Written by: Kimani Roach

Unbound Education

Lesson plan on 50 States of recycling

Inspired by: Amy Braxton & Claire

Lesson Overview

This lesson engages students with a secondary dataset using Tuva Labs to explore and visualize recycling data from all 50 states. Students begin by examining a heat map displaying state recycling percentages and participate in a **Notice and Wonder** activity to identify patterns, trends, and anomalies within different aspects of state recycling. These observations serve as the foundation for generating questions about recycling practices across the United States and distinguishing between statistical and non-statistical questions. Students will then use the Tuva Labs dataset to investigate their statistical questions by creating visualizations and analyzing categorical and numerical data. As students explore the dataset, they will calculate and interpret measures of center (mean and median) and use graphical displays to describe the shape, spread, clusters, and possible outliers within the distribution. This lesson emphasizes mathematics as a tool for making sense of real-world data while developing students' statistical reasoning, data literacy, and the ability to draw evidence-based conclusions. The number of class period it takes to complete this lesson is dependent on the level of student agency you chose to provide during question generation and data exploration,

NC Math Standards (6th grade)

NC.6.SP.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

NC.6.SP.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

NC.6.SP.3 Understand that both a measure of center and a description of variability should be considered when describing a numerical data set.

a. Determine the measure of center of a data set and understand that it is a single number that summarizes all the values of that data set.
    - Understand that a mean is a measure of center that represents a balance point or fair share of a data set and can be influenced by the presence of extreme values within the data set.
    - Understand the median as a measure of center that is the numerical middle of an ordered data set.

b. Understand that describing the variability of a data set is needed to distinguish between data sets on the same scale, by comparing graphical representations of different data sets in the same scale that have similar measures of center, but different spreads.

NC.6.SP.4 Display numerical data in plots on a number line.

• Use dot plots, histograms, and box plots to represent data.

• Compare the attributes of different representations of the same data.

NC.6.SP.5 Summarize numerical data sets in relation to their context.

a. Describe the collected data by:
   • Reporting the number of observations in dot plots and histograms.
   • Communicating the nature of the attribute under investigation, how it was measured, and the units of measurement.

b. Analyze center and variability by:
   • Giving quantitative measures of center, describing variability, and any overall pattern, and noting any striking deviations.
   • Justifying the appropriate choice of measures of center using the shape of the data distribution.

Virginia Math Standards (6th grade)

6.PS.1 The student will apply the data cycle (formulate questions; collect or acquire data; organize and represent data; and analyze data and communicate results) with a focus on circle graphs. Students will demonstrate the following Knowledge and Skills:

a. Formulate questions that require the collection or acquisition of data with a focus on circle graphs.

b. Determine the data needed to answer a formulated question and collect the data (or acquire existing data) using various methods (e.g., observations, measurement, surveys, experiments).

6.PS.2 The student will represent the mean as a balance point and determine the effect on statistical measures when a data point is added, removed, or changed. Students will demonstrate the following Knowledge and Skills:

a. Represent the mean of a set of data graphically as the balance point represented in a line plot (dot plot).

b. Determine the effect on measures of center when a single value of a data set is added, removed, or changed.

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c. Observe patterns in data to identify outliers and determine their effect on mean, median, mode, or range.

Learning Objectives

● **Use** real world issues to frame a problem and come up with Statistical questions for investigation.

● **Understand** the data investigation process using both categorical and quantitative variable with the aid of technology.

● **Understand** how to explore and visualize quantitative data for one or more groups

using technology.

● **Understand** how to communicate results of investigation of data for one or more groups.

● **Summarize and communicate** findings from a real-world dataset by analyzing measures of center, variability, and overall patterns in context using technology.

