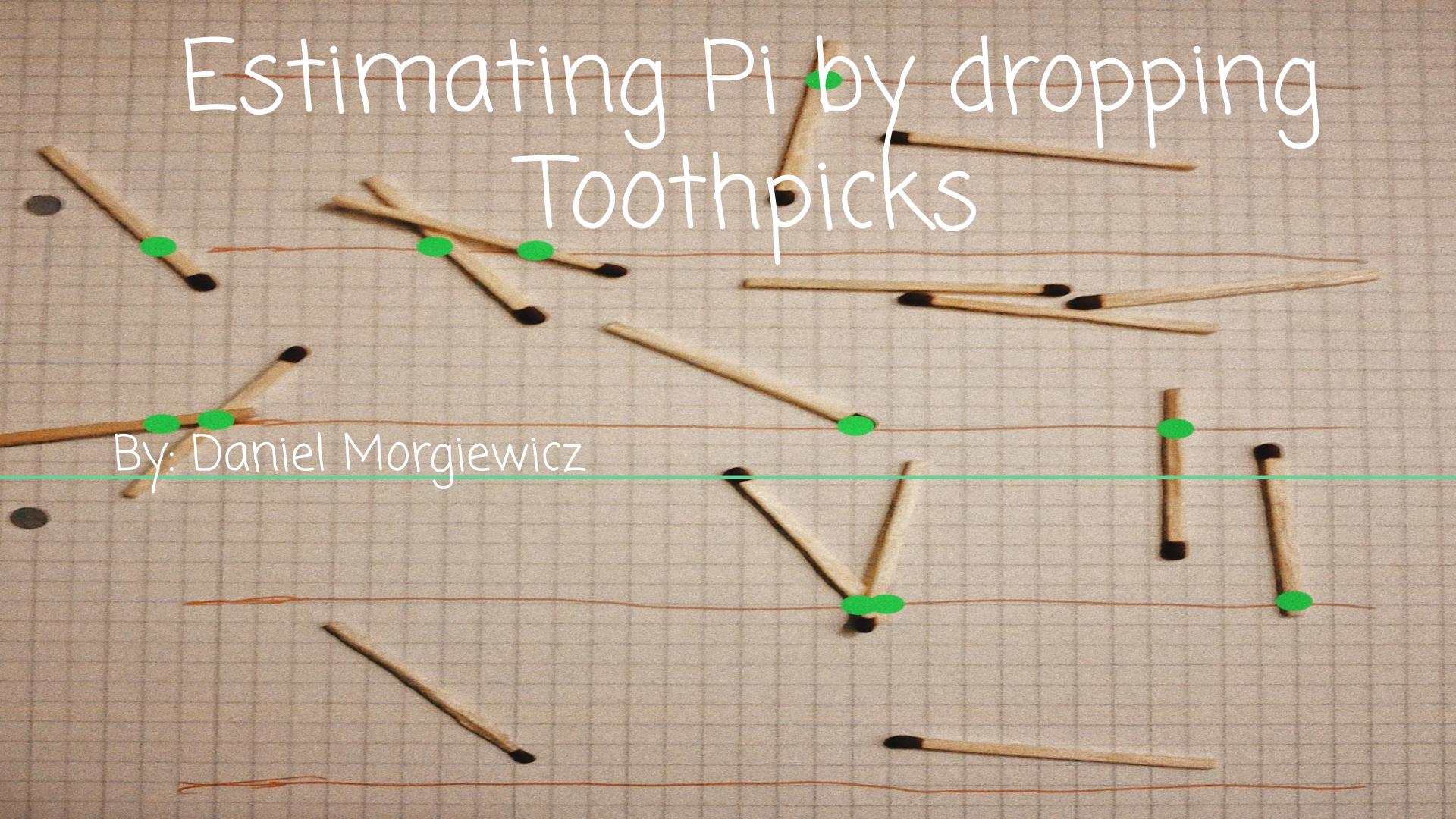
Estimating Pi by dropping Toothpicks



By: Daniel Morgiewicz

Comte de Buffon

- September 7, 1707 - April 16, 1788
- Was educated in law and medicine, but his interest was in nature
    - He was so interested in nature that he created a non-Biblical explanation on the history of earth
- French naturalist, mathematician, and cosmetologist

Background of the Activity

Goals of Activity

- The student will properly lay out the page that toothpicks will be dropped on
- The student will appropriately drop toothpicks onto the page keeping track of how many they dropped
- The student will properly count how many toothpicks intersected the drawn line
- The student will correctly complete the math problem at the end of the experiment to estimate pi.

