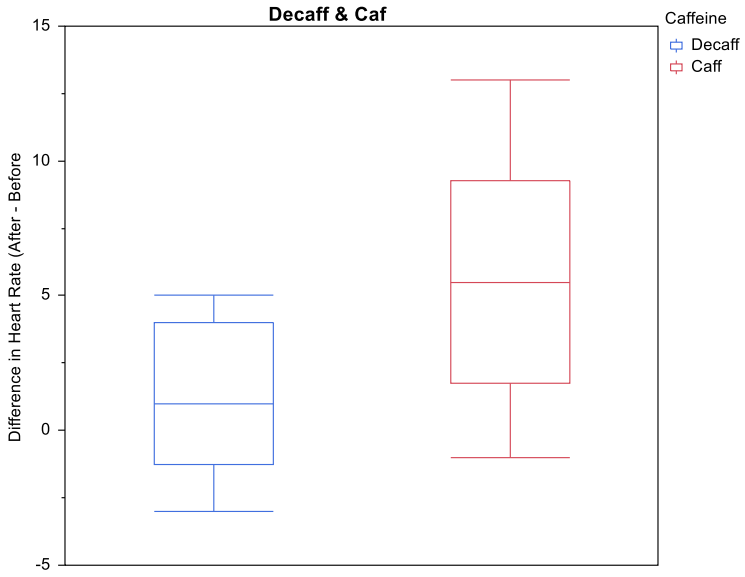


Figure 3. Example Side-by-side Boxplots – Independent Groups.

IV. Interpret the Results

Design A

- The mean difference can be compared to zero (the difference if there was no change after drinking the caffeine).
- If there were outliers, discuss what might have caused them.
- Look at the Interquartile Range, IQR = Q3 – Q1, to see if zero is in the interval – what does it mean if it is not? (it is likely the caffeine did raise the heart rate if the entire interval is above zero).

Design B

- Compare the means of the two groups – is the average difference in heart rate of the caffeinated group higher?
- Compare the five-number summary values and ask the same question.

- Compare the side-by-side boxplots.

Either Design

Discuss the following questions as appropriate:

- Can the results be generalized to the public?
- Can the results be generalized to the whole school?
- Have all the important extraneous variables been adequately controlled? Have you thought of another extraneous variable since yesterday?
- Can any differences seen be attributed to caffeine?
- Can you conclude that caffeine causes the heart rate to increase? (not without a formal test, but the descriptive statistics might indicate it is possible)
- What limitations are there from this study? (some possibilities: not certain all students had no caffeine in their bodies as many foods have caffeine that many are not aware of, this is looking at cola not energy drinks, there may be other ingredients that also affect the heart rate, etc.)

Assessment

1. Two different plant fertilizers are available. Set up an experiment to determine which will grow the largest plant by answering the following questions.
   a) What is the response variable?

   b) What is the explanatory variable?

   c) What are some possible extraneous variables?

   d) Describe how you would control any extraneous variables you mentioned.

   e) The data given is sample data from 10 plants with fertilizer 1 and 10 plants with fertilizer 2, *paired* by location. How can you compare the two fertilizers? Use the appropriate numerical summaries and graphs.

Height of tallest point, in inches

Location	1	2	3	4	5	6	7	8	9	10
Fertilizer 1	17.5	17.9	18.2	16.9	17.2	17.5	17.3	18.9	16.8	17.1
Fertilizer 2	18.4	17.9	18.2	17.6	17.6	18.8	18.1	17.4	17.8	17.6

2. A program for teaching fire safety is being evaluated. The students in this middle school come from four different elementary schools. Set up an experiment to determine if the program is effective in increasing fire safety awareness by answering the following questions.
   a) What is the response variable?

   b) What is the explanatory variable?

   c) What are some possible extraneous variables?

   d) Describe how you would control any extraneous variables you mentioned.

   e) The data given is sample data from 10 students with pre-scores and post-scores. How can you compare the scores? Use the appropriate numerical summaries and graphs.

