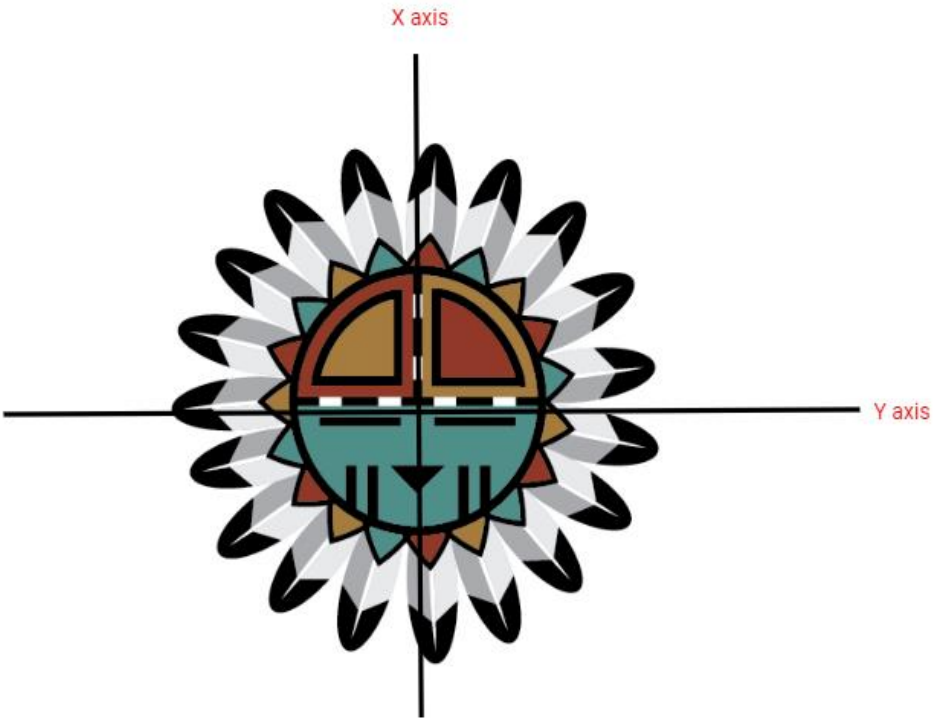


A Math Enrichment for Hopi and Tawa Students in 5th-8th Grade

David Youngberg, M. Ed

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**Context**

I strongly believe in the value of education. To me, education is crucial as it encompasses wisdom, knowledge, and character – it serves as the foundation for everything. Education not only leads to a better life and better decisions but also plays a significant role in shaping an individual's character and completeness. Personally, education has been instrumental in my life, although it hasn't always been easy, free, or enjoyable. I've had to work hard for every educational achievement that I received. When I graduated from elementary school, I struggled to read and write. In my sophomore year of high school, I received a low score of 5% on my first algebra test. Despite these challenges, I persevered. My high school guidance counselor even advised me against taking "real" college classes, stating that they would be too difficult for me. To prepare for college, I had to take foundational English classes such as English 60, 61, 71, and 72 before advancing to English 100, 101, and 102. Despite feeling unprepared for college after high school, I was determined to pursue higher education to secure a better future for myself. I eventually graduated with a bachelor's degree, having attended community college and the University of Arizona, while also completing night school courses. I have now earned an Associate's, Bachelor's, and Master's Degree. During my college years, my college advisors had some concerns about my ability to manage the administrative aspects of teaching, including grading and record-keeping. In 2009 I found a home on the Hopi Reservation. I found myself working as a teacher at Hotevilla Bacavi Community School for a couple of years. I faced many challenges but also grew to many high levels during this time. This role later led to a teaching position at Leupp Arizona, followed by a teaching position at Hopi High School. I eventually transitioned to teaching at the elementary school level in 2015.

