Lab 1. Exercise 2 - Introduction to Biology and the Scientific Method

Overview

During this lab, you will be introduced to the experimental scientific method.

Learning objectives

1. Be familiar with the steps involved in the process of science.
2. Be able to construct and give examples of hypothesis.
3. Define dependent and independent variable and control.
4. Be able to gather, organize and present data using graphics.
5. Be able to differentiate between inductive and deductive reasoning.

Materials and equipment

- Chocolate chip cookies
- Deck of cards (one deck per group)
- Sheets with rules for Eulises card activity

Background

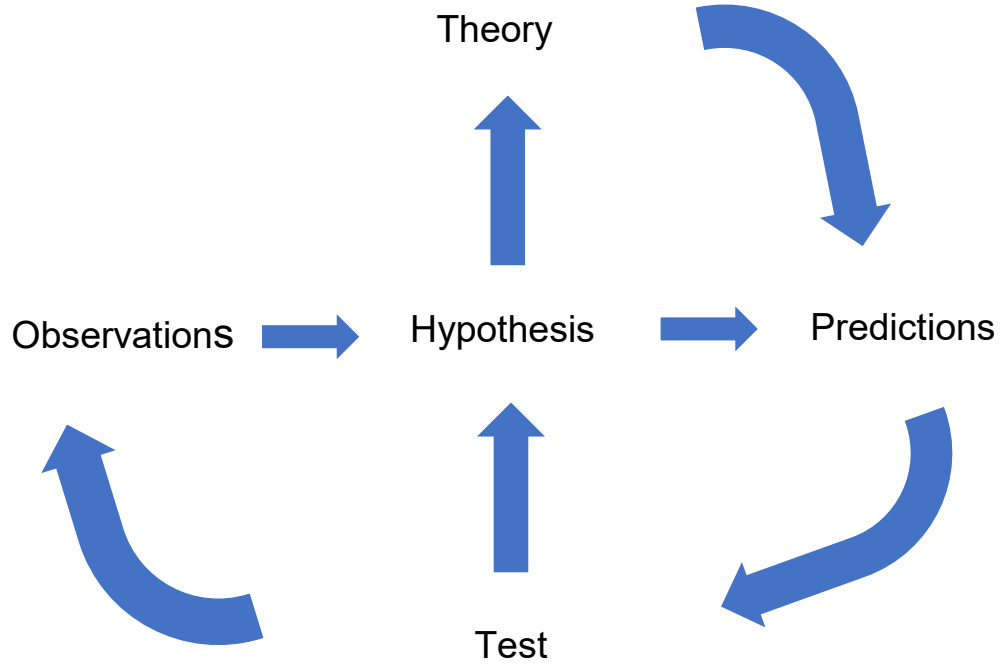
The process of science builds reliable knowledge about the natural world. It assumes:

- There are natural causes for things that happen in the world around us.
- Evidence from the natural world can be used to learn about those causes.
- There is consistency in the causes that operate in the natural world.

Science deals with the observable world (note, this is not equivalent to the visible world). Scientific investigation is not necessarily done by a series of steps which are followed in an immutable order, but the scientific method does require very thorough and strict observations and collection of data to propose explanations for natural phenomena.

Scientific investigation involves active observations which generate questions. Scientists propose answers to those questions, in other words, they present a **hypothesis**, which is an educated “guess” or explanation of the phenomenon. A good hypothesis should allow a scientist to make predictions, this means, the hypothesis is testable. Figure 1 shows the dynamic process involved in testing a hypothesis, as well as how, if a hypothesis is confirmed by multiple scientists approaching the phenomenon from multiple angles, it becomes a **Theory.**

Figure 1. Diagram showing the dynamic nature of the method of science



Procedures

A. Cookie activity

Each group will be provided with 16 chocolate chip cookies. Students will work in groups of 3 or 4 for this activity. In this activity you will learn about different ways of gathering data as well as the accuracy of the data depending on the methods used.

1. Place the cookies, in order, on paper towels on a flat surface and assign a different number to each cookie.
2. Examine the cookies, without breaking them apart. Estimate (just by examining the cookie) the average number of chocolate chips in each cookie and write the number in the corresponding column in Table 1.
3. Devise a method to quickly count the chocolate chips in each cookie. For example, cut the cookie in four, count the number of chocolate chips in one of the quarters and then multiply by four (keep the other three quarters). This illustrates how you can collect data by taking a sample and then projecting the results for the entire field/area examined. In Table 1, record the number of chips in the sample and the total amount calculated when using a sample. In your table, for the column header, you need to specify the sampled portion (e.g. “Sampled ¼ of cookie”, if you sampled ¼ of a cookie, or “Sampled 1/3 of cookie” if you sampled 1/3 or a cookie)
4. Proceed to count the actual number of chocolate chips in the remaining ¾ of the cookies. Record the actual total number of chips in each cookie in the corresponding column in Table 1.

5. Using the data you recorded in Table 1, group the cookies into the different "bins" in Table 2, according to the number of chocolate chips estimated, actually counted or calculated by sampling. So, for example, if you actually counted between 9 to 12 chocolate chips in three of the cookies, you would place a "3" in the row with the bin 9-12 and under the column "Actual Value".
6. Once you have compiled all your data in Table 2. You will proceed to make a graphic representation of your results using Excel. When using "bins" or "categories", one of the most useful ways to represent your results visually is by making a histogram or bar chart. Figure 1 is an example of a bar chart. For a beginner's tutorial on using Microsoft Office Excel to make a bar chart, watch Excel Quick and Simple Charts Tutorial (https://youtu.be/TfkNkrKMF5c). You can also read about and view Excel Training Videos.