Objective of Activity

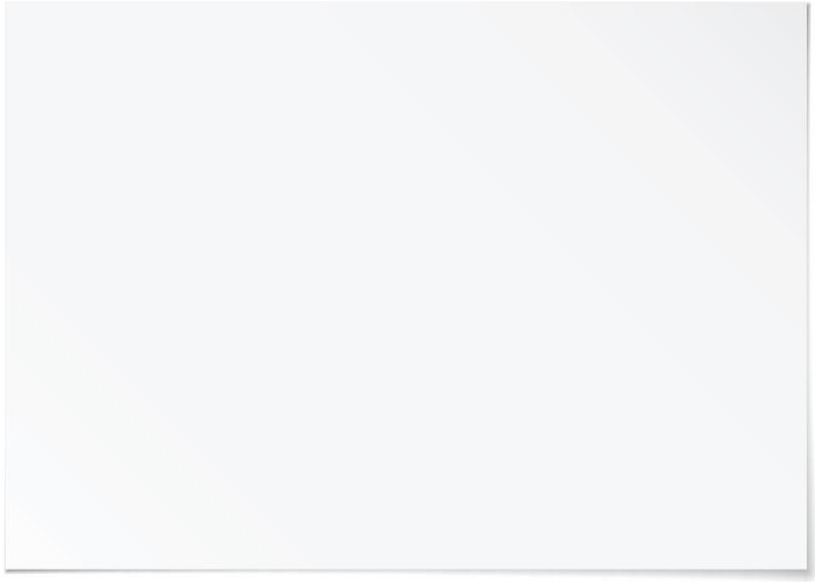
Students will estimate pi (3.14) with correct arithmetic using Buffon's Needle Experiment on ⅔ trials.

Background of the Activity Cont.

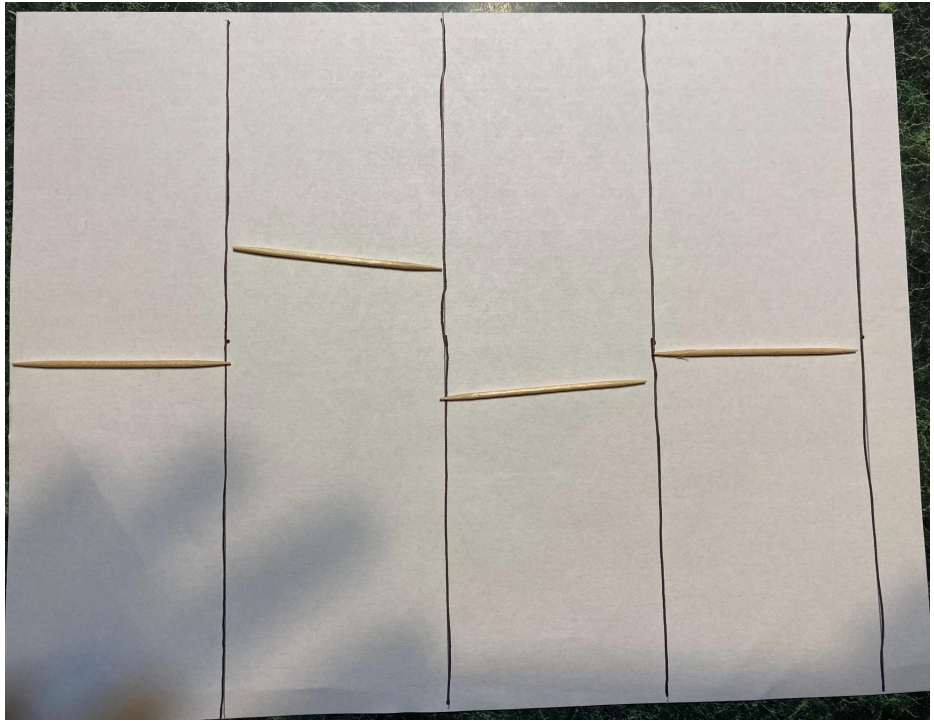
Materials

- Toothpicks
- Pencil/pen
- Activity worksheet
- Ruler
- Paper to drop toothpicks on

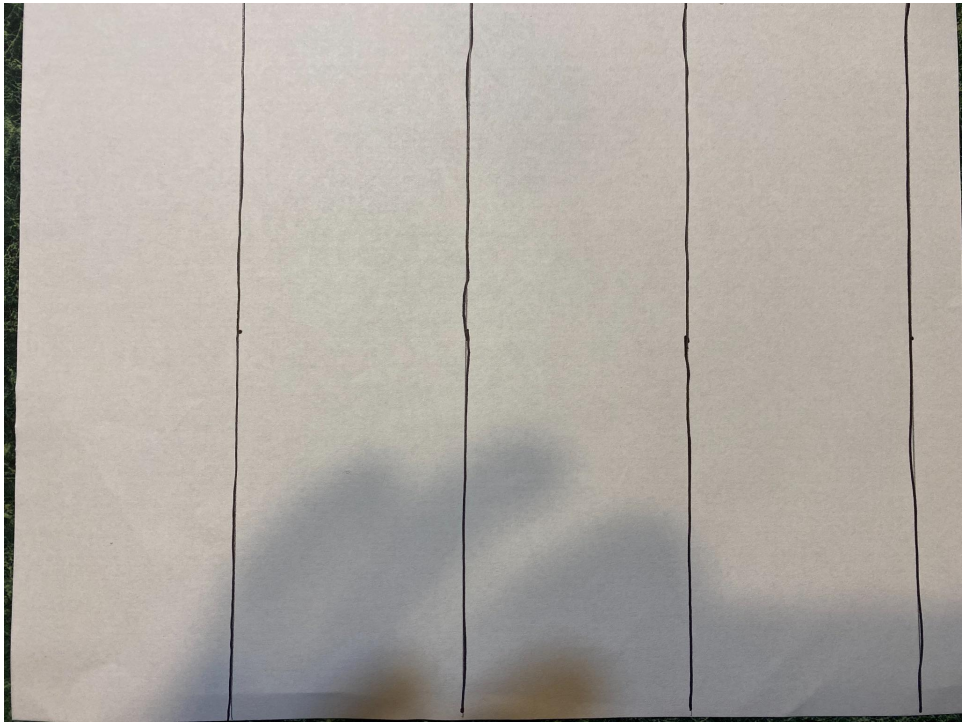
Step 1: Begin with a blank piece of copy paper place in landscape position



