TEACHER INSTITUTE FOR THE EXPERIENCE OF SCIENCE TIES

Data Collection and Sampling

Grades: 6-8
Subject: Science, Math

Overview of Lesson Plan: The purpose of this simulation is to get students to determine for themselves how many samples are enough when conducting an experiment. Students are asked to compare two bags, but only have a limited amount of data to use for their comparisons. Students learn how variability affects the number of samples needed to determine differences between groups.

Suggested Time Allowance: About 30 minutes; can be extended to a full class period.

Oregon State Benchmarks for Scientific Inquiry:

1. Based on observations and scientific concepts, ask questions or form hypotheses that can be explored through scientific investigations.
2. Design a scientific investigation to answer questions or test hypotheses.
3. Collect, organize, and display sufficient data to support analysis.
4. Summarize and analyze data including possible sources of error. Explain results and offer reasonable and accurate interpretations and implications.

Objective:
At the end of the lesson, the student will be able to understand how larger sample sizes can increase a person's confidence in being able to distinguish differences between two groups.

Resources / Materials:

- Pennies and dimes (25 of each) for warm up set.
- Paper bag for each student, plus 2 extra.
- Bag Labels - can be printed in either color (page 10) or black and white (page 13). Affix labels to each paper bag with tape or glue.
- Blood Test Sheets – one page has results from the experimental group, the other page has results from the control group. Blood test sheets can be printed in color (pages 8-9) or in black & white (pages 11-12). Cut each sheet into 20 pieces, which are folded and placed in the paper bag. Seal the bag prior to the lesson. Print one copy of both sheets and leave uncut to hold up at the end of the lesson.
- Blood Test Result Scoresheet - The scoresheets make it easier for students to keep track of the results that they pull from the bags. Sheets can be printed from page 7. Cut in half and hand out one table to each pair.

Activities / Procedures:

Warm Up Set:

Preparation: Place 20 pennies and 5 dimes in one paper bag. Place 5 pennies and 20 dimes in the other paper bag.

Instructions:

1. Explain to class these bags contain 25 coins each.
2. Have two students come to the front of the room. Each should choose one coin from their bag without looking. One student will likely draw a penny, the other will likely draw a dime. (Tell the class that based on these samples, the first bag must be all pennies and that we should sell the bag for 20 cents. The other bag must all be dimes and we should sell the bag for $2.50. Ask students if they agree)
3. Have them repeat the activity, but drawing 5 coins from the bags. What can we say about the bags now? Does it change the class' opinion on the price for each bag?

Sampling Activity:

Situation Set Up:

A community of Native Americans living in several towns along an Oregon river noticed problems in their children. Some were becoming blind, others were sick and a few children died. The doctor who treated the sick noticed that most of these issues were occurring in children. With the consent of the tribal elders, the tribe called OHSU to find out what may be going on.

OHSU sent a researcher to the community to ask questions about the patients' histories, what they ate, etc. (this interview process is called qualitative research).

What OHSU found from the qualitative interview:

- The tribe's diet consisted mainly of salmon from the river, foods harvested locally and duck that they hunted in the nearby wetlands.
- Children were most affected.
- Those who were sick often became blind.
- Blindness appeared to run in families.

Dr. Gilling, an OHSU doctor, read the results from the interview and immediately suspected a genetic defect. This case was very similar to a case she had just solved in Alaska. Dr. Gilling wants to test members of this tribe for the genetic defect. However, genetic tests are very expensive ($2000 each) and there isn't enough money to test everyone. Dr. Ham explains that blood tests can be done as a preliminary test since they only cost $100 each. Drs. Gilling and Ham agree that they will conduct blood tests first so they can find the right patients for further genetic testing. However, the doctors need your help in deciding who they should test first:

<u>Ask students who the doctors should test in their study:</u>

-Who do you measure? Just the kids who are sick? What about who aren't sick (control sample)?
-How do you find your subjects? Do you recruit everyone in a town or just a subset of people? Do you test from several towns along the river or just in one town?
-Should we know if the samples are from sick people when we test them? Could knowing what the samples are skew some of the results? (Importance of double blind samples – where neither the researcher taking the blood or the person measuring the blood levels know if the patient is sick or not.)

Optional Discussion:
- Should we have the same person do all the tests so we know they were measured the same way? (importance of testing uniformity and protocol.)
- Do we announce everyone's test results? (importance of patient confidentiality)

Based on your input, the research team decides to test 20 people in each town along the river. Your task is to see if any groups are different enough to warrant genetic testing.

Inside these bags are the blood test results from different towns along the Oregon river. Each bag contains blood tests from a single town and each slip of paper is the blood test result from one person. There are 20 tests in each bag, representing 20 people.

If you are using <u>colored</u> samples, read this scenario:
Green samples represent normal blood levels.
Yellow samples are questionable.
Red samples represent blood levels in the danger zone and patients would be good candidates for genetic testing.

If you are using <u>black & white</u> samples, read this scenario:
White samples represent normal blood levels.
Grey samples are questionable.
Black samples represent blood levels in the danger zone and patients would be good candidates for genetic testing.

Pair up with the person sitting next to you. Each person should pull only ONE sample from the bag – no peeking! Write the blood test result that you and your partner pulled on the Blood Test Result sheet. (Hand out bags)

Ask students after they have pulled their one sample:

- Is the amount of sickness in your town the same or different than the amount of sickness in your partner's town?
-How confident are you that these towns are either the same or different?
-Would you like to take another sample?

