

Random Sampling

Lesson Overview

In this lesson, students will extend their understanding of samples and populations to include using random sampling to identify subsets of a given population. They will also analyze data and make inferences about the population as a whole.

Alignment

Math Standards

- SCCCR Math 7.DSP.1 Investigate concepts of random sampling.
- Understand that a sample is a subset of a population and both possess the same characteristics.
 - Differentiate between random and non-random sampling.
 - Understand that generalizations from a sample are valid only if the sample is representative of the population.
 - Understand that random sampling is used to gather a representative sample and supports valid inferences about the population.
- SCCCR Math 7.DSP.2 Draw inferences about a population by collecting multiple random samples of the same size to investigate variability in estimates of the characteristic of interest.

Standards for Mathematical Practice

- Standard 1: Make sense of problems and persevere in solving them.
- Standard 2: Reason both contextually and abstractly.
- Standard 3: Use critical thinking skills to justify mathematical reasoning and critique the reasoning of others.
- Standard 7: Identify and utilize structure and patterns.

Science and Engineering Practices

- SEP 4: Analyze and interpret data.
- SEP 5: Use mathematical and computational thinking.
- SEP 6: Construct explanations.

ELA Inquiry Standards

Standard 3: Construct knowledge, applying disciplinary concepts and tools, to build deeper understanding of the world through exploration.

- 3.1 Develop a plan of action by using discipline-specific strategies.
- 3.4 Organize and categorize important information, revise ideas, and report relevant findings.

ELA Communication

Standard 1 Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretation through collaborative conversations; build upon the ideas of others to clearly express one's own views while respecting diverse perspectives.

- 1.2 Initiate and participate effectively in a range of collaborative discussions with diverse partners; build on the ideas of others and express own ideas clearly and persuasively.
- 1.4 Engage in dialogue with peers and adults to explore meaning and interaction of ideas, concepts, and elements of text, reflecting, constructing, and articulating new understandings.
- 1.5 Synthesize areas of agreement and disagreement including justification for personal perspective; revise conclusions based on new evidence.

Connections

This lesson is focused on Mathematics.

Active Learning Strategies (for Purposeful Reading, Meaningful Writing, and Productive Dialogue)

- [Elbow Partners](#)
- [Pairs Squared](#)
- Anchor Chart
- [Card Sort](#)
- Thinking Stems
- [Exit Ticket](#)

- [Paired Reading](#)
- [Say Something](#)

Computational Thinking

In this lesson, students must collect, organize and analyze data then make inferences based on the data. This will involve some degree of ambiguity simply because interpretation of data isn't a perfect process. Students will also collaborate to collect the data and communicate the results.

*Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following **characteristics**:*

- Logically organizing and analyzing data.

*These skills are supported and enhanced by a number of dispositions or attitudes that are essential dimensions of CT. These **dispositions or attitudes** include:*

- Confidence in dealing with complexity
- Persistence in working with difficult problems
- The ability to communicate and work with others to achieve a common goal or solution

Lesson Plan

Time Required

Part A: Approximately 60 minutes

Part B: Approximately 60 minutes

Part C: Time will vary due to students collecting data from their surveys, analyzing the data, and drawing inferences.

Disciplinary Vocabulary – survey, random, sample, representative, population, bias(ed), subset, random sample, inference, valid

Materials Needed:

Standard Materials:

- Student Math notebooks
- post-it notes
- calculators – at least one for each pair of students

Handouts:

- Card Sort – one set of cards for each pair or small group of students
- Demographics slide for interactive white board (You will need to create this. Details are in Part B of the lesson.)
- Sampling Our School Population handout (You will need to create this. Details are in Part B of the lesson.)
- Random Sampling article
- Quick Check ½ sheet handout

NOTE: For Part C of the lesson, you will need to create the following:

- a survey student groups will use to investigate the favorite lunch choices of the student body
- tables based on the data collected by the survey so students can compare subsets of data
- problems based on the data collected by the survey

Students will also need materials to design presentations of their data. This may be done traditionally in the form of posters or charts or digitally.