Note: Setting these up as pairs would be a matched pairs design, **but for illustration purposes, the data is given as *independent* samples.**

Scores on Exam, out of 30 points possible

Pretest	28	14	6	24	8	13	11	11	9	4
Posttest	30	18	15	27	23	28	21	25	26	13

3. Does the use of iPads in the classroom increase the attention span, and therefore the amount of learning? Set up an experiment to determine if iPads increase test scores by answering the following questions.
   a) What is the response variable?

   b) What is the explanatory variable?

   c) What are some possible extraneous variables?

   d) Describe how you would control any extraneous variables you mentioned.

   e) The data given below are test scores from 10 students. Each student completed one unit of geography using an iPad and each completed another unit of geography without the use of an iPad. How can you compare the scores? Use the appropriate numerical summaries and graphs.

Test Scores, out of 80 possible points

Student	1	2	3	4	5	6	7	8	9	10
Used iPad's	78	72	50	67	73	62	69	50	58	69
No iPad's	70	67	46	69	73	60	62	39	63	70

Answers

1. a) size of plant

b) type of fertilizer

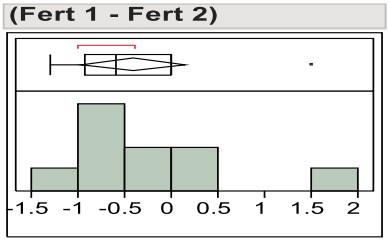
c) temperature of the room/location, amount of sunlight per day, amount of water, time of watering, type of soil, size of plant to start with, etc.

d) set plants side by side or measure temperature in various locations to ensure the temperature is the same, put pairs of plants in the same locations, carefully measure water each time and always water at the same time, use the same soil for potting both plants, select equivalent plants

e) Mean and five-number summary of differences in height (inches):

	Mean	Minimum	Q1	Median	Q3	Maximum
Fert 1 – Fert 2	– 0.41	– 1.30	– 0.90	– 0.60	0	1.50

Histogram and boxplot of differences in height (inches):



2. a) awareness (probably measured with a test)

b) curriculum

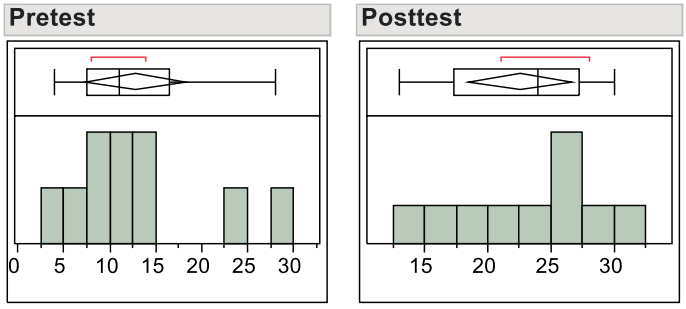
c) previous instruction, life experiences (some may have dealt with fires, extent and content of TV viewing, etc.)

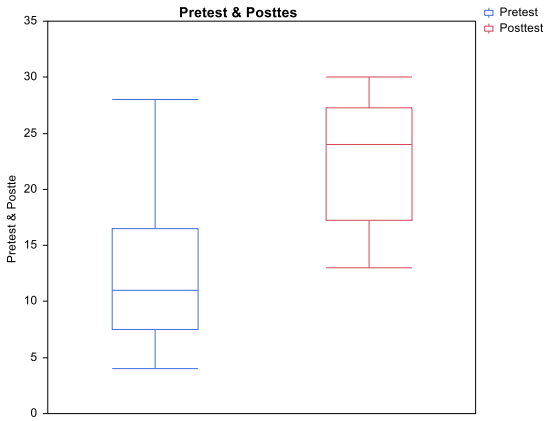
d) give a pretest and a posttest and measure the difference to see how much awareness was increased

e) means and five-number summaries of Pretest and Posttest scores:

	Mean	Minimum	Q1	Median	Q3	Maximum
Pretest	12.8	4	8	11	14	28
Posttest	22.6	13	18	24	27	30

Histograms and boxplots of Pretest and Posttest scores:

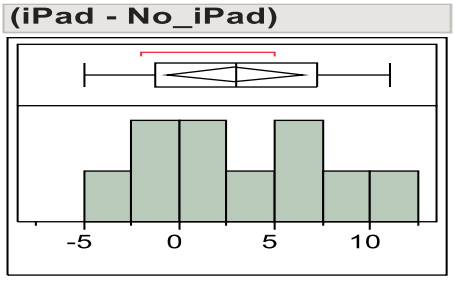




3. a) test score at end of unit
b) use of iPad or no iPad
c) previous knowledge, aptitude for geography, experience with iPad, etc.
d) have the students use iPad's on some units and not on others
e) means and five-number summaries of differences in test scores:

	Mean	Minimum	Q1	Median	Q3	Maximum
iPad – No iPad	2.9	– 5	– 1	3	7	11

Histogram and boxplot of differences in test scores:



Possible Extensions

To explore extraneous variables in other settings, three additional topics are given with the original worksheet. These can be discussed without actually collecting data to apply and extend some of the concepts of controlling extraneous variables.

1. New Patio Material – explores the idea that sometimes experiments take too long so artificial methods may be used for aging and wear in some cases. How does this affect the validity of the results?
2. Therapy for Depression – explores the idea that some situations have an overwhelming number of extraneous variables and not all can be controlled

(side issues – some populations, especially populations of people, have high variation and so larger samples are necessary; using volunteers is not valid, yet it can be difficult to get a random sample).

3. Study Environment – this explores the idea that sometimes a strictly controlled environment is necessary (although, like topic 1 above, an artificial environment can bias results).

References

1. *Guidelines for Assessment and Instruction in Statistics Education* (GAISE) Report, ASA, Franklin et al., ASA, 2007 http://www.amstat.org/education/gaise/

2. Adapted from an activity recorded here: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.como.wa.edu.au%2Fuploads%2Fmedia%2FGood_and_Bad_Experiments2.doc&ei=T_dNUKacLaGi2QWW74HwBg&usg=AFQjCNH3u3AYYlPF6KtgR_T7gIrTW3dAeg

Consuming Cola Activity Sheets
Activity sheets, along with corresponding answers **in red** are given starting on the next page.

Blank student activity sheet handouts are given starting on page 20.

Names _____

Consuming Cola

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

There is a question regarding the safety of energy drinks. This is because of many different ingredients, but especially because of the high level of caffeine in the drinks.
State the hypothesis you want to test (make it specific but concise):

Drinking caffeinated cola increases heart rate

Describe your variables.
Response Variable(s):

Heart rate

Explanatory Variable(s):

Caffeine intake

Treatments:

Before cola	OR	1 can de-caffeinated cola
After 1 can of cola		1 can regular cola

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

possible variables:

- exercise level immediately before consuming the cola
- other intake of caffeine within the previous few hours
- psychological effect (subjects will know they have had an intake of caffeine)
- general physical fitness
- different person taking the pulse (methods and diligence can vary)
- physiological responses to caffeine can vary a lot from person to person

Names _____

Experimental Design:
BE SPECIFIC !!

Main Concern is **How to Control** –should try to control any extraneous variables identified above (suggested strategies are given below)

Sample Size: How big a sample needs to be to account for any variables not controlled? (this will probably be constrained by practical limitations such as class size)	How to Measure the Response Variable(s): Five minutes after drinking the cola, measure heart rate by taking their pulse – count heart rate for 30 seconds, then double
Equipment Needed: Stopwatch for measuring heart rate Cans of cola	How to Take the Sample: Randomly select from class If possible, randomly select from all students at the school
How to Control Other Variables: Describe how each of the extraneous variables will be controlled Do a paired t-test – take pulse before and after consuming the cola (fitness level) * Ensure no other caffeine sources have been consumed within previous 10 hours (previous intake of caffeine) ** Ensure no strenuous exercise was done in the past hour (exercise level) Have all subjects sit for 10 minutes before starting (exercise level) Randomly assign some to drink a de-caffeinated cola and others a caffeinated cola AND keep this secret (psychological effect) Train all students to take the pulse the same way (different ways of using stopwatch, taking pulse) * note that a block design could also be used to account for fitness level ** this is why the data should be collected the next day – so that students will not have any caffeine in their system	Applicable Results: Can the results be generalized to the U.S. public? If not, what would have to be done to be able to generalize to the entire U.S. public? Don't use just students at this school (in this class) Try to include all ages Try to include all health/fitness levels