Instructions for entering the data and using a spreadsheet program, like Microsoft Office Excel or Google sheets:

1. If using the PDF version of the lab, note that the cells in Table 1 have been left blank for you to record your data. You **cannot** copy and paste the entire table with your data to an Excel file or another spreadsheet program (e.g. Google Sheets).
2. You can use Excel or another spreadsheet program to set up a similar table and enter data into that file. Specify your sampled part.

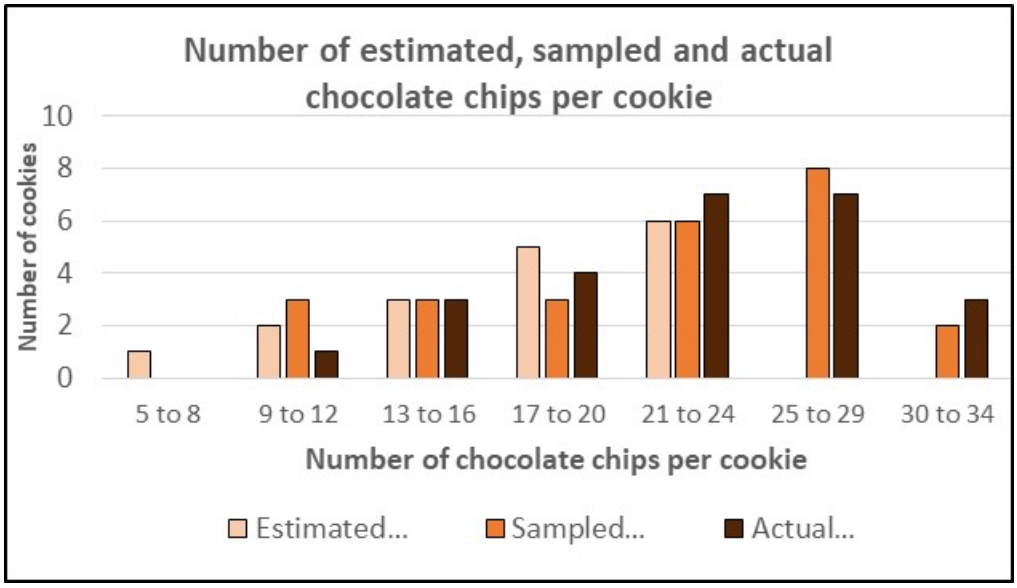
Table 1. Number of chocolate chips per cookie, by estimating, sampling and counting all

Cookie	Estimated	Sampled Part	Sampled Total	Actual
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

Table 2. Estimated, sampled and actual chocolate chips per cookie, by bin

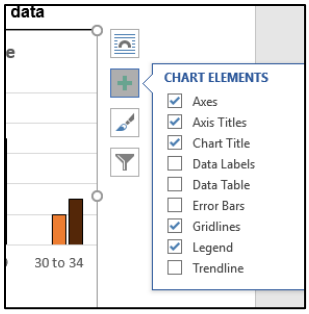
Bin (Chocolate Chips per Cookie)	Estimated Value	Sampled Value	Actual Value
0 to 5			
5 to 8			
9 to 12			
13 to 16			
17 to 20			
21 to 24			
25 to 29			
30 to 34			

Figure 2. Example of a histogram representing grouped data



Instruction for creating a chart like Figure 2 with Excel.

1. After you have created your table with data, select the column header and rows with data. Click insert and select “Insert column or bar chart” in the charts area.
2. Edit the font size, color and labels. Click on the + icon to show chart elements.



Insert your chart in the box below.

B. Eleusis card game: inductive and deductive reasoning

In this game you will learn the difference between inductive and deductive reasoning, which are forms of reasoning used in the process of science. **Inductive reasoning** takes information from many observations to come up with a broad explanation or hypothesis. **Deductive reasoning** takes a general explanation or hypothesis and tries to confirm it with specific observations.

When playing Eleusis, you will be using both inductive and deductive reasoning. You will try to come up with a secret rule, by using information given by the cards played (inductive reasoning). Once you have a hypothesis for the secret rule, you will test it by the subsequent plays (deductive reasoning).

The game should be played with 4-5 students/group.

1. One person in the group will be the dealer. The dealer will also be the person who knows the rule. Once you have chosen the first dealer, your instructor will give the dealer a "rule". The dealer should read the rule carefully and not share it with the rest of the group.
2. The dealer will shuffle the cards and give each player 14 cards. The dealer does not take any cards.
3. The first player puts a card down, face up so everyone can see it.
4. The dealer then decides, based on the rule, whether the card is accepted (if it follows the rule) or rejected (if it does not follow the rule).

5. The game continues with each player taking a turn to put down a card. Players who think they know the rule should ask to present the rule, **when their turn comes and before they put a card down.**
6. If the player guessed the rule correctly, the player is the winner and is given 1 point. If the player is incorrect, the player loses 1 point. For the rest of the game, the player has only one more chance to guess the rule.
7. A player who incorrectly guesses the rule twice is out of that game.
8. After someone has guessed the rule, a new rule can be made up by the dealer. If the group wishes, a different person can be dealer for a different round.

Questions

Using your own specific experience during the card game, describe when you used inductive reasoning and deductive reasoning. Make sure you give some specific detail about your play and rule.

First and last name:

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Follow your instructor's directions in renaming and submitting your lab.

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