ENHANCING STATISTICS TEACHER EDUCATION WITH E-MODULES

SAMPLE CODAP-ENABLED STATISTICS TASK

Part 1: Introductory Information

Brief Summary of Task: In this activity, students will measure the reaction times of a sample of a population. They will find the percentage of this sample that falls within a certain range, and use this percentage to estimate the percentage of the population that falls within this same range. They will then take repeated samples using CODAP, and make a new estimate.

Intended Audience: Grades 7 or 8 students in their statistics unit.

Time and Materials: 45 minutes.

- One internet-connected computer per student or pair of students.
- Website for collecting reaction times https://ww2.amstat.org/education/cas/2.cfm
- Board or Google Sheets for recording class reaction times

Shared Link to CODAP file:
https://codap.concord.org/releases/latest/static/dg/en/cert/index.html#shared=51981

General Statistical Goal: Investigate chance/random processes and develop, use, and evaluate probability models by collecting data using the chance process that produces it. Use repeated sampling to create distributions of data and see how samples start to cluster and become predictably distributed. Determine statistical measures that are appropriate for these distributions and use these measures to make a claim about a larger population, process or model

Specific Learning Objectives for the Task:

- Estimate population proportions using a sample.
- Consider variability in samples and in sample statistics
- Use repeated sampling to estimate a population parameter

Sources: Task adapted from Open Up Resources (Grade 7 Lesson 16.2).

Part 2: Launch the Task

Tell students that we are going to start today's task by testing their reaction times. Direct them to https://ww2.amstat.org/education/cas/2.cfm and have them record their times. Display the list of times for the class to see (you can have students write their time on the board, though it may be more comfortable for

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students if they can submit their times confidentially, either through a Google Sheet or by you collecting them). It may be helpful to allow students a couple of "practice" attempts, and then one "real" attempt.

Introduce the context: The track coach needs students with fast reaction times to help with the upcoming track meet. She wants eighth graders with reaction times of less than 0.4 seconds, so she has all the eighth graders at the middle school take the reaction time test.

Have students complete the questions in the "Introduction" task, and briefly discuss as a group before moving on to the CODAP-enabled task.

Part 3: Student Guide/Handout
HANDOUT 1: Our Class reaction times
Introduction task

Everyone should use this website to collect their reaction time. You can practice twice, then record our time on the third try. Report your time to the teacher.

https://ww2.amstat.org/education/cas/2.cfm

Let's consider only the reaction time data collected from our class.

1. Organize the data in way that is helpful for answering questions about the data.

2. What percent of our class has reaction times less than 0.4 seconds?

3. Suppose another class of students (with same number of students) took this reaction test, and calculated the percent of students with reaction times less than 0.4 seconds. What percent(s) would surprise you, and what are some percents that you would expect?

4. What would be your estimate for the percent of all students in our same grade at this school who have a reaction time of less than 0.4 seconds? Explain your reasoning.

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HANDOUT 2: Samples from a Population (codap-enabled part)

All 8th graders at the school took the reaction time test. They are the population. We are going to examine random samples of size 20 (about the size of a track team) to estimate how many of them would have reaction times less than 0.4. The collection of 120 8th grader reaction times has been loaded into CODAP and hidden in the sampler. Think of this like a bag with 120 pieces of paper in it with a reaction time written on each one.

Open the file

https://codap.concord.org/releases/latest/static/dg/en/cert/index.html#shared=51981

Instructions (these instructions and questions are also in the CODAP file)

We will randomly pick 20 eighth grade students and examine their reaction times. Instead of doing this once, however, we will do it 30 times.

1) Change the values near the top of the sampler so that each sample has 20 students, and we are taking 30 samples. Then press the START button. Change the speed 

to "fast" or "fastest" to speed up the process.
2) For each of our 30 samples, we want to find the percent of students with reaction times less than 0.4 seconds. To do this, we will need to create a new attribute and use a formula. Click the + icon in the "samples" section of the table. Name the variable "percent_fast". Then click on the new attribute you created and select "edit formula".
3) Create a formula to find the *percent* of students with reaction times less than 0.4 seconds. Just like when we did it by hand, we want to count the number of students with reaction times less than 0.4, and then divide by the number of students in our sample (20), and then multiply by 100 to change to a percent. To do so, enter the following formula:
count(Reaction_time<0.4)/20*100.
4) Graph this new attribute as a dotplot, and use this dotplot to answer the following questions:
    a) There should be 30 dots on this graph. What does each dot on the graph represent?

    b) Use the graph to help you estimate the percent of eighth graders at the school with reaction times less than 0.4 seconds. You may want to use some of the options in the  menu. What percent of 8th graders at the school do you expect to have a reaction time less than 0.4 seconds?

    c) Do you feel your new estimate is any better or worse than the estimate you got based on the single sample of our class? Why or why not?