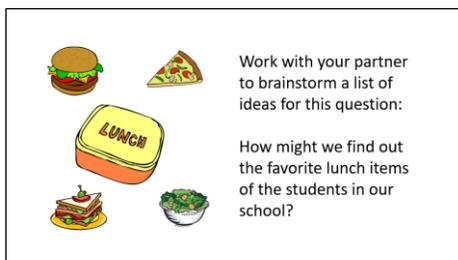
Formative Assessment Strategies: Student dialogue, Card Sort, Exit Tickets, Quick Check

Misconceptions: None noted

Safety Note(s): N/A

Engage

- Display the following prompt for students as they enter the room:

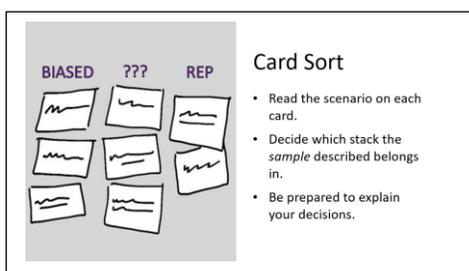


- Give them about 5 minutes to work with their elbow partners. Then have Pairs Square (form groups of four) to compare and combine lists.
- Compile a class list of ideas.
- Introduce the vocabulary: random, sample, representative, population, and biased.

- Present one word at a time and have students discuss possible meanings with their elbow partners.
- As it's likely that students are familiar with at least some of the words outside of Math class, ask guiding questions to help students establish working definitions for those words as they relate to Math.
- Use student responses to begin a vocabulary anchor chart with the words and definitions they develop for them. Those definitions should be added to their Math notebooks with space to add more information later.
- Tell students they will further investigate the definitions of those words by completing a card sort.

Explore

- Students may work in pairs or in the groups of 4 formed from Pairs Squared in [Engage](#). Each pair or small group needs a Card Sort set.
- Card sort note:
There's a ??? column to account for the fact that some of the scenarios don't seem biased because the samples are random but not necessarily representative. For example: Cards C, H, and J say the samples are random, but the samples might not be representative of the larger population. Students need to have the opportunity to discover that on their own to provide a basis for beginning the discussion of random vs non-random sampling and how that affects whether a sample is representative of a larger population.
- Distribute the envelopes and display the instructions for the card sort. The ??? column is for cards they have questions about. See note above.

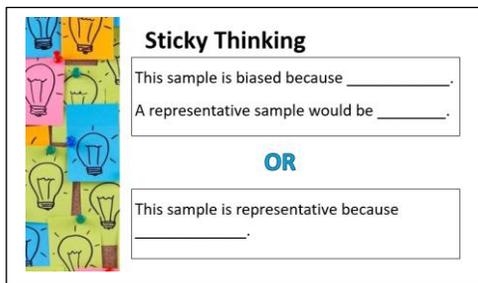


- Circulate as students work to check for understanding and ask guiding questions.
- Bring the class back together and lead a brief discussion of the vocabulary words defined earlier (random, sample, representative, population, and biased). Use the scenarios to help students further develop their understanding of those words

Explain

- Students may work in pairs or small groups.

- Tell students they will continue to work with the card sort scenarios by explaining their thinking regarding why they decided to place each scenario where they did during the sort.
- Students will use thinking stems (prompts) and post it notes to write an explanation for each scenario. Every card will have one of the following written on a post-it and stuck to the card:
 - This sample is biased because (*describe why the sample is biased*). A representative sample would be (*describe how to tweak the sample to make it unbiased*).
 - This sample is representative because (*describe why it is representative*).
- Display the following information:



Sticky Thinking

This sample is biased because _____.

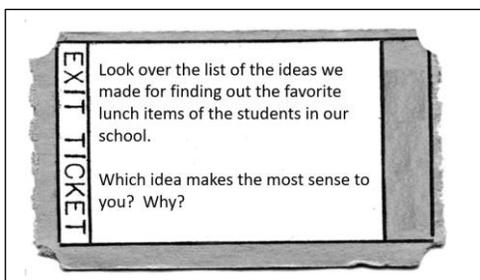
A representative sample would be _____.

OR

This sample is representative because _____.

- Give students time to work on the task.
- Circulate as students work to check for understanding and ask guiding questions.
- Give each group of students an envelope or folder to keep their cards and post-it notes in. They may need to tape the post-its to the cards. Have them put their group members' names on the envelope/folder and collect them. These cards may be used for review/reteaching.

Exit ticket.



EXIT TICKET

Look over the list of the ideas we made for finding out the favorite lunch items of the students in our school.

Which idea makes the most sense to you? Why?

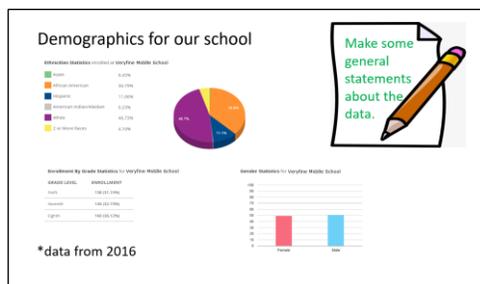
End Part A

Begin Part B

Engage

NOTE: The data here is for a middle school near Columbia, SC and was retrieved from <https://www.homefacts.com>. The graphs and tables are generated by the website, which lets you enter your district and/or school name and location. You may have other sources available to you. The remaining directions for this part of the lesson are based on the demographic information shown below.

