Learning Goals:

- Construct a confidence interval to estimate a population mean when conditions are met and a population standard deviation (σ) is known. Interpret the confidence interval in context.
- Interpret the meaning of a confidence level associated with a confidence interval.
- Adjust the margin of error by making changes to the confidence level or sample size.

Introduction:

In this activity we will learn to construct a confidence interval that provides a range of estimates for the population mean. As before, the confidence interval is based on a normal model for the distribution of sample statistics, in this case, sample means.

1) Recall the general formula for a 95% confidence interval is

   Sample statistic ± margin of error
   Sample statistic ± 2(standard error)

   Given what we have learned about the distribution of sample means, what do you think is the formula for the confidence interval for a population mean? (Use the appropriate symbols: $\bar{x}, n, \mu, \sigma$. You may not need all of these.)

2) What conditions have to be met to use this formula to estimate a population mean? Why?

Group work:

3) Is smoking prior to pregnancy associated with low weight births? To investigate this question, researchers analyzed medical records for a random sample of 100 pregnant women who reported that they smoked prior to pregnancy but stopped smoking during pregnancy. The average birth weight for this sample of previous smokers was 3430 grams. From a large body of research, it is known that birth weights have a standard deviation of approximately 570 grams. The researchers assume that smoking does not affect the variability in birth weight.

   a) Verify that the conditions are met for use of the confidence interval formula for estimating μ.

   b) Based on this study, find a 95% confidence interval for μ, the mean birth weight of women who smoked prior to pregnancy, and interpret your interval in the context of mean birth weights for previous smokers.

   c) This same study found that women who never smoked had a mean birth weight of 3450 grams. Does your confidence interval suggest that women who smoked prior to pregnancy and then stopped smoking tend to have a lower mean birth weight than women who never smoked? Why or why not?

   d) The researchers want to decrease the margin of error for their confidence interval while also maintaining 95% confidence in their results. What advice do you have for them?

4) Is smoking during pregnancy associated with low weight births? To investigate this question, researchers analyzed medical records for a random sample of 100 women who smoked 10 or more cigarettes a day during pregnancy. The confidence interval based on their sample is 2964 to 3192 grams.

   Which of the following interpretations is valid? If an interpretation is not valid, explain why.

   - We are 95% confident that every woman who smokes 10 or more cigarettes a day during pregnancy will have a baby who weighs between 2964 to 3192 grams.

   - We are confident that 95% of the women who smoke 10 or more cigarettes a day during pregnancy will give birth to a baby who weighs between 2964 to 3192 grams.

   - We are 95% confident that the mean birth weight for women who smoke 10 or more cigarettes a day during pregnancy lies between 2964 and 3192 grams.

   - We expect 95% of possible sample means from this population to fall between 2964 and 3192 grams.

5) Here is a StatCrunch printout for estimating the mean birth weight for babies born to mothers who never smoked.

One sample Z confidence interval:
μ : Mean of population
Standard deviation = 570

95% confidence interval results:

Mean	n	Sample Mean	Std. Err.	L. Limit	U. Limit
μ	100	3450	57	3338.2821	3561.7179

a) What does the standard error tell us in this context? How is it related to the margin of error?

b) Give the confidence interval from the print-out and interpret it in the context of birth weights for mothers who never smoked.

6) Instructors will often say that a student should study two hours outside of class for every hour in class. Suppose that a random sample of college students has a mean of 1.5 study hours for each hour in class.

a) Which of these intervals could be the 95% confidence interval? How do you know? 1.3 to 1.7 1.4 to 1.8 1.6 to 1.8

b) Here are a correctly calculated 90% confidence interval and a 99% confidence interval to estimate the mean study hours for each hour in class for the population of college students.

Which is which? How do you know? 1.43 to 1.57 1.39 to 1.61

c) Below are two correctly calculated 90% confidence intervals: one for a random sample of 100 students and the other for a random sample of 1000 students. Each confidence interval estimates the mean study hours for each hour in class for the population of college students.

Which is which? How do you know? 1.45 to 1.55 1.48 to 1.52