The use of the Data cycle

This lesson engages students in the full data cycle (formulate questions; collect or acquire data; organize and represent data; analyze data and communicate results) The Data Cycle in a Nutshell as is shown in figure 1. While the figure shows an ordered cycle the process is not linear and involves moving back and forth between the phases. While the lesson plan is designed to showcase one possible flow of the data cycle/data investigation process (Data investigation Pathways NC Standards Share.pdf - Google Drive), teachers can choose to take their own paths within their respective classrooms. For help in thinking about how to engage in the various aspects of the data cycle, consider the following flowchart that shows possible connections between the elements of the data investigation process based on the type of analysis you want to design for your students.

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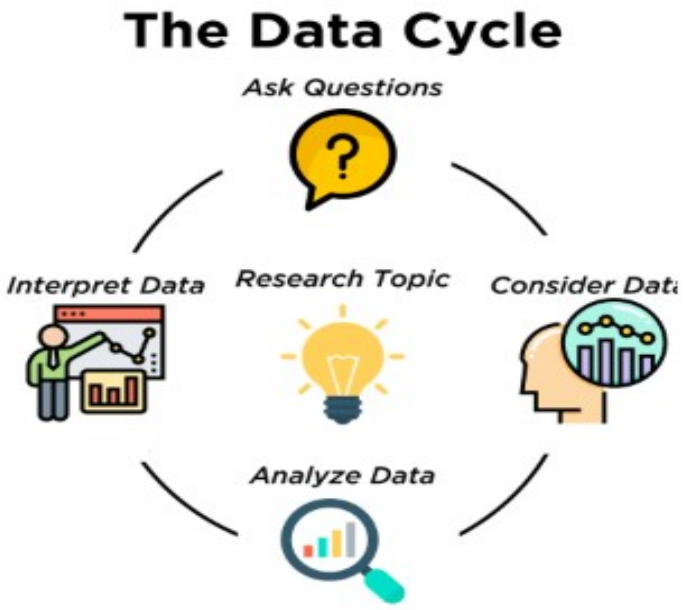

Figure 1. Bootstrap. (n.d.). *The data cycle*. Bootstrap: Data Science. https://www.bootstrapworld.org/materials/fall2025/en-us/lessons/data-cycle/pages/notes-data-cycle.html

Materials

Lesson PowerPoint - 50 states of Recycling.pptx - Google Slides

Data Cycle worksheet - Data Cycle organizer.docx - Google Docs

Instructional Delivery Plan

Launch (15 - 20 minutes)

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The students will be given a data visualization of the percentage of recycling across the 50 states to start the lesson; the visualization will be a color-coded map of each state with the difference in color showing variation in recycling by state. The data visualization will be one published by bell cooperation 50 States of Recycling - Ball. The students will be asked to take some time to examine the data visualization and make a record of what they notice about the data visual and what do they wonder about it. They will be given an opportunity to turn to the student next to them and share one thing they notice and wonder after which the class will have a whole group discussion where the students will be given the opportunity to share their respective notice and wonder.

The goals of this activity are:

1. To have students engage with different data visualization and start thinking about the story that it is presenting to them and have students thinking about data and making sense of it.
2. The other goal is to spark students' interest in thinking about the issue of recycling. Providing a space for students to explore both the content and the social context of data visualization (pollution, climate change, conservation and community responsibility)

Two videos that you could showcase to help direct this conversation of recycling within the North Carolina (NC) setting are:

1. North Carolina Department of Environmental Quality (NC DEQ) - What Happens to Your Recycling | NC DEQ
2. Daniel Toben is an NC resident who cleans up his community, recognized and honored by the state
   Stream Cleanup Time Lapse | Planet Cleaning | AEJeansHaveFun | TikTok
   Daniel Toben goes viral on TikTok after cleaning a polluted stream

Sighting an issue/ Creating a Statistical Question (~15 minutes)

After the launch activity the students will start discussing real societal issues as it relates to recycling withing the United States, by so doing they will start the early work of **framing problems**. This part of the lesson will have already been laid by asking the students question such as "**What do you wondering?"** From this the students will start exploring questions they may have and want to investigate, the class will come up with a question and spend the time refining it as a group to ensure that it is a **statistical question,** one with enough variability and is worth investigating. This will help the class to understand the importance of been able to develop statistical questions and the thought process that must go into developing ensuring that these questions are **NOT** just **yes/no** but have the level of variability needed before investigating.

