Mathematicians: Reflecting the Brilliance of Powerful Minds

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Mathematicians Reflection I

- Which mathematicians or names of mathematicians did you discuss during mathematics? Who are the first five that come to your mind?

- Who is the first mathematician that came to your mind?

- https://www.menti.com/isyzdjxwyq

Mathematicians Reflection II

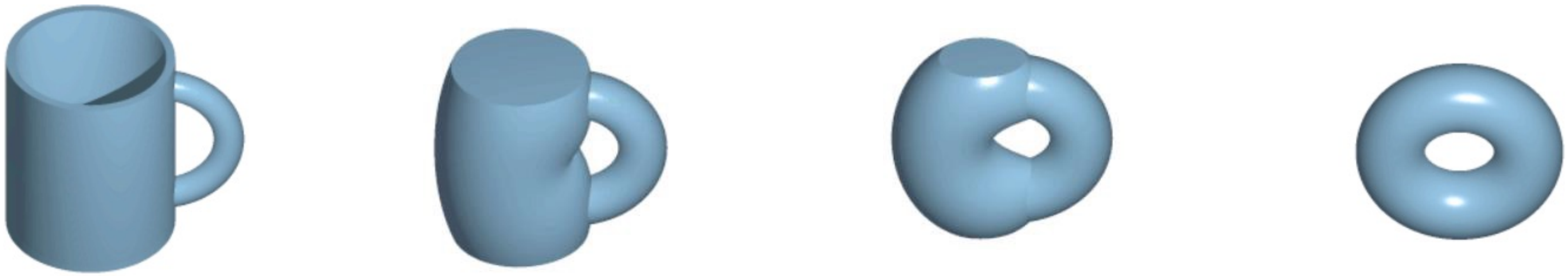
- Consider a mathematician that you have learned about and discussed either during your K-12 career, teacher education preparation, or currently in your teaching practice that reflects the social identities of the learners in your classroom.
- Identify at least three and post it in chat.

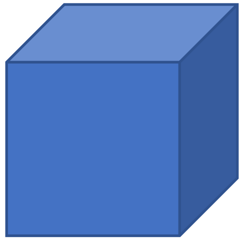
“Representation matters because it can shape the reputation and self-image of women and Black, Indigenous, and People of Color within environments dominated by over-represented majorities” (Ijoma et al., 2022).

Alejandro Adem

1961–

Algebraic Topology and Group Cohomology





Comparing Shapes

In Algebraic Topology, some shapes are considered the same, like a plate and a bowl or a coffee mug and a doughnut shape. Provide students pairs of pictures of shapes and ask them to discuss how they are similar and how they are different. Encourage students to think about attributes of shapes they have learned (i.e., faces, edges, vertices, number of sides, number of angles, etc.). Potential pairs of shapes students could compare are provided below.

Grades K-2

- Square and a rectangle
- Triangle and a diamond
- Small hexagon and a large hexagon
- Cube and a rectangular prism

Grades 3-5

- A right triangle and an equilateral triangle
- Cone and a pyramid
- Cylinder and a rectangular prism
- Parallelogram and a trapezoid

For **Grades 6-8,** the activity can be extended to compare volume and surface area of pairs of three-dimensional solids as well as compare figures after going through a series of transformations (dilation, translation, rotation, reflection, etc.). Potential ideas are provided below.

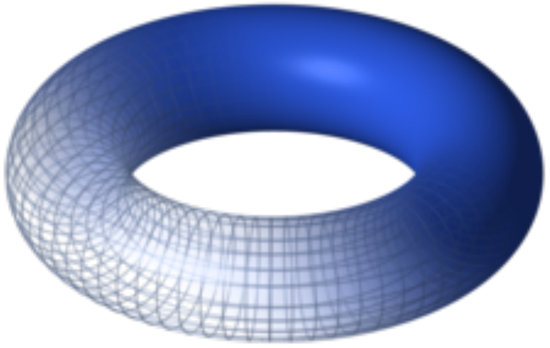
- Compare the volume of a cylinder and cone with the same radius and height/altitude.
- Compare the volume of a rectangular prism and pyramid with the same base dimensions and height.
- Compare the surface area of two different rectangular prisms.
- Compare a triangle and its image after being rotated and reflected.
- Compare a pentagon and its image after being translated and then dilated.

