Throwing Pi

Throw some pi! Understand Buffon's needle problem as you toss toothpicks to calculate an important math ratio.

TEKS:

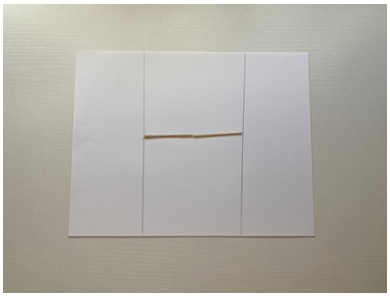
MATH 6.4 D: The student is expected to give examples of rates as the comparison by division of two quantities having different attributes, including rates as quotients.
MATH 6.4 E: The student is expected to represent ratios and percents with concrete models, fractions, and decimals.

Materials:

- Paper
- Pencil
- Ruler
- 20 toothpicks (or more!)

How To:

1. Use a ruler to draw two parallel lines across your paper. Make sure the distance between the lines is twice the length of a toothpick.



2. Toss the toothpicks one at a time onto your paper.
3. Count the number of toothpicks that cross one of the lines on the paper.
4. Divide the total number of toothpicks tossed onto the paper by the number of toothpicks that cross a line.

5. Record your results. Was the number you calculated close to 3.14, or pi?
6. Repeat the process with more toothpicks and see if your results change. As you add more toothpicks, the ratio you calculate should get closer and closer to 3.14.

STEM Explanation:

The ratio that you calculated for this activity comes from a similar experiment called Buffon's needle. Here is the ratio that was discovered as a result of this experiment:

$$\pi \approx \frac{2 \times \text{stick length} \times \text{total sticks tossed}}{\text{distance between the lines} \times \#\text{ sticks crossing a line}}$$

In Buffon's needle, needles are dropped onto a grid of parallel lines. As more and more needles are dropped, the ratio above gets closer and closer to pi, or 3.14. In the activity you just completed, you used twice the length of a toothpick as the distance between the two lines. This simplified Buffon's ratio to focus only on the number of toothpicks tossed and the number of toothpicks crossing a line:

$$\pi \approx \frac{\text{total sticks tossed}}{\#\text{ sticks crossing a line}}$$

Repeating the experiment with more and more toothpicks causes the approximation to get closer and closer to pi! Pi itself is the ratio of a circle's circumference, the distance around a circle, to its diameter, the distance across a circle.

$$\pi = \frac{\text{circumference}}{\text{diameter}}$$

The patterns in Buffon's needle and during this activity are examples of a geometrical probability method that shows how a random collection of data can result in a constant pattern. In this case, the constant pattern is an approximation of pi.

Career Connection:

Mathematicians use mathematical theory, computational techniques, algorithms, and the latest computer technology to solve economic, scientific, engineering, and business problems. Mathematicians think logically and creatively to solve math problems across many different fields.

Resources:

https://www.exploratorium.edu/snacks/pi-toss
https://www.sciencefriday.com/articles/estimate-pi-by-dropping-sticks/