Binomial Test and Probability

Teacher PowerPoint

- Teacher gives a brief introduction to the importance of good statistics in science.
- Teacher introduces the **binomial test, which** is an exact test of the statistical significance of deviations from a theoretically expected distribution of observations into two categories.
- The most common usage is in a situation where there are two kinds of outcomes.
- Teacher explains how to calculate in Excel and find P, the statistical significance of the result.

Engage:

Students, using a coin, scotch tape and any small piece of material they can find, alter the tail side of the coin.

Students make a prediction for how many times heads will come up, if they toss the coin 20 times.

Students share out their predictions.

Explore:

Students flip the coin and record results in a table.

Students write a short analysis of their results. Did their results match their prediction? Students use Excel to find P, the percent chance that the outcome occurred randomly.

Explain:

Student question: If you were just given the results, and didn't see your coin, what would you conclude about this coin?

Elaborate:

Students are given hypothetical bee data and asked to analyze these data to show whether they are significant.

Evaluate:

Why could scientists create experiments that are binomial tests?
Evaluate your own data in groups and save.

Standards:

Investigation & Experimentation - Grades 9 To 12
1.Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
b. Recognize the issues of statistical variability and the need for controlled tests.

Probability and Statistics- Grades 8-12

1. 0 Students know the definition of the notion of independent events and can use the rules for addition, multiplication, and complementation to solve for probabilities of particular events in finite sample spaces.

2.0 Students know the definition of conditional probability and use it to solve for probabilities in finite sample spaces.

3.0 Students demonstrate an understanding of the notion of discrete random variables by using them to solve for the probabilities of outcomes, such as the probability of the occurrence of five heads in 14 coin tosses.

4.0 Students are familiar with the standard distributions (normal, binomial, and exponential) and can use them to solve for events in problems in which the distribution belongs to those families.

Learning Objectives: After completing this activity the students will be able to:

- Calculate the P value for a binomial test using Excel.
- Either accept or reject the null hypothesis based on the p-value.

Materials:

Pennies for each student pair and scotch tape
Student Handout
Computer with Excel

Name : _____Date: _____Class: _____

Binomial Test and Probability

Warm Up:

1. **What is a hypothesis?**

2. **What is a prediction?**

3. **What is the difference between a hypothesis and a prediction?**

Null Hypothesis (H_0):

Probability Equations:

Binomial Test:

Calculating the binomial test in Excel:

Our Question:

=BINOMDIST(6, 20, 0.5, TRUE).
6 = the number of times it is tails, 20-14= 6.
20 = the number of times you flipped the coin.
0.5 = the expected probability of getting heads
TRUE = calculating the sum of the probabilities of the observed number and all more extreme values (14 +15 + 16 + 17 +18 +19 +20)

P:

Generally, when P is < 0.05, we reject the null hypothesis**.**

When P is <0.05 we _____the null hypothesis.

Name : _____Date: _____Class: _____

Binomial Test and Probability

Introduction: In this activity you will learn how to do a **binomial test**, a statistical test that allows us to calculate the deviations observed from what was expected. You will learn how to calculate a binomial test in Excel, and how to calculate the **P value,** the percent chance that what happened occurred randomly. In this way, you will be able to tell whether or not your outcome was due to chance, **a null hypothesis (H_0)**, or happened because something else was changing the outcome.

Materials:
Pennies for each student pair
Scotch tape
Student Handout
Computer with Excel

PART 1: COIN TOSS EXPERIMENTS

EXPERIMENT 1:

Take the tail side of your coin and alter it with scotch tape and some piece of material. Now make a prediction as to how many times heads will come up if you toss the coin 20 times.

PREDICTION:

_____

_____

_____

Collect data:

Record each time that your coin lands on heads or tails. Make big high flips!

Table 1: Heads or Tails in a Coin Toss (n=20)

	Toss 1	Toss 2	Toss 3	Toss 4	Toss 5	Toss 6	Toss 7	Toss 8	Toss 9	Toss 10	
Heads											
Tails											
	Toss 11	Toss 12	Toss 13	Toss 14	Toss 15	Toss 16	Toss 17	Toss 18	Toss 19	Toss 20	Total
Heads											
Tails											

QUESTIONS:

1. Did your results match your prediction? Why or why not?

   _____

   _____

2. Write a equation that you could enter into Excel to calculate the P value of the binomial test:

   P =BINOMDIST(_____, _____, _____, TRUE)

2. Now calculate P, the percent chance that what occurred happened randomly, using Excel.
   P =

3. Is P greater than or less than 0.05?

4. Would you accept or reject the null hypothesis? _____

5. What does it mean to accept the null hypothesis? _____

   _____.

   What does it mean to reject the null hypothesis? _____

   _____.

6. If you were given only the results, without seeing the coin itself, what would you conclude about the coin: is it fair or not? Explain.

   _____

   _____

PART 2: BEE EXPERIMENTS

EXPERIMENT 1:

Two dishes with sugar water were placed 10 meters from a bee hive. Both dishes were the same, except one dish, the experimental dish, had a bee predator glued to it, while the other, *the control dish*, did not. More bees landed on the control dish than the experimental dish.

Below is the data collected from the experiment:

Table 3: Number of Bees Landing on the Experimental and Control Sugar Dishes

Dish	Number of Bees Landed

Control	21
Experiment	8
Total	**29**

1. What is the question that you are asking? _____

_____

2. Write a equation that you could enter into Excel to calculate the P value of the binomial test:

   P =BINOMDIST(_____, _____, _____, TRUE)

3. Calculate your P value by entering your equation into Excel

   P = _____

4. Do you accept or reject the null hypothesis? Why? Show your work.

   _____

   _____

5. Explain what accepting or rejecting the null hypothesis means in the case of the bee experiments.

   _____

   _____

6. Why would scientists design experiments, so that they are binomial in nature?

   _____

   _____

PART 3: ANALYZING YOUR OWN DATA

Open a new Excel Document and title them your "group name bee results".

1. Add up all your bees landing on your control and experimental dishes, Create a table. You can analyze bees and wasps together and/or separately.

e.g. Table 1: Number of Bees Landing on the Experimental and Control Sugar Dishes

Dish	Number of Bees Landed
Control	21
Experiment	8

Total	**29**

2. Make a bar graph of your results.
3. Calculate your P value.

4. Gather data from other groups that tested the same thing and copy their data into your results. Add the results together, as in the example below…

Dish	Exp 1: Number of Bees Landed	Exp 2: Number of Bees Landed	Total
Control	21	4	25
Experiment	8	3	11
Total	**29**	**7**	**36**

4. Calculate P for all the groups combined that did the same experiment. Does your result change? How do you interpret these combined results (could have the different groups have done things differently)?