- Display the following prompt for students as they enter the room.



- Students share their statements with their elbow partners.
- Use Popsicle Sticks to randomly call on students to share their statements.
- Use the data to review how to calculate percentages. Possible calculations include:
 - The number of female and male students.
 - The number of students in each ethnic group.
 - Combinations of ethnic groups.

NOTE: The **Ethnicities Statistics** and **Gender Statistics** are percentages of the total enrollment. Students should understand they can use the statistics to generalize about grade level groups but that they can't determine precisely how many of the students per grade level are members of each ethnic group or how many are female or male. Nor can they determine precisely how many of each ethnic group are female or male. You may simply point this out to them or lead them to the understanding by asking guiding questions.

- Pose this question: Is our class representative of the population of our school?
- Give students time to work on answering the question. The goal is for them to connect the demographic data of the whole school to the demographics of their individual class. This should involve using calculations to support their thinking. For example, if there are 32 students in their class, they can use the percentages in the **Ethnicities Statistics**

table to generalize whether their class is the “right mix” of ethnicities to represent the larger population. Some students may decide to look at gender rather than ethnicity. Further discussion might center around using a combination of ethnicity and gender, as well as whether a sample of 32 students is sufficient to represent the entire population of 543 students.

- Tell students they will use the data and their thinking about how their class relates to the whole school to further explore what it means for a sample to be representative or biased.

Explore

Part 1

- Students work in pairs.
 - Distribute the Sampling Our School Population handout. Pairs of students work to complete the tasks on the handout.
 - As pairs finish, they form small groups of four to compare their thinking.
 - Give each group 2 sheets of plain paper. Each group decides on a description they think is a representative sample and a description they think is a biased (**NOT** representative) sample and writes one of those descriptions on each sheet of paper. The writing should be large enough to be easily seen.
 - Post a t-chart like the one shown here somewhere in the room. One student from each group posts their descriptions in the proper column on the chart.
 - When all descriptions are posted, bring the class to consensus on the best description of a representative sample for the school population.
- NOTE: You may choose to use an app or some other type of software program to collect the descriptions.

REPRESENTATIVE	BIASED

Part 2

- Now that students have identified what a representative sample of the school population might look like, they need to decide how they might choose a subset to survey.
- Distribute copies of the Random Sampling article to students. Display the instructions.

- Read the article with your partner.
- Underline or **highlight** important information.
- When you see 
 - SAY SOMETHING about the prompts and questions in the **box**.
 - Make connections between the answers and the content in the article.

Reading options:

- Both partners read silently until they get to the Say Something symbol and prompts.
- One partner reads a section aloud while the other reads silently until they get to the Say something symbol and prompts. Switch roles and read to the next stop.

Explain

- Bring the class back together.
- Pose each of the prompts and questions from the Say Something boxes in the article to lead a whole class discussion.
- Revisit the vocabulary anchor chart and add any new information to it, including new words and definitions. Students add any new information to their Math notebooks.

Exit Ticket/Homework

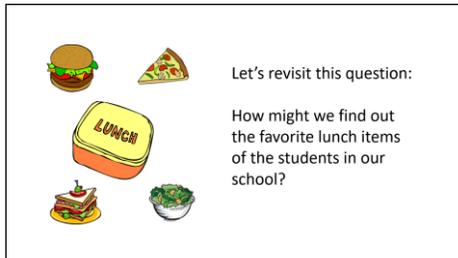
- Distribute the Quick Check ½ sheet handout. Students complete independently and turn it in.

End Part B

Begin Part C

Engage

- Display the following prompt for students as they enter the room:



- Call students' attention to the list of ideas they generated during Part A of the lesson. Pose this question: Given what we've learned about selecting a subset of a population, which – if any – of these ideas will help us answer the question about favorite lunch items?
Note: If none of the ideas they generated will result in a random sample, lead them to the understanding that if they conduct a survey, they need a random sample.
- Tell students they will work in their small groups to conduct a survey to investigate what the favorite lunch items are.

Explore

Students work in groups of four.