Shape Shifter

Provide each student clay or playdough. Have students create topologically equivalent shapes. Create a shape yourself using clay or playdough, show the class your shape, and then ask them to create a shape that is topologically equivalent. Continue the activity by repeating with other shapes, being sure to include figures with no holes, one hole, and two holes. Then, pair students together. Have partners take turns creating an original figure and then the other sculpting a figure that is topologically equivalent.

Volume of a Torus

Alejandro Adem studies concepts of Algebraic Topology, one area of mathematics. One of the most commonly studied shapes in Algebraic Topology is the torus, the doughnut-like figure shown below. Ask students to work with a partner to determine how they could find the volume of a torus [Answer: $V = (\pi r^2)(2\pi r)$]. Provide pairs time to think and support their productive struggle as they discuss the problem. Questions to ask as you monitor students while they work are suggested below.



1. What do you already know about volume?
2. How can you use what you know about volume and apply it to this shape?
3. For Calculus students: Can you use the Shell Method to find the volume? Washer Method? Integrals? If so, how? If not, why not?

Thomas Fuller

1710–1790

Mental Math

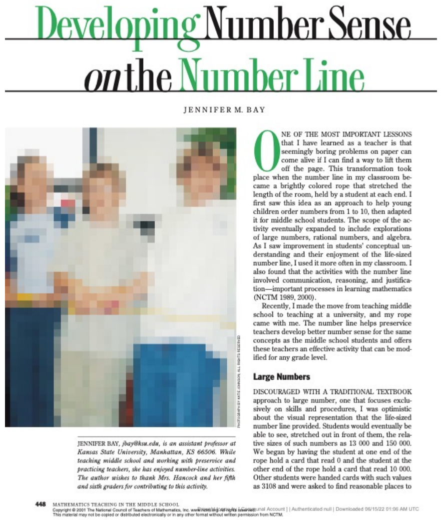
Counting Collections

Students will begin to count efficiently like Thomas Fuller, the Virginian Calculator. Have students count collections of various objects to develop number sense. Counting collections of objects offers multiple entry points for students and provides opportunities for them to develop increasingly sophisticated strategies as they count, organize, and record the number of items in their collection. The article below provides details on how to implement counting collections in your classroom.

Schwerdtfeger, Julie Kern, and Angela Chan. (2007) “Counting collections.” *Teaching Children Mathematics* 13 (7): 356-361. https://doi.org/10.5951/TCM.13.7.0356

Number Line Number Sense

In this activity, students use a life size number line created by a long piece of brightly colored rope to explore the relationships between numbers. Students place numbers on the number line in relation to one another, aiding their development of number sense. This activity can include integers, fractions, and algebraic expressions with variables. Throughout the activity, students communicate and provide reasoning and justification for the placement of the numbers on the number line. A more detailed description with examples of it being used in a classroom is provided in the article.



Bay, Jennifer M. (2001) “Developing number sense on the number line.” *Mathematics Teaching in the Middle school* 6 (8): 448-451. https://doi.org/10.5951/MTMS.6.8.0448 art, as to commence practitioner at New Orleans, under the patronage of his laſt maſter. He is now about twenty-ſix years of age, has a wife, but no children, and does buſineſs to the amount of three thouſand dollars a year.

I have converſed with him upon moſt of the acute and epidemic diſeaſes of the country where he lives, and was pleaſed to find him perfectly acquainted with the modern ſimple mode of practice in thoſe diſeaſes. I expected to have ſuggeſted ſome new medicines to him; but he ſuggeſted many more to me. He is very modeſt and engaging in his manners. He ſpeaks French fluently, and has ſome knowledge of the Spaniſh language. By ſome accident, although born in a religious family, belonging to the church of England, he was not baptiſed in his infancy; in conſequence of which he applied, a few days ago, to biſhop White, to be received by that ordinance into the epiſcopal church. The biſhop found him qualified, both by knowledge and moral conduct, to be admitted to baptiſm, and this day performed the ceremony, in one of the churches in this city.

