RAFT IDEAS

Topics: Sampling Methods, Populations

Materials List
- ✓ Blank playing cards, 1 deck
- ✓ 54 images of 3 or more similar objects w/ 1-2 different attributes, see ***Card Image Sheet***, page 5 or use stickers
- ✓ Marker/pen/pencil
- ✓ Scissors
- ✓ Tape, clear
- ✓ Random Number Table (N = 54), page 3
- ✓ Data Tables, pages 3 & 4

This activity can be used to teach:
Common Core Math:
- Distributions, Samples, & Models (Statistics & Probability, Grade 6, 1-5; Grade 7, 1, 2, 4; Grade 8, 4; High School, Conditional Probability, 4)
- Ratios & Proportions (Ratios & Proportions Grade 6, 1; Grade 7, 1, 2)
- Problem Solving & Reasoning (Math Practices, Grades 6-12)

Next Generation Science:
- Science & Engineering Practices (Grades 6-12)

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Ample Samples

A Sampling of Sampling Techniques

Get a statistical snapshot of a population using simplified versions of the random, systematic, and stratified sampling techniques commonly used by researchers around the world!

Assembly
1. Print the Card Image Sheet in color or, if black and white is preferred, use two or more colored markers and place one colored dot on each image. Alternate assembly: use 18 each of 3 types of stickers in lieu of printed card images.
2. Cut out card images and tape one image to the blank side of each card.
3. Stack the deck with all images face down and thoroughly shuffle deck.
4. Label the non-image side of the cards with a marker from 1 to 54, one number per card. Stack the cards in order with 1 being at the top.

To Do and Notice
Random Sampling with sample size n = 20
1. Place Random Number Table, or RNT, on flat surface. Cover eyes and then place a finger on the RNT. In pencil, circle the starting number underneath or nearest to finger. Working either vertically or horizontally from the starting number and ignoring repeats, slide finger in a random direction and circle the numbers that appear along the path.
2. When the edge of the RNT is reached, slide finger one column to the left or right (if sliding vertically) or one row up or down (if sliding horizontally) and continue in the same direction as before *except start from the opposite side of the table* until a total of 20 numbers are circled on the RNT.
3. Make sure the deck is stacked image-side down in order with #1 at top. Obtain sample by taking cards from the deck that have the numbers circled in the RNT.
4. Count and record each object type in the sample, e.g., number of soccer balls, bowling balls, basketballs. Refer to the example and record data in the Random Sample Data Table.
5. Reorder the cards with 1 at the top of the deck. Erase the circles on the RNT and repeat steps 1-4 two more times.
6. Compare the percent of each object in the sample to the actual percent in the population. For example, if the sample contains 20% soccer balls and the population contains $18/54 \approx 33\%$ soccer balls, the sample differs by 13%. Based on the data, which trial was most representative of the population?

Systematic Sampling with sample size n = 20
7. Place all cards back in the deck image-side-down and shuffle deck. Obtain sample by removing every 3rd card, cycling through the deck until 20 cards are removed. Follow steps 4 and 6 above three times and record data in the Systematic Sample Data Table. Compare random and systematic sampling results. Which method produced samples that best represent the population?

Developed and written by Eric Welker (RAFT)

Stratified Sampling with sample size n = 6

8. Separate cards into stacks with the same background color (or colored dot/sticker). Shuffle each stack image-side down.
9. Obtain 6 cards *from each stack* by removing every 3rd card as in step 7.
10. Count and record each image type per stack and complete Trial 1 box in Stratified Sample Data Table. Repeat steps 8-9 for Trials 2 and 3 and complete the table.
11. Compare the results obtained from the three sampling methods (random, systematic, and stratified). Which method produced the most representative samples?

The Content Behind the Activity

Researchers collect data from a population and then analyze it to answer questions and make generalizations or predictions about the population. The design of a study determines the particular sampling method most appropriate for collecting data. The most important aspect of data collection is sampling. A sample is a subset of a population of manageable size. There are several sampling methods used including random, systematic, cluster, and convenience sampling. Each method has advantages and disadvantages in producing samples that accurately represent the population of interest.

