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Algebra II

Evaluating Effectiveness of Treatments (Mean Differences)

1. Ten tomatoes are randomly selected to test the effectiveness of a treatment. From these ten tomatoes, five were randomly assigned to the treatment group and five were randomly assigned to the control group. The treatment group was administered a treatment while the control group was not. After time passed, the weights of the tomatoes were recorded. The weights are displayed below.

TREATMENT Group A	CONTROL Group B
9.1	7.7
8.4	6.4
8.0	5.2
7.3	4.4
5.9	3.8

$$\frac{9.1+8.4+8.0+7.3+5.9}{5}$$

7.74

$$\frac{7.7+6.4+5.2+4.4+3.8}{5}$$

5.5

What type of statistical study is being performed? Explain your answer.

Controlled experiment. There is a treatment being applied to a randomly assigned treatment group.

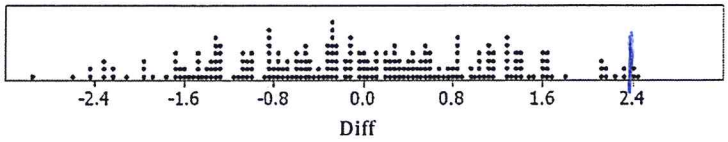
Calculate the mean difference in weight (treatment group – control group). Explain the meaning of what you found.

7.74 - 5.5 = 2.24

On average, tomatoes in the treatment group weigh 2.24 more than the control group.

Randomly assign the tomatoes to two groups (group A and group B) and calculate the mean difference (group A – group B) for the two groups. Repeat this process several times.

The dot plot represents a simulation of calculations of the mean difference in weights of the two randomly assigned groups. The dots are placed at increments of **0.04** ounces.



Based on your data, does the treatment cause the tomatoes to grow bigger? Explain your answer.

Yes, 2.24 is not in the confidence interval

2. Seventy-two students are randomly divided into two equally-sized study groups. Each member of the first group (group 1) is to meet with a tutor after school twice each week for one hour. The second group (group 2), is given an online subscription to a tutorial account that they can access for a maximum of two hours each week. Students in both groups are given the same tests during the year. A summary of the two groups' final grades is shown below:

The students in group 1 scored on average 3.64 points lower than group 2.

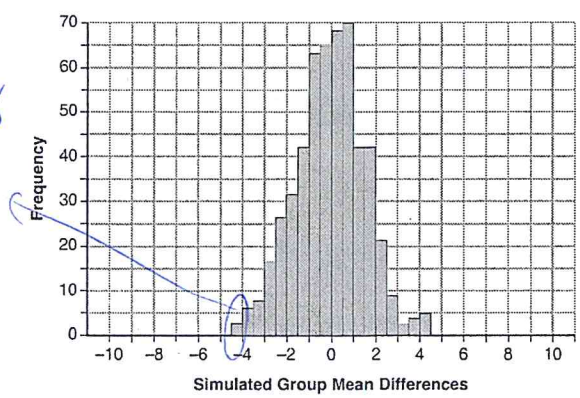
	Group 1	Group 2
$\bar{x}$	80.16	83.8
S_x	6.9	5.2

80.16 - 83.8
-3.64

Calculate the mean difference in the final grades (group 1 – group 2) and explain its meaning in the context of the problem. A simulation was conducted in which the students' final grades were rerandomized 500 times. The results are shown below.

$\frac{9}{500} = .018$

1.8%



Use the simulation to determine if there is a significant difference in the final grades. Explain your answer.