Philadelphia, November 14, 1788.

Account of a wonderful talent for arithmetical calculation, in an African ſlave, living in Virginia.

THERE is now living, about four miles from Alexandria, in the ſtate of Virginia, a negro ſlave of ſeventy years old, of the name of Thomas Fuller, the property of mrs. Elizabeth Coxe. This man poſſeſſes a talent for arithmetical calculation; the hiſtory of which, I conceive, me-

nutes, 47,304,000.

Second. On being aſked, how many ſeconds a man has lived, who is ſeventy years, ſeventeen days and twelve hours old, he anſwered, in a minute and a half, 2,210,500,800.

One of the gentlemen, who employed himſelf with his pen in making theſe calculations, told him he was wrong, and that the ſum was not ſo great as he had ſaid—upon which the old man haſtily replied, "'top, maſſa, you forget de leap year." On adding the ſeconds of the leap years to the others, the amount of the whole in both their ſums agreed exactly.

Third. The following queſtion was then propoſed to him: ſuppoſe a farmer has ſix ſows, and each ſow has ſix female pigs, the firſt year, and they all increaſe in the ſame proportion, to the end of eight years, how many ſows will the farmer then have? In ten minutes, he anſwered, 34,588,806. The difference of time between his anſwering this, and the two former queſtions, was occaſioned by a trifling miſtake he made from a miſapprehenſion of the queſtion.

In the preſence of Thomas Wiſtar and Benjamin W. Morris, two reſpectable citizens of Philadelphia, he gave the amount of nine figures, multiplied by nine.

He informed the firſt-mentioned gentleman that he began his application to figures by counting ten, and that when he was able to count an hundred, he thought himſelf (to uſe his own words) "a very clever fellow."

His firſt attempt after this was to count the number of hairs in a cow's tail, which he found to be 2872.

Just Like Fuller

[https://encyclopediavirginia.org/entries/account-of-a-wonderful-talent-for-arithmetical-calculation-in-an-african-slave-living-in-virginia-american-museum-or-universal- magazine-january-1789/](https://encyclopediavirginia.org/entries/account-of-a-wonderful-talent-for-arithmetical-calculation-in-an-african-slave-living-in-virginia-american-museum-or-universal-magazine-january-1789/)

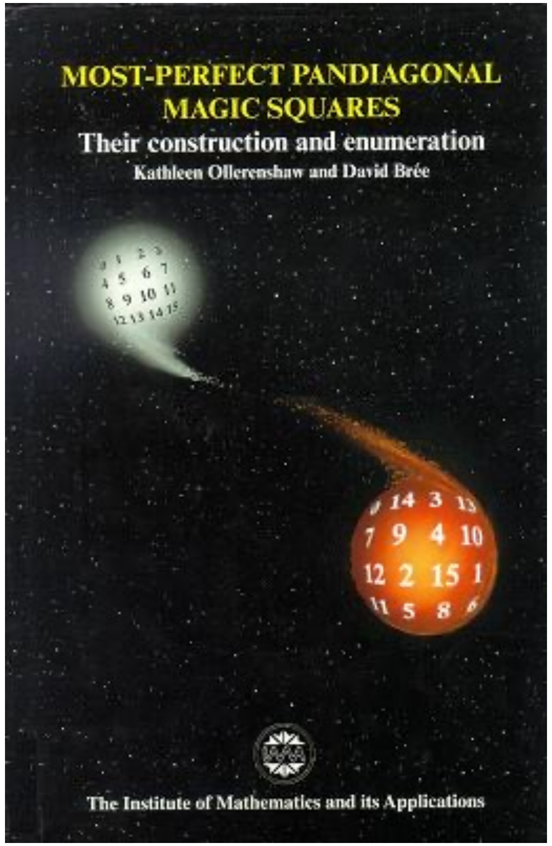
This is an original story written about Thomas Fuller in January 1789 by Dr. Benjamin Rush. It details Thomas' life as a slave and his mental calculation capacity. Before reading the story, have students calculate the number of seconds in 70 years, 17 days, and 12 hours. Discuss answers and strategies as a class. After reading, discuss that Thomas Fuller did all his calculations mentally and remembered the leap years!