Remember, we only have a limited amount of money to spend on these blood tests because we want to spend more money later on the genetic tests. Pull another sample from the bag and record your results. After pulling each sample, talk with your partner about how confident you feel that these towns have the same amount of sickness or differing amounts of sickness. When you and your partner feel confident in your decision, you can stop pulling samples.

Ask students after they have stopped pulling samples:

- Raise your hand if you think that you and your partner have the same amounts of sickness in your towns.
- Raise your hand if you think that you and your partner have different amounts of sickness in your towns.
- How confident are you that this is the case? Raise your hand if you're 100% confident. 90%? 50%?
- How did you decide when to stop pulling more samples? (issues with sample variability will likely arise.)
- Did you and your partner both agree? If not, how did you decide what to do?
- How much money did you spend on these tests? Remember each test is $100, so if you and your partner each pulled 3 tests, that is $600. (Which group spent the most money in the class? Who spent the least money? As a class, discuss why there may be a discrepancy between these two amounts. Issues in sample variability should arise.)
- Did increasing the number of samples increase your confidence that there were differences (or not) between these towns?
- Raise your hand if you think you have a group that needs further genetic testing? What made you think that? Are you confident in your decision?

To break the code to see if students were right:
(Briefly hold up two uncut sheets of blood test results for the class.)

Ask students:

- Raise your hand if you think you had this town (hold up sick group – mostly red/black).
- Raise your hand if you think you had this town (hold up control group – mostly green/white).
- How confident are you that this is the case?

Verify your decision by decoding the unique identifier on the bottom of the blood test sheets. The unique identifier is a series of letters and numbers in the bottom right hand corner of each blood test. The last letter will be either an X or a Y. Blood tests with X are the experimental sick group (mostly red/black). Blood tests with Y are the control group (mostly green/white).

Ask students:

- Raise your hand if you were correct.
- What made you so sure?
- Why do you think a scientist would want to take a larger sample size?
- What do you think would prevent scientists from taking a larger sample size?

Vocabulary:
Some scientific terms that students described but likely did not explicitly say are:

Variance – This is a measure of spread. How different are the numbers within a group? In this simulation, students used colored blood tests. Group 1 may have pulled 5 samples: red, red, yellow, green, green. Group 2: red, red, red, yellow, red. Group 1's samples are all over the board. Group 2's are more specific, even though there is some overlap between the two groups. In this case, Group 1 has more variance and it may take them more samples to detect differences.

Standard deviation – this is also a measure of spread, very similar to variance. In fact, the standard deviation is the square root of the variance. The standard deviation is used to calculate the p value (see next).

p value – This is a mathematical term that uses all of the blood test values to calculate whether two groups are statistically different or not. It takes into account the mean, the number of samples tested and how much variance there was in the tests. The p value tells you whether two groups are different or not. After doing the math, if the p value is less than 0.05 (written as $p<0.05$ – you may see this in scientific papers), the two groups are said to be "significantly different" (see next).

Significance – Based on a math formula that asks if two groups are different from each other. Significance is determined by a p value (see above), which takes into account the number of tests done as well as their average and variance.

For more information, visit the TIES website (http://ties.ohsu.edu)

	Blood Test Results	
Sample #	Mine	Partner’s
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

	Blood Test Results	
Sample #	Mine	Partner’s
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Blood Test Level
(microgram/milliliter)
2
rsk29a8x1

Blood Test Level
(microgram/milliliter)
3
rhk2823a8x2

Blood Test Level
(microgram/milliliter)
2
Rhq8k29a8x3

Blood Test Level
(microgram/milliliter)
1
segk289a8x4

Blood Test Level
(microgram/milliliter)
5
Rhk59a8x5

Blood Test Level
(microgram/milliliter)
3
oahk259a8x6

Blood Test Level
(microgram/milliliter)
2
ph37js2539a8x7

Blood Test Level
(microgram/milliliter)
3
Rh5w292a8x8

Blood Test Level
(microgram/milliliter)
3
2B2k32x9

Blood Test Level
(microgram/milliliter)
4
2B2k329a8x10

Blood Test Level
(microgram/milliliter)
1
oahk29a8x11

Blood Test Level
(microgram/milliliter)
1
B2k429a8x12

Blood Test Level
(microgram/milliliter)
9
Aehk17a8qx13

Blood Test Level
(microgram/milliliter)
7
ayhk2569a8x14

Blood Test Level
(microgram/milliliter)
2
Da8ehk29a8x15

Blood Test Level
(microgram/milliliter)
3
oahk29a8x16

Blood Test Level
(microgram/milliliter)
2
Bcvhk54a8x17

Blood Test Level
(microgram/milliliter)
1
tcvhk229a8x18

Blood Test Level
(microgram/milliliter)
5
scvhk2452a8x19

Blood Test Level
(microgram/milliliter)
3
B2k42a8x20

Blood Test Level
(microgram/milliliter)
2
rsk29a8y1

Blood Test Level
(microgram/milliliter)
4
rhk2823a8y2

Blood Test Level
(microgram/milliliter)
6
Rhq8k29a8y3

Blood Test Level
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5
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Blood Test Level
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Rhk59a8y5

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Blood Test Level
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ph37js2539a8y7

Blood Test Level
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7
Rh5w292a8y8

Blood Test Level
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7
2B2k32y9

Blood Test Level
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Da8ehk29a8y15

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oahk29a8y16

Blood Test Level
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7
Bcvhk54a8y17

Blood Test Level
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