Grade Level/Course: Grade 7
Lesson/Unit Plan Name: Using Random Sampling to Draw Inferences
Rationale/Lesson Abstract: Making inferences from sample data can develop understanding of proportional relationships, including percentages. In this lesson, students examine samples for bias by categorizing scenarios in the warm-up, and then use random samples to predict outcomes in larger populations. The lesson spirals review of solving equations with common denominators and inverse operations.
Timeframe: 50 minutes
Common Core Standard(s): 7.SP.1, 7.SP.2 Use random sampling to draw inferences about a population. 1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences. 2. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. *For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.*

Instructional Resources/Materials:
Copies of scenarios, enough for groups or partners
Poster paper or white board space

Activity/Lesson Warm-up:
Introduce why it would be difficult to gather statistics on an entire population. "For example, what if we wanted to know the school lunch preferences of all of the 60,000 students in Elk Grove?" [We wouldn't have time or a way to ask all students.] Introduce statistics as a way to gain information about a large population by studying just a sample of the population and that generalizations from a sample are only valid if the sample truly represents the population (is representative).

Make two headings for categories on the board: Biased and Representative. Leave space in between for scenarios that don't fit easily into a category. Students will examine and categorize a scenario in groups. If they determine their sample is biased, they will propose a representative sample on the back of their paper. If their sample is representative, they will justify their reasoning on the back. Groups will present to the whole class using sentence stems:

This sample is biased because_______________. A representative sample would be ___________.

This sample is representative because___________________________________.

[Each part of the population has an equal chance of being chosen.]

Model the first example. Decide as a group how to categorize and justify the second example.

Note: Some groups may decide that their sample goes in between biased and representative (randomly selected, but not representative). Random samples are more likely, but not guaranteed, to be representative. If a sample is representative we can make valid claims about the whole population.

Example 1: The nutrition department wants to know the school lunch preferences of the K-12 students in Elk Grove. They survey 100 kindergarteners.	Example 2: What is the average amount of time Rutter Middle School students spend watching TV each week? Ask every tenth student exiting the school today how many hours he/she watches TV each week.
Predict the winner of the state election for governor. Survey 100 randomly selected ninth grade students.	The principal wants to know the favorite songs of the eighth grade class of 600 students. She randomly selects three names from the Grade 8 pages of the yearbook and asks those students.
How long, on average, does it take eighth grade students to complete their science homework? Ask all science teachers at the school.	A PE teacher wants to know the average number of pull-ups the 7^{th} graders at Jackman Middle School can do. All 7^{th} grade students in first period are tested on pull-ups.
What percent of middle school students enjoy going to movies? Ask every tenth person leaving a theater.	Predict the winners of a school election. Randomly select 200 students to ask about their votes.
What proportion of the seventh grade at your school chooses soccer as their favorite sport? Ask everyone on the football team.	How many seventh graders had protein for breakfast? Randomly select 50 seventh grade students to ask what they had for breakfast.
Predict the winner of a school election. Ask my friends at the lunch table about their votes.	An author wants to know the average number of words per page in his new novel. Use a computer program to count the words on every tenth page of the novel.

Activity/Lesson:

Example 1 (We do):
The data from two random samples of 100 students regarding their lunch preferences are given below.

Student Sample	Burgers	Tacos	Pizza	Total
#1	12	14	74	100
#2	12	11	77	100

Possible Inferences:

- Most students prefer pizza.
- Tacos and burgers are about tied.
- About six times as many students prefer pizza as those who prefer tacos.
- More students prefer pizza than those who prefer burgers and tacos combined.

About how many servings of pizza should we order to serve lunch to 1200 students?
If we combine the two samples we have 151 out of 200 students who prefer pizza. The combined sample is stronger than either sample alone. We'll use equivalent fractions to make an inference about the whole population.

Common Denominator

$$\frac{151}{200} = \frac{x}{1200}$$

$$\frac{6}{6} \bullet \frac{151}{200} = \frac{x}{1200}$$

$$\frac{906}{1200} = \frac{x}{1200}$$

$$\therefore \quad x = 906$$

We can *infer* that we would need about 906 servings of pizza for 1200 students.

Inverse Operation

$$\frac{151}{200} = \frac{x}{1200}$$

$$\frac{151 \bullet 1200}{200} = \frac{x}{1200} \bullet 1200$$

$$\frac{151 \bullet 6 \bullet 200}{200} = x$$

$$906 = x$$

Estimating

$$\frac{151}{200} \approx \frac{150}{200}$$

$$\approx \frac{150}{200} \bullet \frac{6}{6}$$

$$\approx \frac{900}{1200}$$

We can *infer* that we would need about 900 servings of pizza for 1200 students.

Example 2 (We do): Given the data in the table below from a random sample of 5000 registered voters, predict the outcome of the election. What percentage of the voters supports the winning candidate?

Candidate A	Candidate B	Candidate C	Total
1505	2074	1421	5000

Possible Inferences:

- Candidate B will most likely win the election.
- The winning candidate will have fewer than half of the votes.
- Candidates A and C are about tied.

Common Denominator

$$\frac{2074}{5000} = \frac{x}{100}$$

$$\frac{2074}{5000} \div \frac{50}{50} = \frac{x}{100}$$

$$\frac{2074 \div 50}{100} = \frac{x}{100}$$

$$\therefore \quad x = 2074 \div 50$$

$$x = 41.48$$

41.48 % of the voters support the winning candidate.