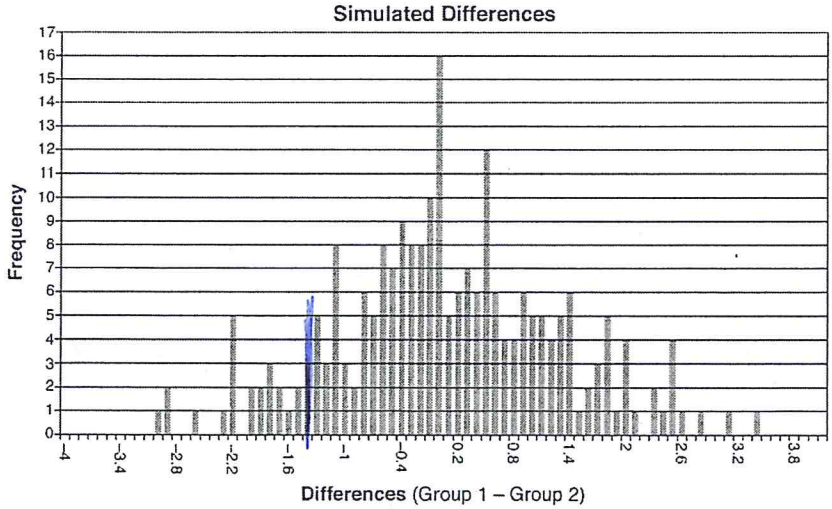
Yes, -3.64 is not in the confidence interval

3. Ayva designed an experiment to determine the effect of a new energy drink on a group of 20 volunteer students. Ten students were randomly selected to form group 1 while the remaining 10 made up group 2. Each student in group 1 drank one energy drink, and each student in group 2 drank one cola drink. Ten minutes later, their times were recorded for reading the same paragraph of a novel. The results of the experiment are shown below.

Group 1 (seconds)	Group 2 (seconds)
17.4	23.3
18.1	18.8
18.2	22.1
19.6	12.7
18.6	16.9
16.2	24.4
16.1	21.2
15.3	21.2
17.8	16.3
19.7	14.5
Mean = 17.7	Mean = 19.1

Some students in group 2 read faster than group 1.

Ayva thinks drinking energy drinks makes students read faster. Using information from the experimental design or the results, explain why Ayva's hypothesis may be *incorrect*. Using the given results, Ayva randomly mixes the 20 reading times, splits them into two groups of 10, and simulates the difference of the means 232 times.



Ayva has decided that the difference in mean reading times is not an unusual occurrence. Support her decision using the results of the simulation. Explain your reasoning.

