Unit 8, Lesson 14

Questioning Experimenting

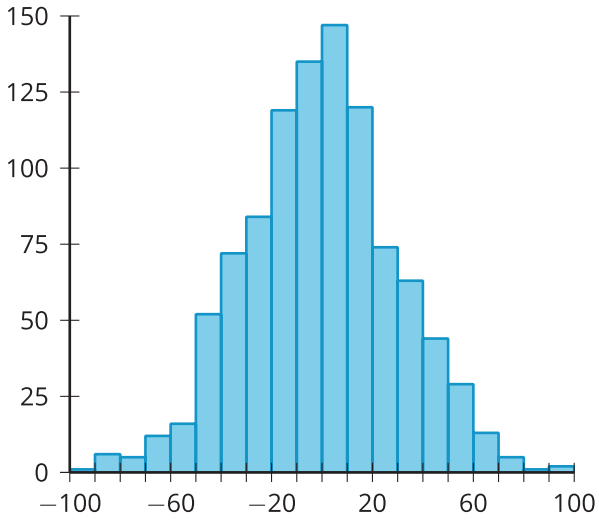
Let's ask the right questions to analyze data from an experiment.

14.1 Is It the Treatment?

A scientist divides 30 strawberry plants into two groups at random. One group of 15 plants represents the control group and grows in standard greenhouse conditions. The second group of 15 plants represents the treatment group and grows under the same conditions except the type of soil the plants are grown in. After 6 weeks, the total weight (in grams) of the strawberries are measured for each plant. The scientist then performs a randomized experiment to compare the groups.

The data are summarized by these statistics and histogram.

- Mean for the control group: 238.67 grams
- Mean for the group with different soil: 347.47 grams
- Standard deviation of differences in means from randomized groupings: 29.83 grams



differences in means from random groupings

Is there evidence that the difference in means from the original groupings is due to the different soil? Explain your reasoning.

14.2 Info Gap: Is There a Difference?

Your teacher will give you either a problem card or a data card. Do not show or read your card to your partner.

If your teacher gives you the problem card:

1. Silently read your card and think about what information you need to answer the question.
2. Ask your partner for the specific information that you need. "Can you tell me _____?"
3. Explain to your partner how you are using the information to solve the problem. "I need to know _____ because _____."

   Continue to ask questions until you have enough information to solve the problem.
4. Once you have enough information, share the problem card with your partner, and solve the problem independently.
5. Read the data card, and discuss your reasoning.

If your teacher gives you the data card:

1. Silently read your card. Wait for your partner to ask for information.
2. Before telling your partner any information, ask, "Why do you need to know _____?"
3. Listen to your partner's reasoning and ask clarifying questions. Only give information that is on your card. Do not figure out anything for your partner!

   These steps may be repeated.
4. Once your partner says they have enough information to solve the problem, read the problem card, and solve the problem independently.
5. Share the data card, and discuss your reasoning.

14.3 Using Tables for Normal Distribution Areas

A factory produces baseballs. The weights of the baseballs produced are approximately normally distributed with a mean weight of 145 grams and a standard deviation of 2 grams. Official rules require the balls to weigh between 142 and 149 grams.

Recall that the proportion of items in an interval of an approximately normally distributed situation can be estimated by the area under the normal curve. A table can be used to determine the area under a normal curve bounded by an interval.

First, the relevant values need to be converted to a *z-score*. A value's z-score represents the number of standard deviations it is above the mean. In the baseball example, the value 147 grams has a z-score of 1 because it is 1 standard deviation above the mean. The value 140 grams has a z-score of -2.5 because it is 2.5 standard deviations below the mean.