Part 4: Anticipating Students' Work

Here is a sample graph from the CODAP-enabled portion of the task:

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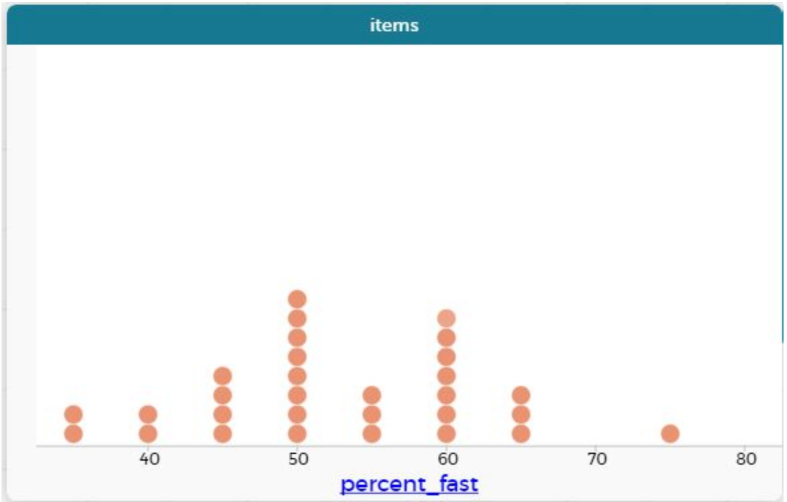
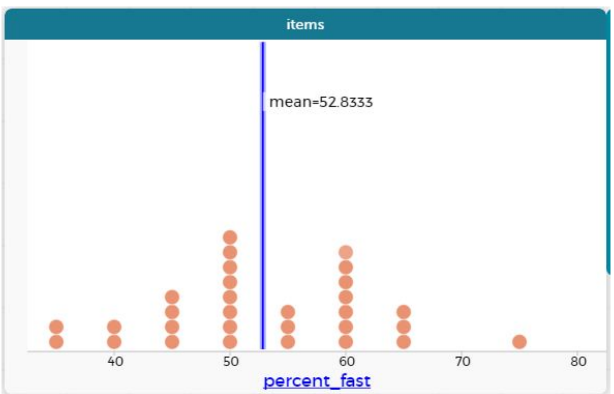


While this is a valuable display of data, some students may have trouble grappling with what each dot on the graph represents. Some may think that each dot represents a single student, or that this is a graph of reaction times in seconds.

Once they understand what the graph is representing, there are various tools in CODAP students may use to obtain a population estimate for the percent of students who have a reaction time less than 0.4. They may use a mean, median, or even a movable line to arrive at a point estimate:



This student might say that "About 52.8% of the eighth graders in the school have reaction times less than 0.4 seconds".

Other students may use a boxplot, or the standard deviation measure, or a pair of movable lines to get a range estimate:

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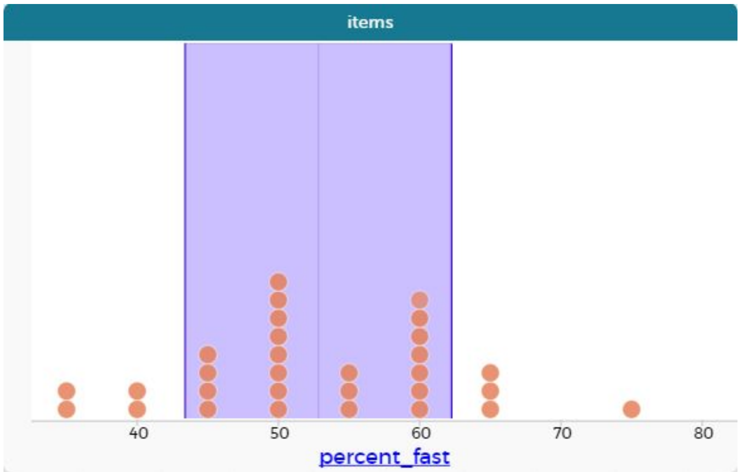

This student might say something like “between 43% and 62% of students in the school have reaction times less than 0.4 seconds”

Students may also arrive at an estimate without using the measurement tools. For example, in the above graph, a student may look at the graph and say something like “most of the points are between 50% and 60%, so that is what I would expect the percentage of students to be in the whole school that have fast reaction times”. Another student may simply choose 50% as their estimate of the percentage of the population that has fast reaction times, since 50 is the most common value on the graph.