Other Comments:

Names _____

Patio Tile

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

A construction company wants to compare a new type of tile used for patios to the currently used tile. Does the new tile last longer?
State the hypothesis you want to test (make it specific but concise):

New material lasts longer than tile

Describe your variables.
Response Variable(s):

Life of patio (duration)

Explanatory Variable(s):

Material used

Treatments:

Current tile
New material

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

possible variables:

- location – different weather types
- usage – home with children? pets?
- if using just some tiles in the patio (not the whole patio), need to ensure all are in areas of similar use

Experimental Design:
BE SPECIFIC !!

Main Concern is **How to Control** – should try to control any extraneous variables identified above (suggested strategies are given below)

Sample Size: Answer may depend on what the class has previously learned about sample size	How to Measure the Response Variable(s): Record how long the material lasts until the first chip (this may be a long time, could use special equip to artificially age & weather slabs of material)
Equipment Needed: Slabs of the materials Possibly equip to age & weather the slabs	How to Take the Sample: Randomly assign the slabs of material to different homes If in a lab, randomly assign to times, take materials from different factory lots
How to Control Other Variables: Put slabs in different locations (controls weather) Put slabs in different types of homes (controls usage, i.e. children, pets, etc.)	How to Ensure Results Apply to the Real World: Actually installing real patios in real homes is best If slabs in homes, ensure they are high traffic areas If in a lab, ensure effects of weather, use, etc. are realistic If artificially aging, ensure it's done according to current best practices

Other Comments:

Names _____

Depression

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

A new therapy is designed to help with the depression that often follows the break-up of a long-term relationship.
State the hypothesis you want to test (make it specific but concise):

The new therapy alleviates depression

Describe your variables.
Response Variable(s):

Level of depression

Explanatory Variable(s):

Therapy availability

Treatments:

Given new therapy
No therapy

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

possible variables:

- job stress
- health status
- family dynamics
- financial situation
- religious outlook
- any chemical dependencies
- type of long term relationship
- too numerous to list!!

Experimental Design:
BE SPECIFIC !!

Main Concern is **How to Control** – should try to control any extraneous variables identified above (suggested strategies are given below)

Sample Size: Answers can vary depending on the background of the students	How to Measure the Response Variable(s): Use standard test for depression from professional sources Also can have psychiatrist do evaluation
Equipment Needed: Any test questionnaires used to evaluate depression (otherwise, none)	How to Take the Sample: Find those with a recent break-up of a long-term relationship (possible sources: psychiatrist offices, hospital clinics, doctor's offices …) [Note: if volunteers are sought through advertising, what could be a problem with that? (Only certain personalities tend to volunteer …)] Randomly select participants from those sources
How to Control Other Variables: Randomly assign who is in which group Ensure all personality types are in both groups (either take large enough samples or measure this and ensure groups are similar) Really need a large enough sample to ensure all groups are similar in such areas as: job stress, health concerns, family dynamics, etc. * could try blocking on some of the variables if this concept is known to the students	How to Ensure Results Apply to the Real World: Be sure the new therapy provided is not unrealistic by using only the best, well-trained, experienced therapists Be sure the sample includes all types of people

Other Comments:

Names _____

Study Environment

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

A quiet environment seems to help retention when studying for an exam.
State the hypothesis you want to test (make it specific but concise):

A quiet environment improves retention and comprehension

Describe your variables.
Response Variable(s):

Retention, Comprehension

Explanatory Variable(s):

Environment

Treatments:

Quiet environment
Moderately noisy environment
Noisy environment

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

possible variables:

- individual abilities in the subject area of the exam
- possible background noises (outside hallways, busy streets, people in the room, etc.)
- possible movement in the room

Names _____

Experimental Design:
BE SPECIFIC !!

