**Total Time needed 1 hour 40 minutes**

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| **Handouts:**   * Pennies Task | **Materials:**   * TI-Navigator * TI-Nspires * File: ***Pennies Resampling.tns*** |

**Objectives**

The students will explain the role that sample size and sampling distribution play in gauging the reliability of a point estimate. Also, this lesson will serve as an introduction to approximate sampling distributions and sampling distribution theory.

**Questioning Portion (15 min)**

Ask students to think about pennies in circulation and to write down questions they can ask about these pennies.

1. *What questions can we ask regarding pennies in circulation?*

Anticipated responses:

* How old are they?
* How many are in circulation?
* What are they made of?
* Are they roughly the same measurements?
* How long do they stay in circulation?

Send students a quickpoll to retrieve one of these from each student.

Once a list of questions is displayed, TTW reveal a sample of 500 pennies collected in January 2008. For the purpose of this task, this will represent “pennies in circulation. TTW remind students of the definition of a statistical question (A question that can be answered using data that varies). TTW lead students in a discussion to answer the following question:

1. *What questions can we answer today about pennies in circulation?*

Anticipated response

* With the exception of “What are they made of” and “how long do they stay in circulation”, all the above questions can answered.

For the purpose of this task, reveal to the students that we will focus on the ***average year of the pennies*** in circulation.

**Data Collection and Analysis Portion (40 min)**

Data collection should be done in pairs for this task. One person should collect the sample and read the pennies while the other person records the data. The pennies should be randomly collected and taken back to the tables.

1. *To answer our question, collect a sample of five pennies and gather information that will help us answer our question. What does this information tell you about a possible answer to our question?*

Anticipated responses

* Some students will not summarize this data.
* Some will likely say their result is invalid.
* Some will computer a summary statistics.
* They may or may not look at the graph

At this point, randomly select a couple students to be large and in charge. Use this information to facilitate a discussion.

1. *Collect the results from the other groups and compare them to yours. Where does your answer fit in the distribution of the class’s answers? How does this affect the confidence in the accuracy of your answer?*

Teacher should use Navigator to quickly collect an average from every student. Once this average is collected, send the data set back to the students. Randomly choose a couple students to be large and in charge.

For questions 5 and 6, repeat the procedures for 3 and 4, except have the students select 25 pennies.

1. *Collect a sample of 25 pennies and repeat the process you carried out in question 3 above.*
2. *Collect the results from the other groups and compare them to yours. Where does your answer fit in the distribution of the class’s answers? How does this affect the confidence in the accuracy of your answer?*

**Communicating Final Results (15 min)**

Students should discuss their complete analysis and arrive at a final guess. It is likely that they will choose a single estimate, but that is o.k. at this point. It is more important that they select their average from the sample of size 25.

1. *Based on all the evidence you have collected, what is the final answer to your question? Use words, pictures, and/or symbols to demonstrate the statistical reasoning you are using to support your answer.*

Anticipated responses

* Picking a single average
* Some may create an interval
* Some may want to stick with their own average since they know how the data was gathered.

**Connecting to Sampling Distribution (30 min)**

Open the file Pennies Resampling.tns. Lead the students in a discussion that addresses the following:

* If they chose a single estimate, it is technically wrong. How would they adjust their estimate to have a better chance of being right?
* The actual sampling distribution consists of all the means from all possible samples of a particular size. Thus, our use of 15 values to approximate the distribution is not going to be completely accurate.
* As sample size increases, the distributions become more normal, have less variability, but are all centered at the true average.

**Total time: 1 hours 40 minutes**