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Sample Question: How do Aluminum recycling rates vary across 50 states?

Why is this a statistical question: a statistical question because it anticipates variability in the data and requires analyzing a dataset to answer.

Consider Data (10-20 minutes)

Before exploring the data, the statistical question will help students to have a sense of focus as to what they need to investigate now they can check out the actual data available for them to explore. For this section of the lesson teacher will explain to students that some statistical questions require students to design and collect actual firsthand data to answer questions however, sometimes data is availed and can be used. To this investigation students will use data already available to them. For this specific lesson **TUVA** workspace will be used to explore the data and create examples 50 States of Recycling - Tuva. This workspace is user friendly and will help students to prepare for more complex workspace like **CODAP**.

The students will be given some time to explore the different attributes within the dataset and what they each say about the data collected and how the dataset is structured. This can be done with the aid of the teacher or using a brief demo of how to navigate TUVA if the students are unfamiliar with it.

Here are some 6th grade friendly questions you can use to help guide your consideration of the data specific to investigating a single quantitative variable and a single categorical variable.

What numerical (quantitative) data do we have?

What category (categorical) data do we have?

Which categories can we use to compare groups?

What values can the numerical data take?

What are the different categories in the dataset?

How is the numerical data measured? What units are used (such as percent, pounds, or dollars)?

How are the categories recorded or labeled?

Which variable would be best to investigate using a histogram, box plot, mean, and median?

What patterns or questions do you notice about the data before you begin analyzing it?

Note: once the data is considered if the statistical question the students have cannot be answered by the data, this is the opportunity to have them revisit and make the necessary adjustment or design a new question all together. The teacher can use the opportunity to inform the students that the data cycling process is not always perfectly linear and will require people to move back and forth between phases during the investigation like they are doing now.

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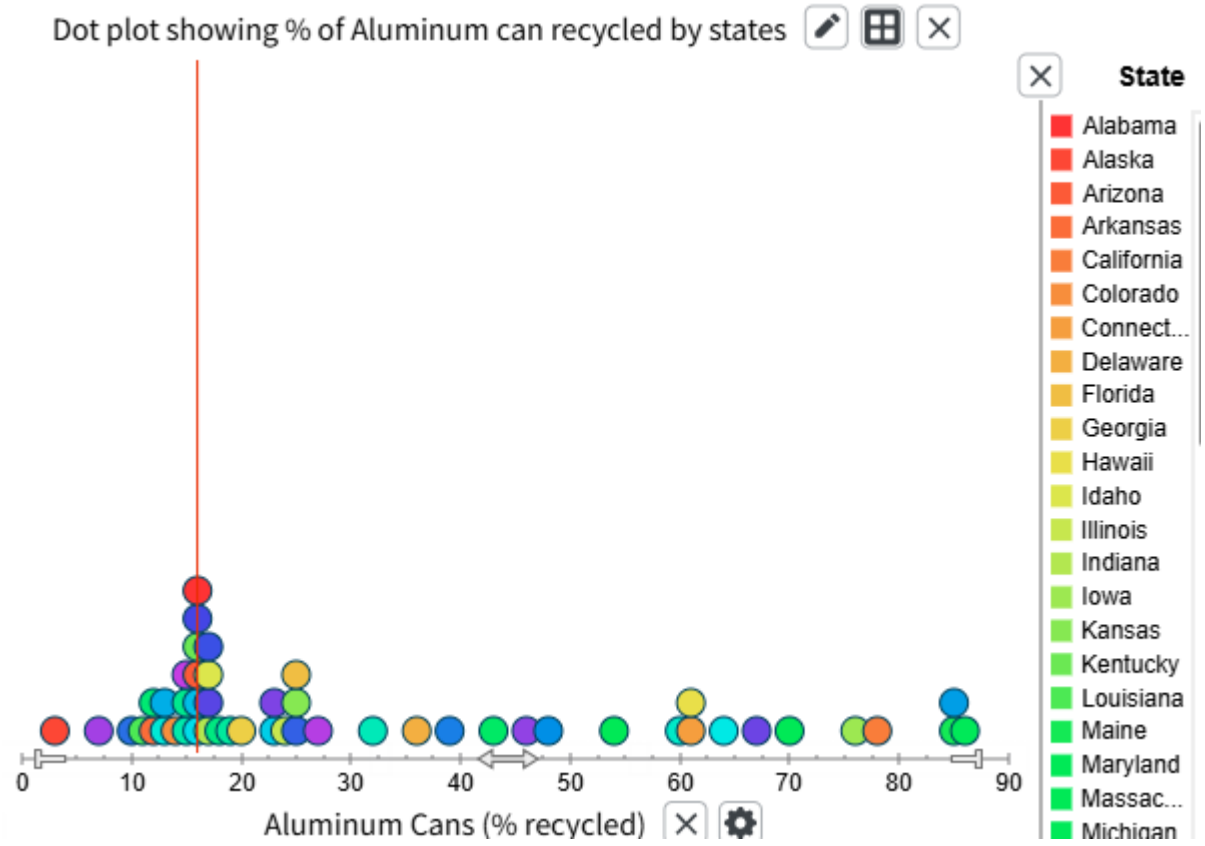
Explore, Visualize and do Statistic (10-15 minutes)