Kathleen Ollerenshaw

1912–2014

Magic Squares

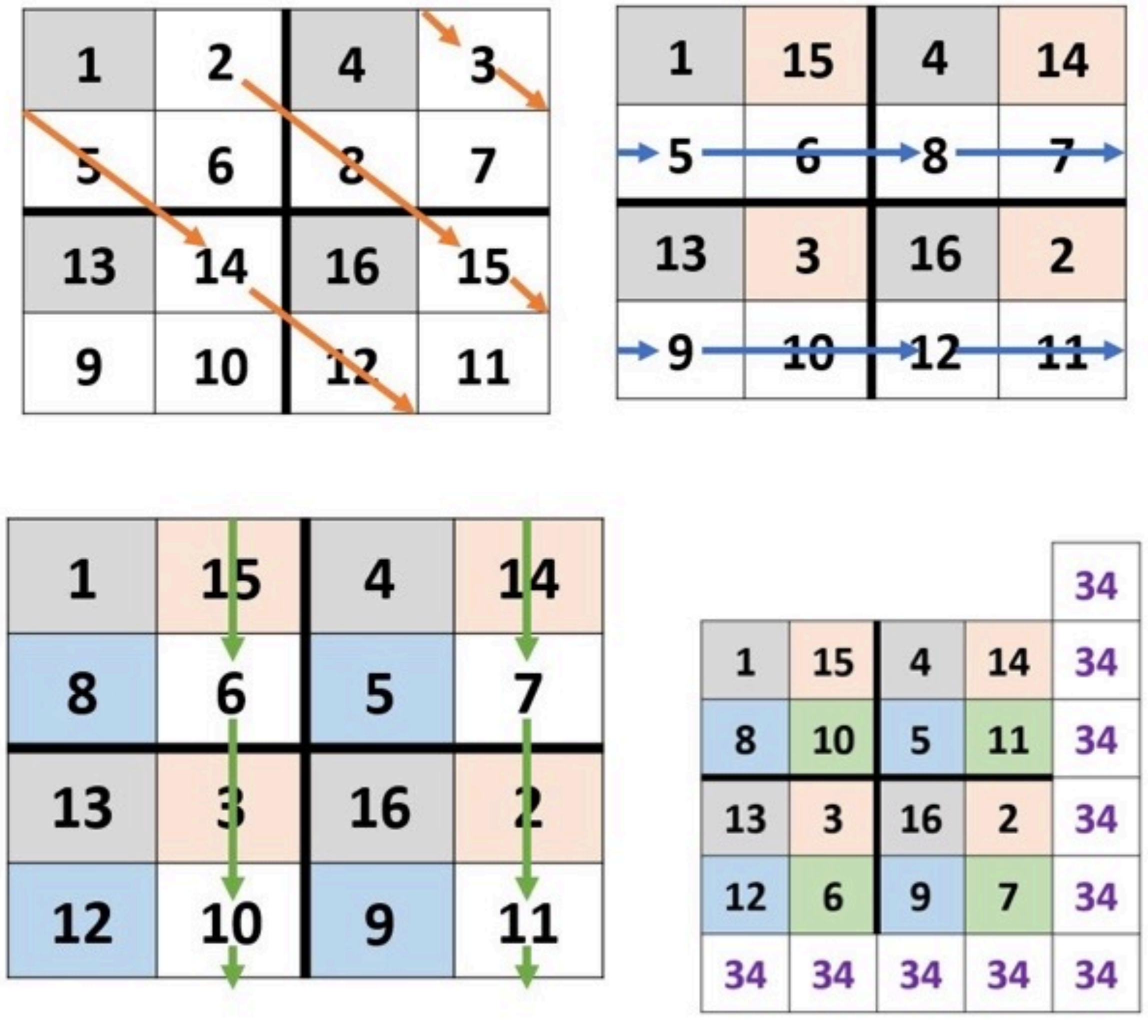
Magic Cube (Rubik's Cube)



The Magic, or Rubik's, Cube is one of the world's top-selling toys. Kathleen Ollerenshaw was the first person to identify the general solution to the colorful cube puzzle.