In general, a z-score can be found using

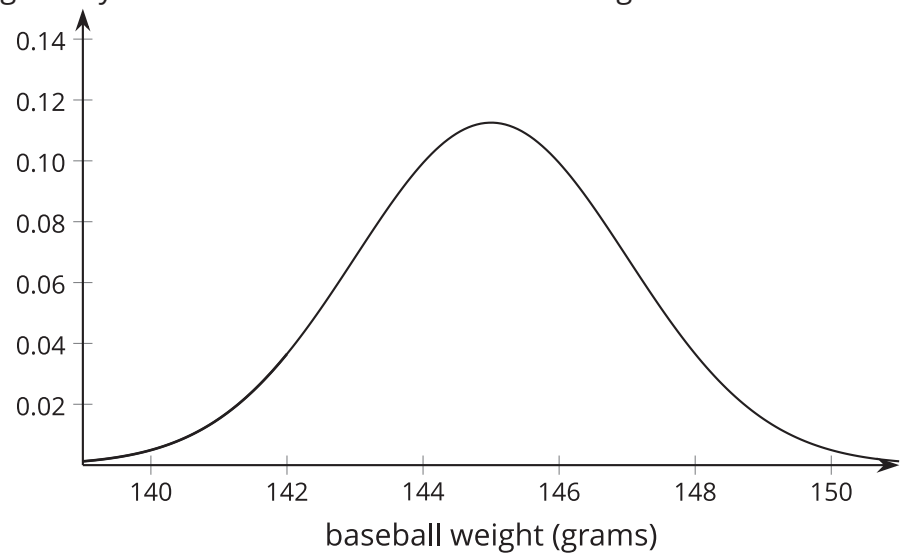
$$z = \frac{\text{value} - \text{mean}}{\text{standard deviation}}$$

1. Find the z-score for 142 grams.

2. Find the z-score for 149 grams.

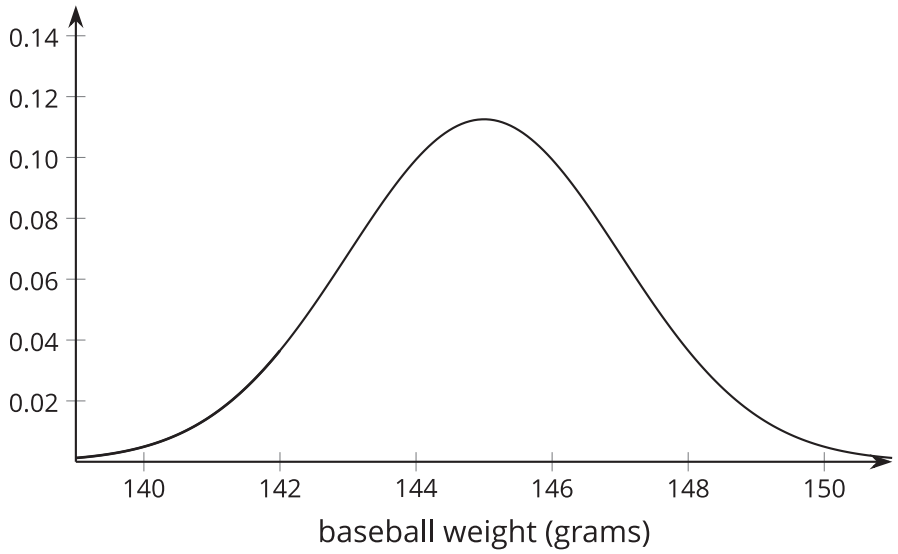
3. What value has a z-score of 1.45?

4. The table gives the area under the normal curve that is less than the given value. Shade the region that is given by the table for the area related to 142 grams.



5. Use the z-score for 142 grams and the table to find the area under the normal curve that is less than 142 grams.

6. Shade the region that is given by the table for the area related to 149 grams.



7. Use the z-score for 149 grams and the table to find the area under the normal curve that is less than 149 grams.

8. Use the two areas to find the area under the normal curve between 142 and 149 grams. Explain or show your reasoning.

9. What proportion of the baseballs that the factory makes is estimated to be within the official rules?

Are you ready for more?

Here are descriptions of 2 different approximately normal distributions. Distribution A has a mean of 55 and a standard deviation of 8. Distribution B has a mean of 6 and a standard deviation of 1.6.

From Distribution A, a person is interested in a value of 70. From Distribution B, the person is interested in a value of 10. How can z-scores be used to determine which is more relatively extreme?

Lesson 14 Summary

After collecting data from an experiment, it is important to analyze the data to determine whether there is evidence that the difference in means for the groups is due to the treatment or whether the difference might be explained by the random groupings. There are several things that an experimenter needs to know to determine the possible cause of the differences.

First, the difference in the means for the two groups is important to know. Then the difference can be compared to the differences in means collected from regrouping the data into groups at random. The proportion of differences in means that are more extreme than the original difference can help determine whether the results we observed are inconsistent with the assumption that the treatment had no effect.

The proportion can be determined either from counting the actual number of differences that are more extreme or modeling the differences with a normal distribution.