

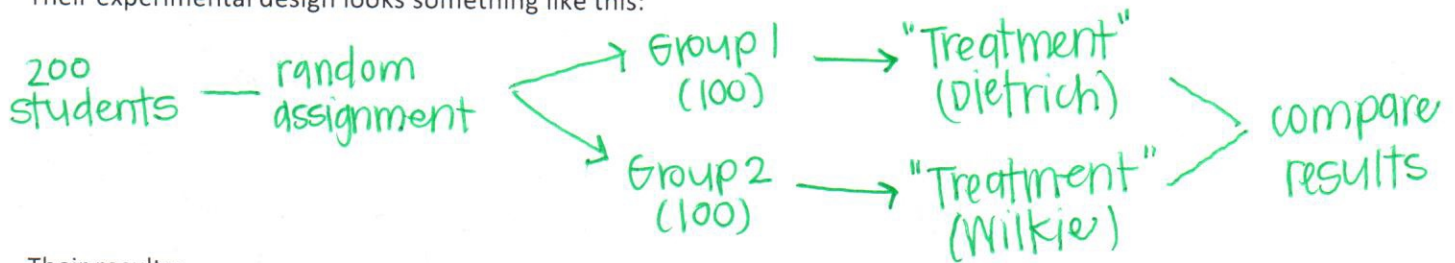
OBJECTIVES:

- Through a Simulation, develop an understanding of what it means to be statistically significant.
- Be able to explain what the chance variation from inherent randomness is that occurs when sampling and how we deal with it.

Resource: <https://www.khanacademy.org/math/statistics-probability/significance-tests-confidence-intervals-two-samples/comparing-two-means/v/statistical-significance-experiment>

EXAMPLE: Mr. Dietrich and Mr. Wilkie want to teach a new unit, two different ways. This year, they decided to teach it both ways and then compare results. The results would help them could choose the best way for the following year. One aspect they wanted to compare was how engaging the lessons were (essentially, whose lesson was more boring). Since testing levels of engagement is hard to actually measure, both teachers agreed that an experiment would be the best way to test the levels in their students during the lessons. However, they can't afford brain wave monitoring equipment, so they determined that when you are bored you eat more. This prompted them to monitor how many grams of goldfish crackers were consumed during the lessons to indicate how bored students are.

Their experimental design looks something like this:



Their results:

They found that Mr. Dietrich's class consumed 9 grams more on average

Does this mean that Mr. Wilkie's lessons were more engaging, or could this have occurred just by chance?

- Maybe the students who tend to eat more got randomly assigned to Mr. Dietrich's class.
- Maybe it's the time of day.

Understanding aspects about statistics, both teachers know that they can't just say that the way Mr. Wilkie taught was "better". They need to see if the results they found were unlikely to have occurred due to just chance variation. This

means that they will check to see if their result is statistically significant

↳ didn't just happen by chance or is what we saw strong enough to actually show results.

Using a simulation:

We will use a simulation to test "**If there was ^{H₀} no difference in boringness**". What is the probability that there is a mean difference of 9 grams or more just by chance? ↳ assumption

we need to keep track of all goldfish consumed by students.

1. First, we want to simulate what we could see in samples, "**If there was no difference in boringness.**" If there is no difference, then keeping track of what treatments student received (whose class they were in) should be ignored.

maybe we are assuming each individual student ate what they ate just because of who they are.

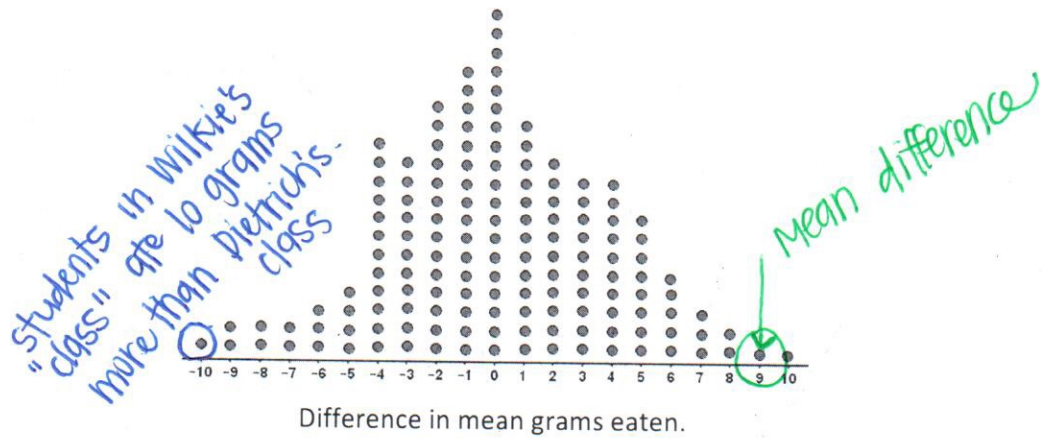
students

1. 9 g
2. 1 g
3. 5 g
4. 0 g
- ...
198. 3 g
199. 14 g
200. 2 g

Random Assgn

- ① #1-100 → D $\bar{x} = 9$
#101-200 → W
- ② odd → D $\bar{x} = 2$
even → W
- ③ every 5th # → D $\bar{x} = -4$
all others → W
- ④ 1-50, 150-200 → D $\bar{x} = -10$
50-150 → W

2. Results from Simulating this 150 times:



This is what is known as a sampling distribution.
Many statistical ideas are founded on the understanding of what these are.

We observed, from our two samples, a mean difference of 9 grams. Label this on the sampling distribution.

In this case, a statistic is the sample difference of means. So, calculate the probability of observing a statistic as extreme, or more extreme, of what we saw.

$$\hat{p} = \frac{2}{150} = 0.0133 \text{ OR } 1.3\% \text{ probability of getting 9 grams more BY CHANCE}$$

Our statistic turned out to be an extremely rare occurrence. Remember, this is rare only if we are assuming that THERE ISN'T ANY DIFFERENCE between Mr. Wilkie's lesson and Mr. Dietrich's.

so, if there is no difference the sample mean of 9 grams was so rare that it makes us think our assumption is WRONG! so, the has to be a difference in boringness!

Therefore, we would conclude that there is a difference in how engaging Mr. Dietrich's and Mr. Wilkie's classes are.

When a situation results in a statistic that occurs only a small amount of the time, it means that we have statistically significant evidence.

In conclusion, the difference of 9 grams that was observed is extremely unlikely to occur just by chance.