- What ways can you turn the sections of the cube?
  - What is the difference between clockwise and counterclockwise?
  - How can we describe the different turns?
    - What is a 90 degree turn? What is a 180 degree turn?
    - What would happen if you rotated a section of the cube 360 degrees?
  - How many squares are on each face of the cube?
    - What is a quick way to determine the number of squares?
    - How many squares are on the faces of the entire cube?
    - What are the characteristics of a cube? What other objects do you encounter that are cubes?
  - How many small cubes make up the entire Rubik's cube?
    - What strategies did you use to figure that out?

Look at the following figure and make observations about what you notice. What patterns are occurring and how do the arrows represent how the numbers are moved around the magic square (aka Rubik's cube)?



Gladys West

1930–

HOW GPS WORKS

GPS IS A CONSTELLATION OF 24 OR MORE SATELLITES FLYING 20,350 KM ABOVE THE SURFACE OF THE EARTH. EACH ONE CIRCLES THE PLANET TWICE A DAY IN ONE OF SIX ORBITS TO PROVIDE CONTINUOUS, WORLDWIDE COVERAGE.

$\{t_1\}$

$\{c\}$

$\{t_2\}$

1 GPS satellites broadcast radio signals providing their locations, status, and precise time $\{t_1\}$ from on-board atomic clocks.

2 The GPS radio signals travel through space at the speed of light $\{c\}$, more than 299,792 km/second.

3 A GPS device receives the radio signals, noting their exact time of arrival $\{t_2\}$, and uses these to calculate its distance from each satellite in view.

To calculate its distance from a satellite, a GPS device applies this formula to the satellite's signal:

distance = rate x time

where **rate** is $\{c\}$ and **time** is how long the signal traveled through space.

The signal's travel **time** is the difference between the time broadcast by the satellite $\{t_1\}$ and the time the signal is received $\{t_2\}$.

The GPS Master Control Station tracks the satellites via a global monitoring network and manages their health on a daily basis.

Ground antennas around the world send data updates and operational commands to the satellites.

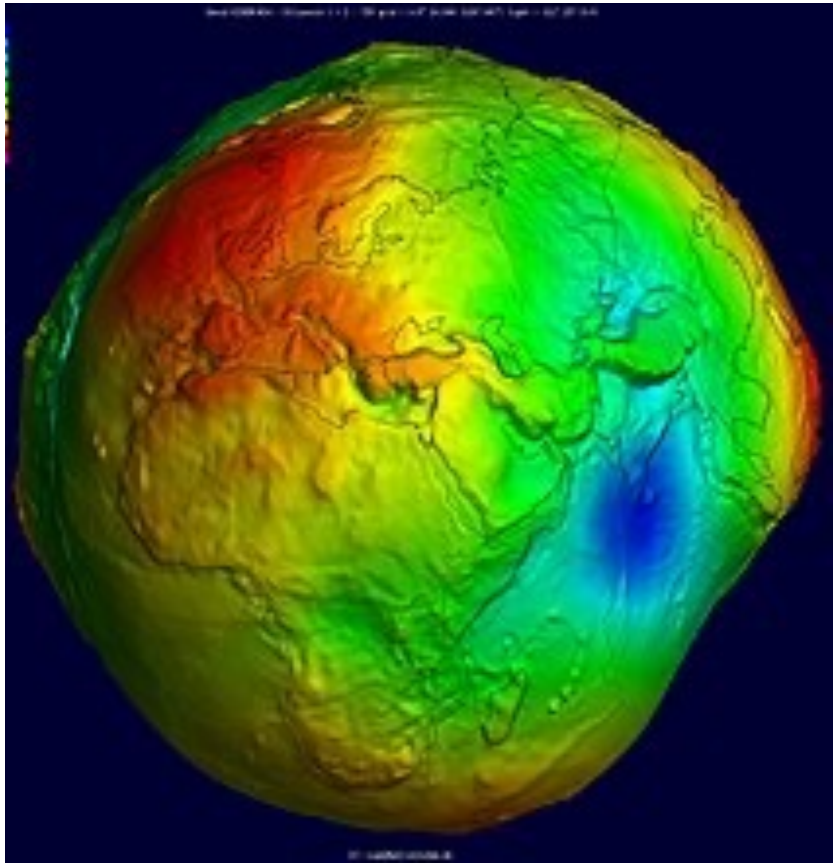
4 Once a GPS device knows its distance from at least four satellites, it can use geometry to determine its location on Earth in three dimensions.