17.7 - 19.1 = -1.4

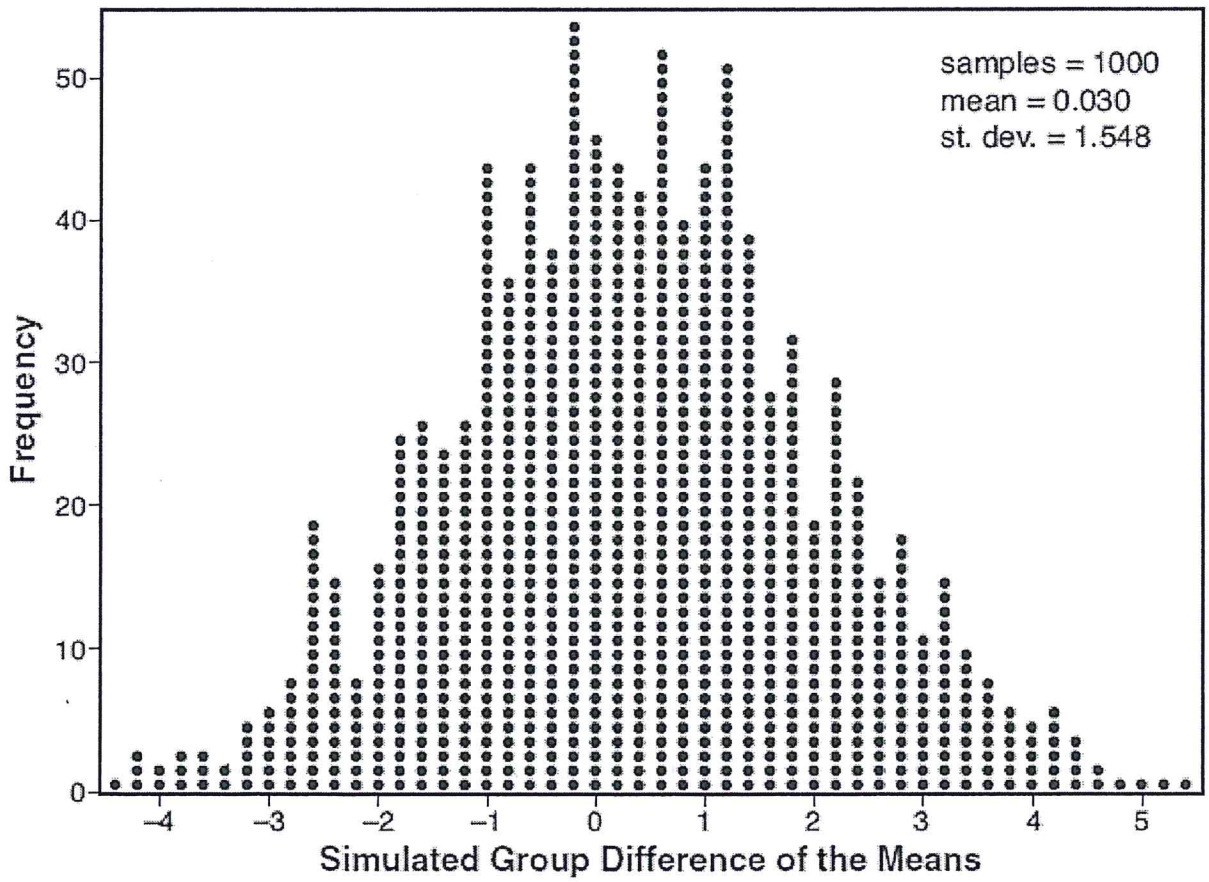
-1.4 is inside the confidence interval

4. Joseph was curious to determine if scent improves memory. A test was created where better memory is indicated by higher test scores. A controlled experiment was performed where one group was given the test on scented paper and the other group was given the test on unscented paper. The summary statistics from the experiment are given below.

	Scented Paper	Unscented Paper
$\bar{x}$	23	18
s_x	2.898	2.408

23-18=5

Calculate the difference in means in the experimental test grades (scented -unscented). A simulation was conducted in which the subjects' scores were rerandomized into two groups 1000 times. The differences of the group means were calculated each time. The results are shown below.



Use the simulation results to determine the interval representing the middle 95% of the difference in means, to the *nearest hundredth*. Is the difference in means in Joseph's experiment statistically significant based on the simulation? Explain.