Inverse Operation

$$\frac{2074}{5000} = \frac{x}{100}$$

$$\frac{100}{1} \bullet \frac{2074}{5000} = \frac{x}{100} \bullet \frac{100}{1}$$

$$\frac{100}{1} \bullet \frac{2074}{50 \bullet 100} = x$$

$$\frac{2074}{50} = x$$

$$x = 41.48$$

Estimating

$$\frac{2074}{5000} \approx \frac{2000}{5000}$$

$$\approx \frac{2}{5}$$

$$\approx \frac{2}{5} \bullet \frac{20}{20}$$

$$\approx \frac{40}{100}$$

$\therefore$ About 40 % of the voters support the winning candidate. The estimate helps us determine that our answer is reasonable.

Note: Samples can give us estimates for the population, not an exact number. If our sample changed just slightly, we would have a different estimate.

Example 3 (You do together): The data from two random samples of 200 students regarding their favorite sports are given below. Make inferences about the data and give the percentage of students who prefer basketball.

Student Sample	Soccer	Football	Basketball	Track	Total
#1	40	62	63	35	200
#2	43	64	61	32	200

Possible Inferences:

- Basketball and football are more popular than soccer and track.
- Football and basketball are about tied.
- Track is the least popular sport listed.

Common Denominator

$$\frac{124}{400} = \frac{x}{100}$$

$$\frac{124}{400} \div \frac{4}{4} = \frac{x}{100}$$

$$\frac{31}{100} = \frac{x}{100}$$

$$\therefore \quad x = 31$$

We can *infer* from the samples that 31% of students prefer basketball.

Inverse Operation

$$\frac{124}{400} = \frac{x}{100}$$

$$\frac{100 \bullet 124}{400} = \frac{x}{100} \bullet 100$$

$$\frac{100 \bullet 124}{4 \bullet 100} = \frac{x}{100} \bullet 100$$

$$31 = x$$

Example 4 (We do): Random samples show that about 10% of the population is left handed. How many pairs of left-handed scissors should we have for classes of about 40 students?

Common Denominator

$$\frac{10}{100}=\frac{x}{40}$$

$$\frac{10}{100}\div\frac{10}{10}=\frac{x}{40}$$

$$\frac{1}{10}=\frac{x}{40}$$

$$\frac{1}{10}\bullet\frac{4}{4}=\frac{x}{40}$$

$$\frac{4}{40}=\frac{x}{40}$$

$$\therefore \quad x=4$$

We *infer* that we would need 4 pairs of left handed scissors for 40 students.

Cross Products

$$\frac{10}{100}=\frac{x}{40}$$

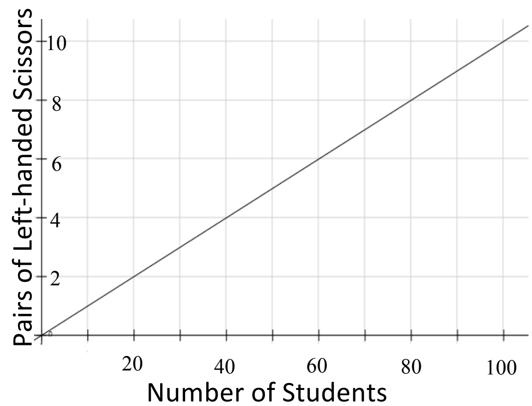
$$400=100x$$

$$\frac{400}{100}=\frac{100x}{100}$$

$$x=4$$

Solve as a one-variable equation if students are not ready to justify $\frac{a}{b}=\frac{c}{d}$ when $ad=bc$.

Graphing



With the graph, we can also *infer* how many left-handed pairs of scissors would be needed for other numbers of students without additional calculations.

Example 5 (You do): There are 924 students at a middle school. Random samples of students show that about one third attend after-school clubs, how many chairs should be set up for the school-wide Club Day meeting?

Common Denominator and Estimating

924 is rounded to 900.

$$\frac{1}{3}=\frac{x}{900}$$

$$\frac{1}{3}\bullet\frac{300}{300}=\frac{x}{900}$$

$$\frac{300}{900}=\frac{x}{900}$$

$$\therefore \quad x=300$$

We can *infer* from the samples that about 300 seats are needed. Would it be better to set up too many or too few?

Inverse Operation

$$\frac{1}{3}=\frac{x}{924}$$

$$924\bullet\frac{1}{3}=\frac{x}{924}\bullet 924$$

$$\frac{924}{3}=x$$

$$\frac{900+24}{3}=x$$

$$300+8=x$$

$x=308$ chairs

Assessment: Exit Ticket

In a random sample, 45 out of 60 seventh grade students said they prefer pizza for lunch. How many servings should the cafeteria staff prepare for a class of 1000? Select all correct work shown.

A) $1000 \bullet \frac{45}{60} = \frac{x}{1000} \bullet 1000$ Yes No

B) $\frac{3}{4} = \frac{x}{1000}$ Yes No

C) Yes No

1000			
250	250	250	250

750

D) $60x = 45$ Yes No

E) $\frac{45}{60} = \frac{x}{1000}$ Yes No

In a random sample, 45 out of 60 seventh grade students said they prefer pizza for lunch. How many servings should the cafeteria staff prepare for a class of 1000? Select all correct work shown.

A) $1000 \bullet \frac{45}{60} = \frac{x}{1000} \bullet 1000$ Yes No

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C) Yes No

1000			
250	250	250	250

750

D) $60x = 45$ Yes No

E) $\frac{45}{60} = \frac{x}{1000}$ Yes No

Assessment: Exit Ticket Key **A)** Yes **B)**Yes **C)**Yes **D)**No **E)**Yes