- Decide as a class how the random sample will be collected, including the number of participants who will be surveyed. 100 is a nice number if your student body population is large enough.
- Also decide as a class what food items will be included in the survey questions.
 - One option is to download the school lunch menu for a given month for students to use to select the foods they want to include in their survey. The focus for this part of the lesson is on collecting the sample and analyzing the data. Students should understand their methodology isn't perfect but will help them make sense of the math involved.
- Each group collects data using the survey and the random sampling method agreed upon.

Explain

Students continue to work in groups of four.

- Each group analyzes the data they collected and prepares a presentation with their inferences. Provide guidelines for groups to follow.

- It's likely that the data will show some variation across subsets. Take time to have students consider why this is true.
- Use the data to design a table comparing the different samples and have students make inferences based on the data. For example:

Sample	Burgers	Tacos	Pizza	Salad	Total
#1	12	14	70	4	100
#2	12	11	70	7	100
#3	8	25	50	17	100
#n					

- Comparing across classes would be interesting if you teach more than one block.
- Also have students use proportional reasoning to compute how many students in the population would prefer each of the foods based on the numbers in the samples.

Another possible resource:

School Lunch Survey problem-based lesson

https://www.ecoliteracy.org/sites/default/files/uploads/shared_files/CEL_School_Lunch_Survey.pdf

HANDOUTS BEGIN ON THE FOLLOWING PAGE

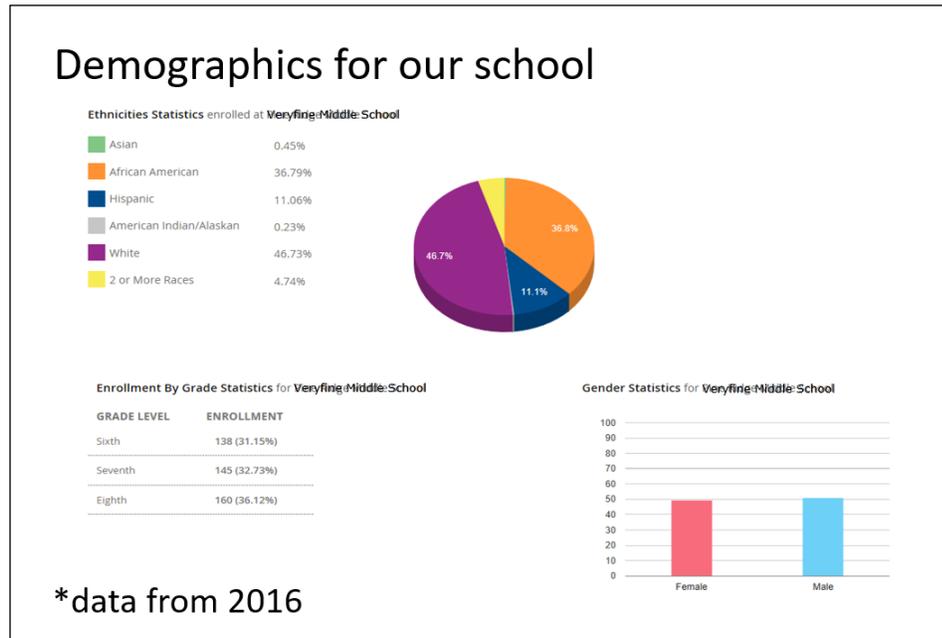
Random Sampling Card Sort

Personalize the cards by including the name of your school, school district, and teacher names in the scenarios.

<p>A</p> <p>The nutrition department wants to know the school lunch preferences of the K-12 students in (your school district).</p> <p>They survey 100 kindergarteners.</p>	<p>B</p> <p>What is the average amount of time (<i>Insert name of your school</i>) Middle School students spend watching TV each week?</p> <p>Ask every tenth student exiting the school today, how many hours he/she watches TV each week.</p>
<p>C</p> <p>Predict the winner of the state election for governor.</p> <p>Survey 100 randomly selected ninth grade students.</p>	<p>D</p> <p>The principal wants to know the favorite songs of the eighth-grade class of 600 students.</p> <p>She randomly selects three names from the Grade 8 pages of the yearbook and asks those students.</p>
<p>E</p> <p>How long, on average, does it take eighth grade students to complete their science homework?</p> <p>Ask all science teachers at the school.</p>	<p>F</p> <p>A PE teacher wants to know the average number of pull-ups the 7th graders at Jackman Middle School can do.</p> <p>All 7th grade students in first period are tested on pull-ups.</p>

<p>G</p> <p>What percent of middle school students enjoy going to movies?</p> <p>Ask every tenth person leaving a theater.</p>	<p>H</p> <p>Predict the winners of a school election.</p> <p>Randomly select 200 students to ask about their votes.</p>
<p>I</p> <p>What proportion of the seventh grade at your school chooses soccer as their favorite sport?</p> <p>Ask everyone on the football team.</p>	<p>J</p> <p>How many seventh graders had protein for breakfast?</p> <p>Randomly select 50 seventh grade students to ask what they had for breakfast.</p>
<p>K</p> <p>Predict the winner of a school election.</p> <p>Ask my friends at the lunch table about their votes.</p>	<p>L</p> <p>An author wants to know the average number of words per page in his new novel.</p> <p>Use a computer program to count the words on every tenth page of the novel.</p>

Sampling Our School Population



Use the demographics data to complete the following tasks.