This section will help the students to dig a little deeper into the data by starting to visualize the different attributes related to their respective questions to see the patterns and trends within them. Let us consider the attribute related to our sample question "**: How do Aluminum recycling rates vary across 50 states?"** we can start looking t aluminum and states using a simple dot plot as shown in figure 2 below:

Figure 2: Dot plot showing the percentage of Aluminum can recycle by states



This data visualization will start helping students to see how the percentage of aluminum can recycle by state is spread. Students can start seeing which states have higher percentage of recycling of these types of can and which states do not. But as students explore this visual, they will start examining things like data cluster (mode), **overall spread/width (range).** They will also be able to start observing where majority of the states are in terms of their percentage recycled of aluminum cans and that very little states have high percentage of recycled aluminum cans. This will start informally by laying the groundwork for data skewness which they will formalize later. The students will also use this opportunity to explore other data Visuals that they can use to tell the story of what the dataset is talking about, "how **Aluminum recycling rates vary across 50 states." As shown in figure 3 and figure 4 below:**

Figure 3: Histogram showing percentage of Aluminum can recycle the total generated

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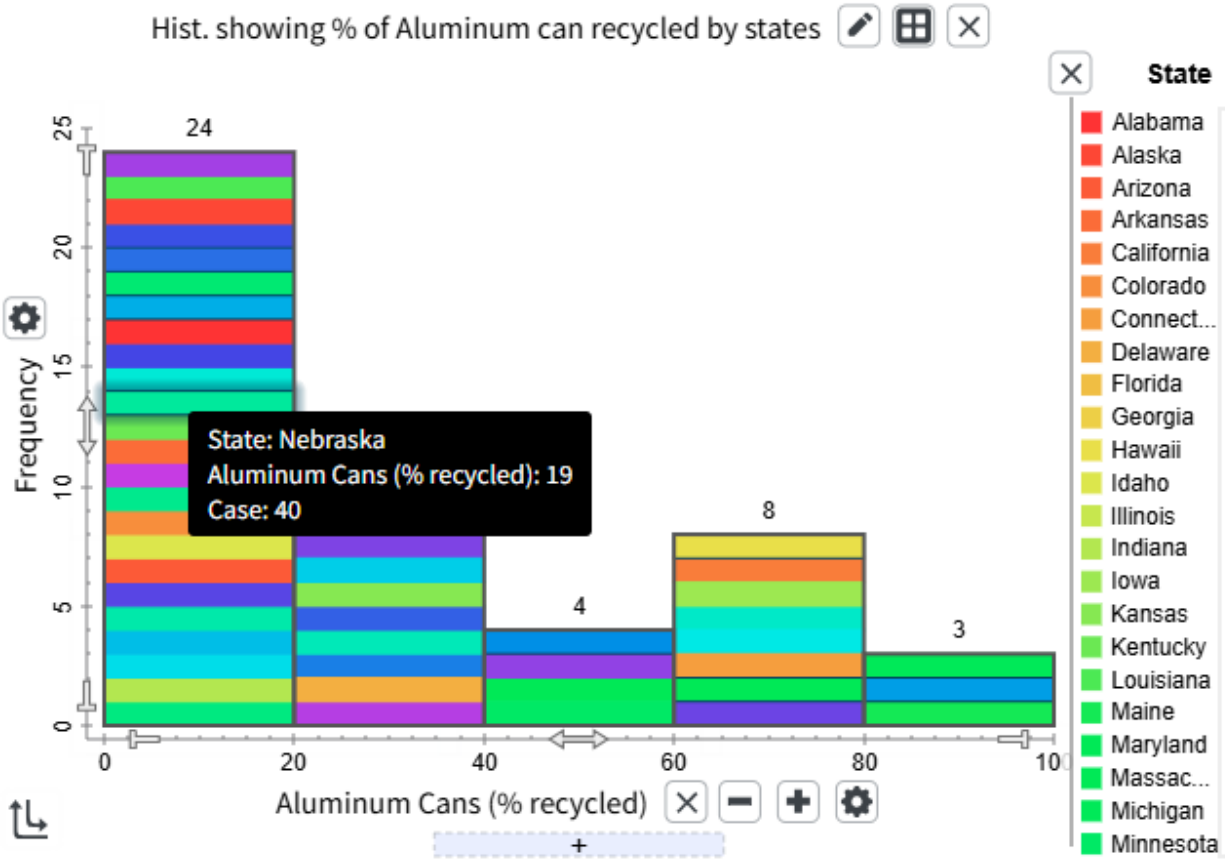

Figure 4: Box Plot showing percentage of Aluminum can recycled of the total generated