The Air Force launches new satellites to replace aging ones when needed. The new satellites offer upgraded accuracy and reliability.

How does GPS help farmers? Learn more about the

Exploring Earth

The Seasat satellite, a project Gladys West managed, could remotely sense oceans using radar to measure the distance between the satellite and the ocean. This helped Gladys gather the data needed to develop a more accurate model of the shape of the Earth – a geoid. Show students the image of the geoid. Ask students what they notice and wonder.

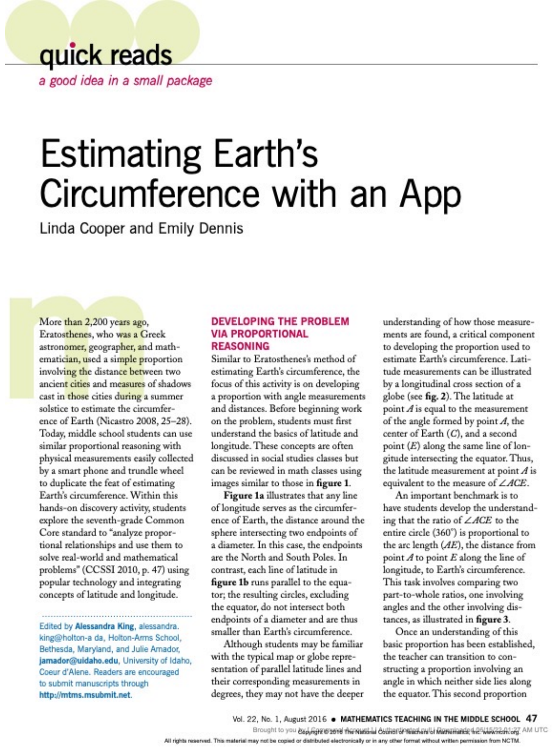


https://upload.wikimedia.org/wikipedia/commons/thumb/4/4a/Geoid_undulation_10k_scale.jpg/220px-Geoid_undulation_10k_scale.jpg

Estimating Earth's Circumference

This article provides a lesson idea in which students use proportional reasoning, apps, and GPS technology to estimate the circumference of the Earth.

Cooper, Linda & Emily Dennis. 2016. "Estimating Earth's Circumference with an App." *Mathematics Teaching in the Middle School* 22 (1): 47-50. https://doi.org/10.5951/mathteacmiddscho.22.1.0047



quick reads

a good idea in a small package

Estimating Earth's Circumference with an App

Linda Cooper and Emily Dennis

More than 2,200 years ago, Eratosthenes, who was a Greek astronomer, geographer, and mathematician, used a simple proportion involving the distance between two ancient cities and measures of shadows cast in those cities during a summer solstice to estimate the circumference of Earth (Nicastro 2008, 25–28). Today, middle school students can use similar proportional reasoning with physical measurements easily collected by a smart phone and trundle wheel to duplicate the feat of estimating Earth's circumference. Within this hands-on discovery activity, students explore the seventh-grade Common Core standard to "analyze proportional relationships and use them to solve real-world and mathematical problems" (CCSSI 2010, p. 47) using popular technology and integrating concepts of latitude and longitude.