Random sampling is designed to produce samples free of researcher bias because this method uses a random number table. Each individual in a population is numbered and a random number table is used to select individuals to include in the sample. The table is created using software (such as *Excel*) that randomly assigns a table cell to all digits between 1 and the population size, i.e. the number of cells in the table is equal to the population size. Since the table cell values are randomly placed there can be repeated numbers and occasionally a few numbers will not appear in the table at all. The use of random number tables is standard practice when a completely random sample is necessary, e.g., a medical study testing the effects of a drug on human subjects. Random sampling minimizes experimenter bias in terms of subject selection from the population. Random sampling is impractical when dealing with large populations, e.g., the fish population in Monterey Bay. Another disadvantage is that the randomness itself can produce outliers in the sample that may be difficult to spot and thus could yield inaccurate results. For example, a sample containing birds unable to produce eggs would skew the results in a study of the mean number of eggs laid per bird.

Systematic sampling yields samples more representative of a population than simple random sampling. The samples are obtained according to a fixed period or rule, e.g., every 7th part on an assembly line, which can eliminate sources of bias. Systematic sampling is frequently used in industry when items are made in mass production and must be tested for quality before distribution. This method can introduce bias, however, when a pattern exists in the population that coincides with the fixed rule. For example, suppose that a machine that produces parts on an assembly line has a tendency to make a mechanical error on every 7th part along the line. Systematically sampling every 7th part for quality will likely yield invalid results because the fixed sampling rule matches the error pattern in the population of parts along the assembly line.

Stratified sampling is used most frequently by researchers because there are no major disadvantages in terms of sample or researcher bias. It yields more accurate results than random or systematic sampling, and can reveal tendencies within categories of individuals within the population. The population is broken down into categories that differ by one or more attributes, e.g. men and women. Then, samples are taken from each category using either random number tables or systematic fixed rules. The sample size per category is the same proportion as each category is to the whole population. For example, the included card image sheet contains a population of 54 balls (18 of each type), six of each type having a different background color. With color as the category criterion, the proportion of each category to the whole is 18/54=0.33. With a *category* population size of 18, the *sample size n* to be taken from each category is $18 \times 0.33 \approx 6$, specified for steps 8-10 above.

Taking it Further

- Increase sample sizes and/or number of trials for each sampling method

Web Resources (Visit www.raft.net/raft-idea?isid=640 for more resources!)

- Sampling method details - http://www.socialresearchmethods.net/kb/sampling.php
- Teacher designed math courses from the New Jersey Center for Teaching & Learning – https://njctl.org/courses/math

Random Number Table (For population size N = 54)

53	38	6	31	33	52	6	33	35	23
46	26	47	16	18	8	45	37	13	7
10	26	41	15	7	18	46	23	5	4
44	28	3	54	41	34	47	35	51	40
18	22	37	36	32	11	54	42	29	50
12	47	10	37	32	20	44	54	44	36
43	40	35	47	17	36	44	28	41	16
22	43	37	29	23	1	21	34	24	7
29	14	16	31	18	1	16	35	16	51
3	21	10	9	41	1	23	31	12	29

Random Sample Data Table

	Ball Type	Sample Breakdown		Ratio	% of Sample
		Tally	Count (c)	c / n	(c / n) x 100 = %
EX.	*Soccer*	*IIII*	*4*	*4 / 20*	*(4 / 20) x 100 = .20 x 100 = 20%*
Trial 1	Basket				
	Bowling				
	Soccer				
Trial 2	Basket				
	Bowling				
	Soccer				
Trial 3	Basket				
	Bowling				
	Soccer				

Systematic Sample Data Table

	Ball Type	Sample Breakdown		Ratio	% of Sample
		Tally	Count (c)	c / n	(c / n) x 100 = %
EX.	*Soccer*	*III*	*3*	*3 / 20*	*(3 / 20) x 100 = .15 x 100 = 15%*
Trial 1	Basket				
	Bowling				
	Soccer				
Trial 2	Basket				
	Bowling				
	Soccer				
Trial 3	Basket				
	Bowling				
	Soccer				

Stratified Sample Data Table

	Color	Ball Type	Sample Breakdown		Ratio	% of Sample
			Tally	Count (c)	c / n	(c / n) x 100 = %
EX.	*Orange*	*Soccer*	*//*	*2*	*2 / 6*	*(2 / 6) x 100 = .33 x 100 = 33%*
Trial 1	Blue	Basket				
		Bowling				
		Soccer				
	Orange	Basket				
		Bowling				
		Soccer				
	Purple	Basket				
		Bowling				
		Soccer				
Trial 2	Blue	Basket				
		Bowling				
		Soccer				
	Orange	Basket				
		Bowling				
		Soccer				
	Purple	Basket				
		Bowling				
		Soccer				
Trial 3	Blue	Basket				
		Bowling				
		Soccer				
	Orange	Basket				
		Bowling				
		Soccer				
	Purple	Basket				
		Bowling				
		Soccer				

Card Image Sheet