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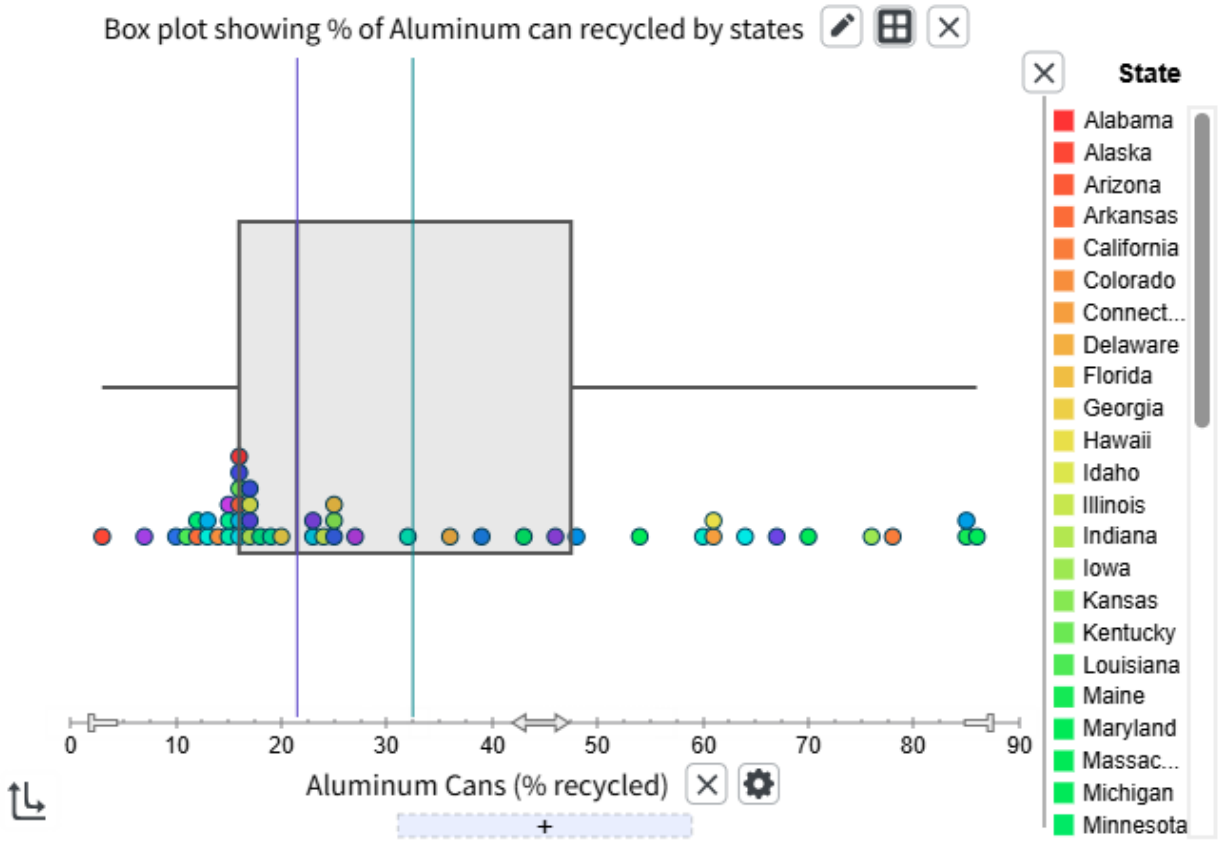

Communicate Findings and answer Statistical Question

Once the students have considered the data, generating the different visuals gives them an opportunity to explore their findings for patterns and trends and write them as they find them. This can be done by first having them doing some indevidual noticing then pairing and sharing with another student; as they share, they will start to formalize their findings and statistics as shown below**:**

Communicating Our Findings

Statistical Question: How do aluminum recycling rates vary across the 50 states?

- Most states recycle between 10% and 20% of the aluminum they generate. The most common **(modal**) recycling rate is 16%, so many states recycle about 16 out of every 100 aluminum cans they use.
- The recycling rates go from 3% to 86%. This means there is a large spread because some states recycle very little aluminum while others recycle a lot.
- 12 out of the 50 states (24%) recycle more than half (50%) of the aluminum they generate. This means that most states recycle less than half of their aluminum.

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- The median recycling rate is 21.5%. The median is the middle value when all the recycling rates are put in order from least to greatest. This tells us that half of the states recycle less than about 22% of their aluminum, and half recycle more.
- The mean recycling rate is 32.5%. The mean is the balance point, or fair share, of the data. If all 50 states recycled the same percentage of aluminum, each state would recycle 32.5%.
- The mean is higher than the median because a few states recycle much more aluminum than most other states. These high recycling rates pull the mean up. **(this will later help them when they start looking at data skewness)**

Once the students communicate their findings, get them to start concluding by answering the statistical question they had set out to investigate, a sample conclusion to the example question is given below:

Conclusion:

The recycling rates are not the same in every state. Most states recycle about 10% to 20% of the aluminum they generate. A few states recycle more than 50%, but most recycle much less. This shows that aluminum recycling is different across the United States, and some states recycle much more aluminum than others.

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Acknowledgements

This lesson was developed using openly available educational resources and real-world datasets to support student learning in statistics and data science.

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