The Hopi Reservation is 2,439 sq miles, with 12 villages located in three regions: First Mesa, Second Mesa, and Third Mesa. All villages have the Hopi language, customs, and traditions. All the villages have clans, kivas, and fields. Seven Hopi schools serve young people. These schools are currently BIE schools and are in the process of becoming Tribally Controlled Schools. These schools include Moencopi Day School, Hotevilla Bacavi Community School, Hopi Day School, Second Mesa Day School, First Mesa Elementary School, Keams Canyon Elementary School, Hopi Junior Senior High School.

This math enrichment resource involves the acknowledgement that a child, to become a better member of society, needs to develop their emotional, social, physical, and spiritual dimensions. This approach also highlights the concept of peoplehood, which acknowledges that an individual's identity transcends geographical borders and encompasses cultural, social, and historical dimensions (Holm, et al., 2003). This Connecting Hopi and Tewa culture to school mathematics can support academic achievement and cultural ties (Gilbert, et al 2018).

**Rationale**

Throughout my teaching career on the Hopi Reservation, I have encountered numerous students who struggle with math during middle grades but thrive in the lower grades. I have been connected to the Hopi Reservation community since 2009 and have observed that less than 10% of fifth through eighth graders demonstrate proficiency in math, according to Arizona state standards. This proficiency rate is even lower among traditional and male students. While teaching at the high school level, I noticed that out of approximately 100 to 130 students in each class, only a small fraction of them continued to pursue higher education at universities or community colleges. However, I observed that traditional students demonstrated exceptional skills in basic geometry, fractions, and general computation through their artwork. Something is missing with this connection.

I have worked at four of the schools. I have also worked at Jeddito, a Navajo state school, and Leupp, a Navajo BIE. Most of these schools have similar challenges and need structures. All the schools have independent school boards The Hopi School System is trying to unify Hopi's seven schools. They keep running into issues. As far as I know, there has not been a common local curriculum that is shared by the schools. Some schools have used Beyond Textbooks, and Eureka Math as their math curriculum but it has had intermittent results. I have put together enrichment mathematics lessons that all middle grades can use. One that all Hopis can relate to.

Indigenous students, including those from the Hopi community, utilize math to comprehend and interact with their environment. In their traditional lifestyle, math is applied in various ways, such as measuring water for planting corn and watermelon using irrigation methods, studying and honoring the sun, rain, and earth, and predicting seasonal trends to track and anticipate food and water sources. Math has been deeply ingrained in Hopi culture for centuries, allowing them to appreciate the order and patterns it reveals in the world. With 18 years of experience in education, I have taught math at the elementary, middle school, and high school levels. Through my experiences, I have observed students struggling due to a lack of foundational knowledge. Upon reflecting on how best to improve mathematics education, I identified the middle grades as a critical point. Our current generation faces challenges in learning and excelling in modern mathematics. Having witnessed the educational challenges at the elementary, middle grades, and secondary levels on the Hopi Reservation, I recognized the need to braid math within Indigenous contexts (Snively and Williams, 2017) in the middle grades. According to the Arizona state educational standards (ADE, 2024), there are specific skills that students should possess at each grade level. It is crucial to focus on developing these skills for students in fifth to eighth grade within the school setting.

I developed a curriculum unit that helps make connections between the Arizona math standards and Hopi and Tewa students' lives and culture. The unit includes standards that span across 4 different grade levels (5th-8th grade). This content should be taught both from a content and a contextual perspective. For instance, by the end of sixth grade, students should be proficient in operations with whole numbers, decimals, and fractions. To initiate teaching these operations, we will use corn as a tool, as it holds great importance in Hopi culture both physically and spiritually. By examining corn fields, students will learn to measure and calculate area and perimeter, which also lays the foundation for multiplication and division. The area of the field represents the corn yield. Single-digit and multi-digit operations, with rational numbers (including decimals and fractions), will be included.