Edited by **Alessandra King**, alessandra.king@holton-a da, Holton-Arms School, Bethesda, Maryland, and Julie Amador, **jamador@uidaho.edu**, University of Idaho, Coeur d'Alene. Readers are encouraged to submit manuscripts through **http://mtms.msubmit.net**.

DEVELOPING THE PROBLEM VIA PROPORTIONAL REASONING

Similar to Eratosthenes's method of estimating Earth's circumference, the focus of this activity is on developing a proportion with angle measurements and distances. Before beginning work on the problem, students must first understand the basics of latitude and longitude. These concepts are often discussed in social studies classes but can be reviewed in math classes using images similar to those in **figure 1**.

Figure 1a illustrates that any line of longitude serves as the circumference of Earth, the distance around the sphere intersecting two endpoints of a diameter. In this case, the endpoints are the North and South Poles. In contrast, each line of latitude in **figure 1b** runs parallel to the equator; the resulting circles, excluding the equator, do not intersect both endpoints of a diameter and are thus smaller than Earth's circumference.

Although students may be familiar with the typical map or globe representation of parallel latitude lines and their corresponding measurements in degrees, they may not have the deeper understanding of how those measurements are found, a critical component to developing the proportion used to estimate Earth's circumference. Latitude measurements can be illustrated by a longitudinal cross section of a globe (see **fig. 2**). The latitude at point A is equal to the measurement of the angle formed by point A, the center of Earth (C), and a second point (E) along the same line of longitude intersecting the equator. Thus, the latitude measurement at point A is equivalent to the measure of $\angle ACE$.

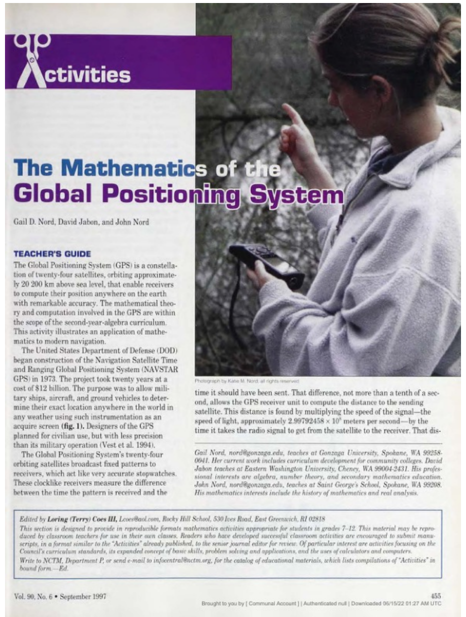
An important benchmark is to have students develop the understanding that the ratio of $\angle ACE$ to the entire circle (360°) is proportional to the arc length (AE), the distance from point A to point E along the line of longitude, to Earth's circumference. This task involves comparing two part-to-whole ratios, one involving angles and the other involving distances, as illustrated in **figure 3**.

Once an understanding of this basic proportion has been established, the teacher can transition to constructing a proportion involving an angle in which neither side lies along the equator. This second proportion

The Mathematics of GPS

This journal article provides a series of scaffolded activities in which students explore the mathematics underlying GPS technology and apply their mathematical knowledge and skills to solve real world problems involving GPS.

Nord, Gail D., David Jabon, & John Nord. 1997. "The Mathematics of the Global Positioning System." *Mathematics Teacher* 90 (6): 155-160. https://doi.org/10.5951/MT.90.6.0455



Activities

The Mathematics of the Global Positioning System

Gail D. Nord, David Jabon, and John Nord

TEACHER'S GUIDE

The Global Positioning System (GPS) is a constellation of twenty-four satellites, orbiting approximately 20 200 km above sea level, that enable receivers to compute their position anywhere on the earth with remarkable accuracy. The mathematical theory and computation involved in the GPS are within the scope of the second-year-algebra curriculum. This activity illustrates an application of mathematics to modern navigation.

The United States Department of Defense (DOD) began construction of the Navigation Satellite Time and Ranging Global Positioning System (NAVSTAR GPS) in 1973. The project took twenty years at a cost of $12 billion. The purpose was to allow military ships, aircraft, and ground vehicles to determine their exact location anywhere in the world in any weather using such instrumentation as an acquire screen **(fig. 1).** Designers of the GPS planned for civilian use, but with less precision than its military operation (Vest et al. 1994).