Part 5: Notes for Implementing the Task

Discussing the introduction task

The key question for the introduction task is whether or not we can use the percentage of students in your class with fast reaction times to estimate the percentage of all eighth graders in the school with fast reaction times. And if so, how close do we expect this estimate to be and/or how confident we can be in our estimate? (Note: the class does not need to arrive at definitive answers to these questions before starting the CODAP-enabled task)

Before making the transition from the sample of your class to the population of all eighth graders in the school, it may be helpful to discuss other samples of the same size, i.e. another class. You can ask the students if another class took the test, would the percent of students in that class with fast reaction times be the same? Similar? It is possible that students may have a reason to believe their class is faster or slower than most classes (e.g. there are a lot of athletes in the class), and this is okay. This can help show the need for a *random sample*, which students will use in the second part of the task. The key point is that even though we only examined the reaction times of a small sample, it can still tell us *something* about the population of all eighth graders at the school.

Introduce students to part 2 of the task: instead of looking at our class, we are going to randomly select 20 students from the 8th graders at our school and look at their reaction times (if it has not come up before now, a brief discussion on why this is a better approach could be useful here). And instead of

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doing this once, we are going to do it many times. Direct students to the CODAP file, and have them complete the rest of the task:
https://codap.concord.org/releases/latest/static/dg/en/cert/index.html#shared=51981

Implementation tip: Students may have trouble interpreting the graph produced in Part 2. It may be helpful to point out that we are doing a similar thing they did in the introduction task, just repeating the process 30 times. Remind them of the steps they did in the introduction task (i.e. looking at a list of 20 reaction times, finding the percentage that are less than 0.4 seconds), but with the addition of one final step of taking their percentage, and plotting it on this graph. This graph is the distribution of all sample percentages for students with less than 0.4 reaction times. Each sample of 20 contributed one percentage.

Whole-class discussion and closure:

Have a pair that found a point estimate (e.g. using the sample mean percentage) share their new estimate, and compare it to the class's old estimate. Ask the class if they think the new estimate is a better estimate, and why (e.g. "With only one sample, we might have picked a lot of fast students, but with 30 samples, the samples with more fast students should balance out with the samples with less fast students").

Have a discussion about whether or not we think this is the "true" answer. This estimate is still just an estimate based on samples, so it is still likely off from the true population percentage. If a pair came up with a range estimate, have them share how they arrived at a range (if not, work with the class to come up with a range estimate together).

The actual percentage for the population of 120 8th graders is 56.7%. Most pairs will see that their new estimates are closer to the actual percentage than the class's estimate.

End with a discussion about variability students saw in the data from our class. We all did not have the same reaction times. When we took random samples of 20 from the population of 8th grader times each sample was different, leading to different values for the percent of students in each sample with reaction times less than 0.4. How did this variability between the samples impact your confidence in predicting the percentage of the whole population with reaction times less than 0.4?

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Part 6: Reflection

I started by choosing a task that was part of a local school curriculum, but one that I felt was lacking in some areas, and that could greatly benefit from the addition of technology. I thought that starting with students doing a hands-on activity collecting reaction times themselves would be more engaging than simply being given a list of times, as in the original task. Even though the end goal of the new task involved taking repeated samples with technology, I felt that it was still important to start with a single sample, so that students could better understand what was happening in each sample. I put a whole-class discussion between the introduction part of the task and the technology-enabled part because I thought it was important that students consider the process of making inferences about a population from a sample before starting to take multiple samples. This also allows the class to see and discuss the need for repeated samples.

There were several parts of the task where I had decisions to consider when creating it. I decided to have the students take 30 samples because that was hopefully large enough for students to start to see some clumping of sample statistics, but small enough so that there was still some variability in the means between groups. I debated whether or not to give students the formula to enter in CODAP for computing the percentage of people with reaction times less than 0.4 seconds. In the end, I decided to give it to them, because I wanted the underlying statistics to be the focus, rather than technological issues (which can be particularly problematic in a large class). The teacher can always discuss where the formula comes from if he/she wants to highlight the connections to the computations performed in the introduction part .

In creating this task, I learned that the process of adapting a task can be very different than creating a task from scratch. I struggled with how “true” I wanted to stay to the original task, and how much of it I needed to change. The original task was meant as one of a series of “mini-tasks”, but I decided to make the task more stand-alone. This meant giving a lot of thought to how the task starts and ends, and considering what previous knowledge students would need and exactly what learning objectives I wanted to accomplish. The original task was presumably created so that some ideas could be introduced, but not fleshed out, intended to be expanded upon in the text mini-task. But in this task, I didn’t like leaving students with only partially-formed concepts, so I had to particularly pay attention to the wrap-up and closure portions of the task to ensure that students reached the intended learning goal.

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