- 1) Describe a sample that is representative of our school population. Explain why you think the sample is representative.

- 2) Describe a sample that is biased (**NOT** representative of our school population). Explain why you think the sample is biased.

Random Sampling

Statistics are all around us. So many numbers are quoted for so many things:

- Four out of five dentists use Crest toothpaste.
- 32% of teenagers like to watch a certain show on Netflix.
- The average American family spends about \$330 each month on groceries.

Where do all these statistics come from? Why might they be important? How can you know they're valid?

In each of the examples above, the goal was to gather information about a large population and use statistics to report about the findings. For example, if you want to know something about the students at your school (perhaps their favorite show on Netflix), it would be incredibly difficult to interview every single kid. However, you can survey a subset of the student population at your school and make some inferences based on the results you get. BUT, to be assured those inferences are valid, a method called random sampling must be used to identify the smaller subset of the larger population. Random sampling means that everyone in the population has an equal chance to be selected for the survey.



SAY SOMETHING:

- Define **subset** and **population**. Why might it be necessary to choose a subset when you need to gather information about a population?
- Define **random sampling**.

Inferences are the assumptions you make about a population based on your sample. Random sampling is necessary to make valid inferences because there can be a great deal of variety within a population. When you make sure everyone in the population has an equal chance to be chosen, you're doing your best to make sure that variety is well represented. The better your sample, the more likely any inferences you make will be accurate. Samples that aren't randomly chosen are also referred to as being biased.

Let's say you want to know what lunch items the favorites of students at your school are. Remember, you need a random sample to better support any inferences you make. If you only ask the girls in your first period class, it's very unlikely the inferences you make based on that sample will be accurate. This is because you didn't use a biased sample. There was no way that anyone who isn't in your first period class could be chosen. When you choose students to survey, you need to be sure every student in the school has a chance to participate. Getting a random sample of the larger population is the most effective way to ensure you can make accurate inferences about that population.



SAY SOMETHING:

- Define **inference**? What does it mean for an inference to be **valid**?
- How does choosing a subset using random sampling help ensure you can make valid inferences about the population?

Examples of random sampling methods:

- Selecting participants according to a set interval.
 - You decide to ask every 10th student who leaves the cafeteria over the course of a week. Each of those students is a participant.
- Using a lottery.
 - You assign every student a number and use a random number generator to choose numbers. The students those numbers represent are your participants.
 - Or, you have each student's name on a slip of paper. Put the slips in a bowl or bag, mix well, and choose slips. Those students are your participants.

NON-examples. These are NOT random sampling methods. Using them will likely result in a biased sample.

- Convenience sample.
 - You pick participants according to how "convenient" it is. Asking only the girls in your first period class would be a convenience sample because no one else has any chance of participating. Remember, easy isn't often right.
- Voluntary response.
 - You set a stack of surveys on a table outside the cafeteria. Only those who are interested in completing the survey are possible participants.
 - Or, you send out an email link to a survey. Only those who are interested in responding and completing the survey are possible participants.

Add to the definitions you have for these words in your Math notebook. If you don't have them in your notebook, put them there now. 😊

- | | | |
|--------------|------------------|-----------------|
| • population | • sample | • subset |
| • inference | • bias(ed) | • random sample |
| • survey | • representative | • valid |

Describe how you might select a random sample of the student body to survey to find out the favorite lunch choices.

Quick

Reach each scenario and determine the following:

- The population and subset. Tell how you know.
 - Whether the sampling method was random. Tell why or why not.
 - Whether the surveyor will be able to make valid inferences. Tell why or why not.
-
- You want to decide which of three bowling alleys in the area is the best, so you randomly survey people at a local sports store.
 - To find out how much money the average American family spends each year to cool their home, 100 Alaskan families are surveyed at random.
 - To evaluate the quality of their product, a manufacturer of cell phones checks every 50th phone off the assembly line.
 - A magazine asks its readers to complete and return a questionnaire about popular TV actors.

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