The Global Positioning System's twenty-four orbiting satellites broadcast fixed patterns to receivers, which act like very accurate stopwatches. These clocklike receivers measure the difference between the time the pattern is received and the time it should have been sent. That difference, not more than a tenth of a second, allows the GPS receiver unit to compute the distance to the sending satellite. This distance is found by multiplying the speed of the signal—the speed of light, approximately 2.99792458×10^8 meters per second—by the time it takes the radio signal to get from the satellite to the receiver. That dis-

Photograph by Katie M. Nord; all rights reserved

Gail Nord, nord@gonzaga.edu, teaches at Gonzaga University, Spokane, WA 99258-0041. Her current work includes curriculum development for community colleges. David Jabon teaches at Eastern Washington University, Cheney, WA 99004-2431. His professional interests are algebra, number theory, and secondary mathematics education. John Nord, nord@gonzaga.edu, teaches at Saint George's School, Spokane, WA 99208. His mathematics interests include the history of mathematics and real analysis.

Edited by ***Loring (Terry) Coes III,*** *Lcoes@aol.com, Rocky Hill School, 530 Ives Road, East Greenwich, RI 02818*

This section is designed to provide in reproducible formats mathematics activities appropriate for students in grades 7–12. This material may be reproduced by classroom teachers for use in their own classes. Readers who have developed successful classroom activities are encouraged to submit manuscripts, in a format similar to the "Activities" already published, to the senior journal editor for review. Of particular interest are activities focusing on the Council's curriculum standards, its expanded concept of basic skills, problem solving and applications, and the uses of calculators and computers.

Write to NCTM, Department P, or send e-mail to infocentral@nctm.org, for the catalog of educational materials, which lists compilations of "Activities" in bound form.—Ed.

Powerful Mathematicians Book Series

Powerful Mathematicians who Changed the World from A to Z

- Kelley Buchheister
- Kari Jurgenson
- Vashalice Kaaba
- Jessica Stagg
- Cynthia Taylor

PreK-2 Grade Band

- Kelley Buchheister
- Amy Napoli

3-5 Grade Band

- Naomi Jessup
- Eva Thanheiser

6-8 Grade Band

- Debra Goldstein
- Kari Jurgenson
- Jessica Stagg
- Cynthia Taylor

9-12 Grade Band

- Zandra de Araujo
- Maria del Rosario Zavala
- Toya Frank

Powerful Mathematicians Book Series

Liliana is a fourth-grade girl whose strategy is misunderstood when solving a multi-step word problem using multi-digit numbers. Liliana's method was shared with her by family in Peru. The teacher invites mathematician Marcia Ascher to connect mathematics and culture by counting quipus which originated in Peru. This book provides a glimpse into a mathematics learning space that honors multiple strategies and children's cultural ways of reasoning about mathematics.

Knotting Numbers: Marcia Ascher

Powerful Mathematicians Book Series

Five friends go on adventures to learn more about secret, coded messages they find in a tunnel in the woods. As they learn more about cryptography and Agnes Meyer Driscoll, a remarkable cryptologist, they crack the codes and discover something disturbing is happening in their town. Readers will have opportunities to code and decode messages and learn more about an underrepresented mathematician and her field of cryptology.

The Mystery Underground: Agnes Meyer Driscoll

Powerful Mathematicians Book Series

Moises wakes up across the country, briefly remembering he's no longer home in Oakland, CA but has made a life-changing move with his family to St. Louis, MO. Pretty soon he makes new friends Astrud and Marissa. When the trio investigates inequities in the local magnet school's admission process, they join forces with mathematician Federico Ardila to find a solution. Bonding over math and a desire for making things a little better, these three amigos set out on an ambitious path. Teachers can bring this story into their classroom to help students see how math can help you to combat injustice and investigate how equal is not always equitable.

What We Do When Fairness Fails Us: Featuring Federico Ardila

Thank You!!!