Step 2:Place a toothpick on the paper and make columns with a width of the size of the toothpick.

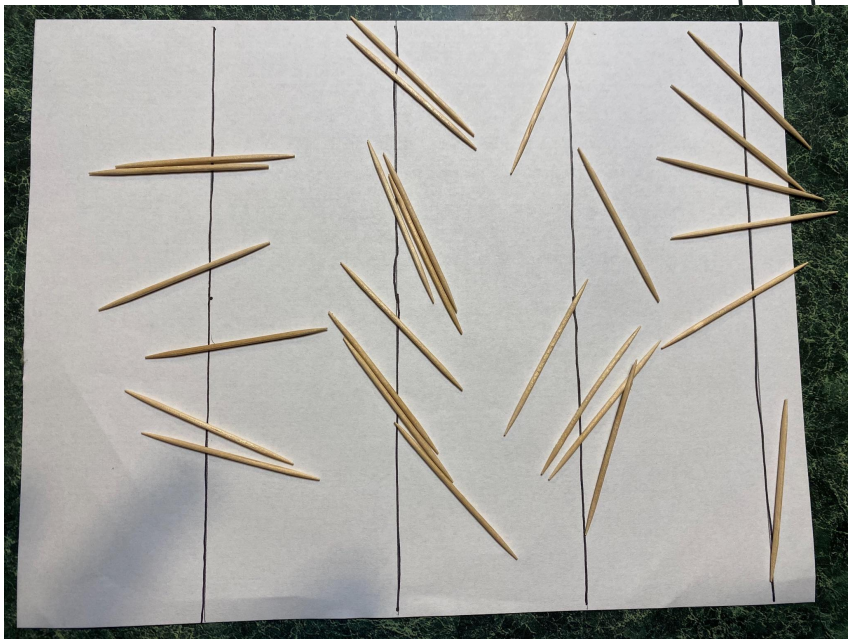


Once you place draw columns a toothpick width apart from each other your paper will look like this



Step 3: Randomly toss toothpicks on the paper, keeping track of how many you toss onto the paper.

Step 4: Of the toothpicks tossed onto the paper, count how many toothpicks intersected or touched the lines that were drawn on the paper



I removed all tooth picks that did not intersection the drawn lines.

I originally tossed 40 toothpicks onto the paper, with 27 of them intersecting the lines

Step 5: The Math (Estimating)

We are going to use the formula:

$$\frac{2\ x\ the\ \#\ of\ toothpicks\ thrown}{\#\ of\ toothpicks\ intersected\ with\ the\ lines}$$

Our information:

We threw 40 toothpicks

27 of them crossed the lines

$$\frac{2(40)}{27} = \frac{80}{27} = 2.96296296$$

We get 2.96296296 as our estimation which some may say is not very close to pi (3.14159), but the more toothpicks you drop the closer your estimation will be. Let's try one together with dropping 55 toothpicks

Using 55 toothpicks... (Let's do this together)

How can this activity be altered?

- This activity can work on any lined surface
- While doing research I found many interesting forms of how this activity/ experiment was completed
- As a teacher you can alter this activity to the needs of your students
- Different alterations I saw were:
    - Life size activities (the "students" were using a sandbox like bos to toss the toothpicks into. The box already had the lines in it)
    - Using garlic stick (the setup was exactly the same, but you just used garlic bread instead of toothpicks). This can be split into both a math and cooking lesson based on the type of classroom you are teaching

Online Simulation

-Here is a link to a website that does animations of dropping toothpicks and shows you what happens as the amount of toothpicks increases

https://mste.illinois.edu/activity/buffon

My Sources

- Ali. (2019, November 03). 17 innovative Mathematics projects that inspire students. Retrieved May 04, 2021, from https://medium.com/however-mathematics/17-innovative-mathematics-projects-that-inspire-students-c652005cc627
- Buffon's needle. (n.d.). Retrieved May 04, 2021, from https://mste.illinois.edu/activity/buffon/
- Pi toss. (2020, October 02). Retrieved May 04, 2021, from https://www.exploratorium.edu/snacks/pi-toss