$CI = \bar{x} \pm 2S_x$

$CI = .03 + 2(1.548) = 3.13$

$.03 - 2(1.548) = -3.07$

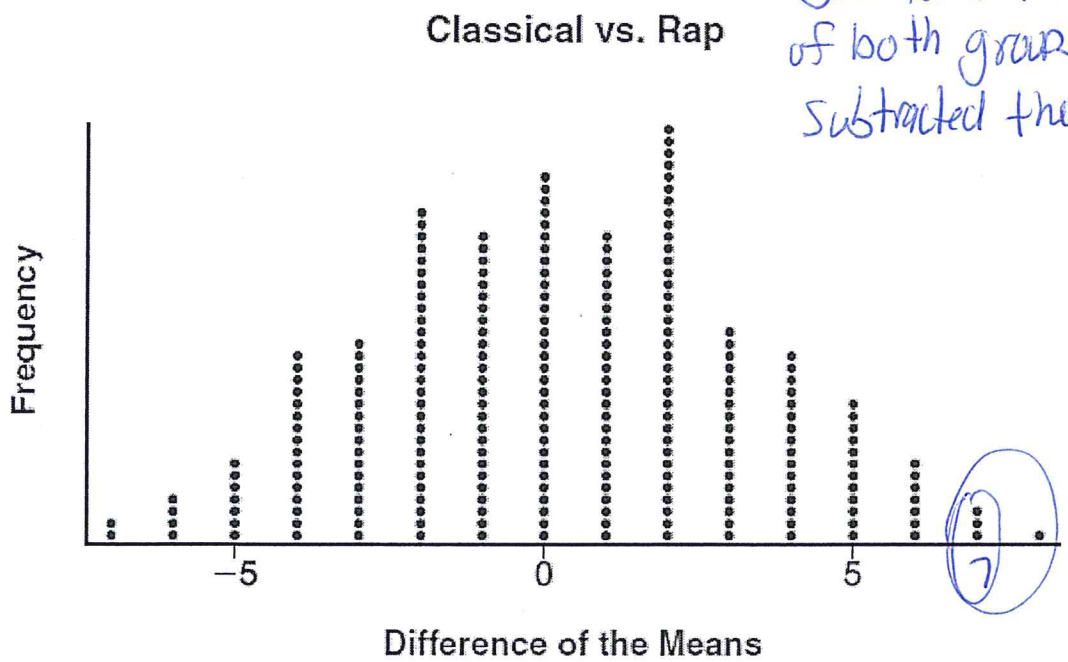
$[-3.07, 3.13]$

5. To determine if the type of music played while taking a quiz has a relationship to results, 16 students were randomly assigned to either a room softly playing classical music or a room softly playing rap music. The results on the quiz were as follows:

Classical: 74, 83, 77, 77, 84, 82, 90, 89
Rap: 77, 80, 78, 74, 69, 72, 78, 69

John correctly rounded the difference of the means of his experimental groups as 7. How did John obtain this value and what does it represent in the given context? Justify your answer. To determine if there is any significance in this value, John rerandomized the 16 scores into two groups of 8, calculated the difference of the means, and simulated this process 250 times as shown below.

John found the mean of both groups and subtracted them.

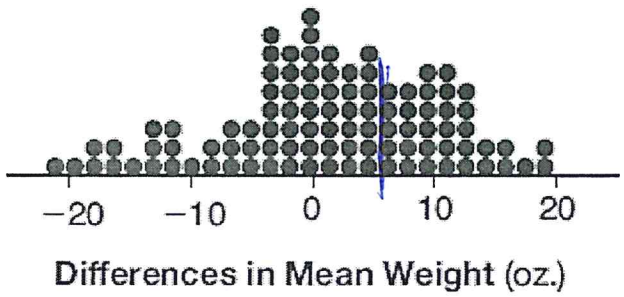


Does the simulation support the theory that there may be a significant difference in quiz scores? Explain.

Yes, 7 or more extreme occurs less than 5% of the time. 7 is not in the confidence interval.

$\frac{4}{250} = .016$
1.6%

6. Gabriel performed an experiment to see if planting 13 tomato plants in black plastic mulch leads to larger tomatoes than if 13 plants are planted without mulch. He observed that the average weight of the tomatoes from tomato plants grown in black plastic mulch was 5 ounces greater than those from the plants planted without mulch. To determine if the observed difference is statistically significant, he rerandomized the tomato groups 100 times to study these random differences in the mean weights. The output of his simulation is summarized in the dotplot below.



Do you believe that planting in black plastic mulch causes larger tomato size? Explain your answer.

No, 5 occurred more than 5% of the time. 5 is inside the confidence interval.

7. A researcher wanted to determine whether a certain drug led to higher birthweights of newborn babies. She randomly selected a sample of pregnant women and randomly divided them into two groups, one of which received the drug while the other received a placebo. She found that the babies of the parents who received the drug weighed 0.8 pounds more than the babies of the parents who did not receive the drug. The researcher then re-randomized all of the subjects and created a sample distribution of all of the means. What would the researcher now have to do to determine whether or not the drug is effective in increasing the birthweight of newborn babies?

Determine if 0.8 is in the confidence interval.