Main Concern is **How to Control** – should try to control any extraneous variables identified above (suggested strategies are given below)

Sample Size: Answer may depend on what the class has previously learned about sample size	How to Measure the Response Variable(s): Immediately after studying take a test for retention and a test for comprehension
Equipment Needed: People/recorder for making noise/distractions Tests for retention/comprehension	How to Take the Sample: Ask for volunteers of regional high school students Randomly select participants from volunteers (better would be to ask for teachers to allow their classes to participate – and select randomly from this larger group)
How to Control Other Variables: Randomly assign who is in which group Give before and after tests and use the difference so that individual abilities are accounted for Do in a controlled environment so that the effects of background are removed (all have same noise/distractions – no trains, sirens, construction, etc. differences) Ensure all cell phones and similar devices are turned off!	How to Ensure Results Apply to the Real World: Don't use just college students **IF** the intent is for high school students (if the intent is for college, then use only college students) Make the noise/distractions realistic, i.e. use music, TV programs that the participant likes, have realistic background noises

Other Comments:

Names _____

Consuming Cola

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

There is a question regarding the safety of energy drinks. This is because of many different ingredients, but especially because of the high level of caffeine in the drinks.
State the hypothesis you want to test (make it specific but concise):

Describe your variables.
Response Variable(s):

Explanatory Variable(s):

Treatments:

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

Experimental Design:
BE SPECIFIC !!

Sample Size:	How to Measure the Response Variable(s):
Equipment Needed:	How to Take the Sample:
How to Control Other Variables: Describe how each of the extraneous variables will be controlled	Applicable Results: Can the results be generalized to the U.S. public? If not, what would have to be done to be able to generalize to the entire U.S. public?

Other Comments:

A

Group Data Collection Sheet

(Cola Consumption)

Student ID Number	Pulse Before	Pulse After	Difference (After – Before)

A

Class Data Collection Sheet

(Cola Consumption)

Student ID	Pulse Before	Pulse After	Difference (After – Before)

Student ID	Pulse Before	Pulse After	Difference (After – Before)

B

Group Data Collection Sheet

(Cola Consumption)

Student ID Number	Pulse

B

Class Data Collection Sheet

(Cola Consumption)

Student ID	Pulse	Treatment (C/D)

Student ID	Pulse	Treatment (C/D)

(C/D) – caffeinated cola / decaffeinated cola

Names _____

Patio Tile

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

A construction company wants to compare a new type of tile used for patios to the currently used tile. Does the new tile last longer?
State the hypothesis you want to test (make it specific but concise):

Describe your variables.
Response Variable(s):

Explanatory Variable(s):

Treatments:

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

Experimental Design:
BE SPECIFIC !!

Sample Size:	How to Measure the Response Variable(s):
Equipment Needed:	How to Take the Sample:
How to Control Other Variables:	How to Ensure Results Apply to the Real World:

Other Comments:

Names _____

Depression

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

A new therapy is designed to help with the depression that often follows the break-up of a long-term relationship.
State the hypothesis you want to test (make it specific but concise):

Describe your variables.
Response Variable(s):

Explanatory Variable(s):

Treatments:

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

Experimental Design:
BE SPECIFIC !!

Sample Size:	How to Measure the Response Variable(s):
Equipment Needed:	How to Take the Sample:
How to Control Other Variables:	How to Ensure Results Apply to the Real World:

Other Comments:

Names _____

Study Environment

Design an experiment. Be detailed. Use this outline.

Turn in ONE sheet for your group with all names listed above.

A quiet environment seems to help retention when studying for an exam.
State the hypothesis you want to test (make it specific but concise):

Describe your variables.
Response Variable(s):

Explanatory Variable(s):

Treatments:

Extraneous Variables:
These are variables that may affect the outcome of the experiment, but are not really of interest to this study.

Names _____

Experimental Design:
BE SPECIFIC !!

Sample Size:	How to Measure the Response Variable(s):
Equipment Needed:	How to Take the Sample:
How to Control Other Variables:	How to Ensure Results Apply to the Real World:

Other Comments: