

FOR TEACHERS

MAKER LESSON PLAN: Exploring Area and Circumference with a Torus Drawing Machine

Essential Questions:

- What is the difference between “area” of a geometric figure and “surface area” of a geometric figure?
- What is the relationship between the circumference and area of a circle

Lesson Objectives:

Students will:

- know and apply the formulas for the area and circumference of a circle
- solve problems involving the area and circumference of circles

Materials:

- Torus Drawing Machine Instructable: <http://www.instructables.com/id/Torus-Drawing-Machine/>
- Materials needed to build multiple Drawing Machines
- Additional ruler for each student
- Math Notebooks, data collection sheets, or notebook paper

Video Resources:

- https://www.youtube.com/watch?v=cC0fZ_lkFpQ&t=278s
- <https://www.youtube.com/watch?v=O-cawByg2aA&t=23s>

Getting Started: Before starting this math activity, review the following definitions and formulas with students:

Torus - a surface or solid formed by rotating a closed curve, especially a circle, around a line that lies in the same plane but does not intersect it (e.g., like a ring-shaped doughnut).

Area - the space occupied by a flat shape or the surface of an object. (The area of a figure is the number of unit squares that cover the surface of a closed figure. Area is measured in square units.)

Circumference - the (linear) distance around a circle. (The circumference would be the length of the circle if it were opened up and straightened out to a line segment.) Formula: $C = 2 \pi r$

Area of a Circle - the number of square units inside a circle. Formula: $A = \pi r^2$

Surface Area - the total area of all the surfaces of a three-dimensional object. Example: the surface area of a cube is the area of all 6 faces added together. (Volume and surface area help us measure the size of 3D objects.)

Radius - the distance from the center of a circle to a point on the circle.

Pi (π) - the ratio of a circle's circumference to its diameter. Pi is a constant number, meaning that for all circles of any size, Pi will be the same.

Diameter - the distance from edge to edge of a circle, measuring straight through the center.

Note: After building the Torus Drawing Machines, students will need to let the machine run for a few minutes to fill in a complete torus.

1: Start with the Center (Radius): After creating a torus, students should measure to find and mark the center of the inner circle created by the torus (the hole of the donut). Students can then record the radius of the inner circle as well as the radius that extends to the outer edge of the torus.

2: Calculating the Area and Circumference: Once students have determined the radiuses, they can begin calculating the area and circumferences of the inner and outer circles using the following formulas: $A = \pi r^2$ and $C = 2 \pi r$.

3: Problem Solving: Once students have calculated the area and circumference of the two circles created by the torus, they have the information needed to find the area of the torus shape that has been filled in with the marker. Provide time for students to determine their method for finding the area of the filled in space and have them describe their problem solving steps. Check their results for understanding and determine the need for review or extension activities.

4: Extensions: To extend this activity further, students can change the drawing machine settings to create new torus sizes for additional problem solving.

5: Share - We can't wait to see the machines your students MAKE! Feel free to email us at teachers@instructables.com or share with us on Twitter and Instagram @instructables. We would love to send your class a gift for showing off their hard work!