The proficiency in math among fifth to eighth graders in most cohort classes is less than 10%. Many traditional students show exceptional skill in drawing, utilizing basic geometry, fractions, and computation skills in their artwork. I hope this unit helps students to solidify pre-algebra skills and presents them in a way that students can relate to in their daily lives. In traditional education, subjects are taught in a linear progression. However, in traditional Native American teaching methods, education is delivered in a spiral manner. Spiral learning entails revisiting concepts to connect them to the bigger picture. My goal is to teach math through an Indigenous perspective, demonstrating how math can be relevant in everyday life.

**Instructional Strategies –**

Arizona State Mathematics Practice Standards and Traditional and/or cultural knowledge are included in this unit.
Students are encouraged to exercise self determination

Arizona Mathematics Teaching Standards (ADE, 2024b) include teaching and using stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures.

1. Making sense of problems and persevere in solving them.
2. Reasoning abstractly and quantitatively.
3. Constructing viable arguments and critiquing the reasoning of others.
4. Modeling with mathematics.

# Lesson 1: *QooQa-o Hopi Corn Field*

Corn goes back to their very creation story of Hopi. As the Hopi people emerged into this world, the Creator gave them three things: a gourd of water, a planting stick and a short ear of blue corn. Hopi farmers plant corn in clumps. 10–20 seeds are deposited into the hole. The excavated earth is put back gently into the hole in the order it was removed with the moist soil covering the seeds on the bottom and the drier soil on top. The loose dry dirt is on the top, but a small basin is created on the surface to collect any precipitation that falls and to create a dust mulch that reduces evaporation.. The farmer stands and takes three steps to measure where the next clump of corn will be planted. Approximately one stack of corn will be grown in each square yard. We are going to find the area of cornfields, and how much corn is in the fields, using fractions, decimals, and percents with area models.

Objective: I can Understand and demonstrate the relationship between fractions, decimals, and percent and all operations.

Arizona Mathematics Standards (ADE, 2024a)4.OA.A Use the four operations with whole numbers to solve problems.

6.NS.A Apply and extend previous understanding of multiplication and division to divide fractions by fractions.

7.NS.A.3. Solve real-world and mathematical problems involving the four operations with rational numbers.

Name:

1. Break down the rectangle

Show students how to break the rectangle into smaller sections to make the problem easier to solve.

2. Split the area by number size

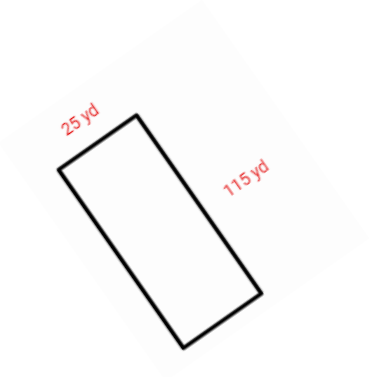
When multiplying double digit numbers, split the area based on the size of the numbers. For example, if you're multiplying 34 by 6, split 34 into 30 and 4

We start with a field with whole numbers.


*Typically Hopi uses steps to measure on the field so we are going to use yds because yds (3ft) are pretty close to an average man steps. This field is 115 steps by 25 steps so we assume that it is 25 yd by 115 yd

Steps:

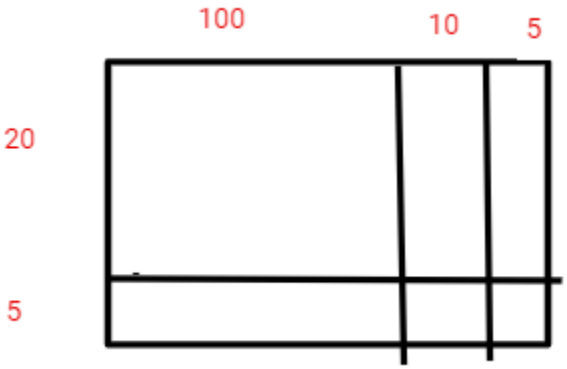
1. Using a Decompose bubble separate the whole number and fractions.
2. Label and Multiply the factors and write the products in the boxes.
3. Add the products in each box to get the total product.




Decompose the measurements

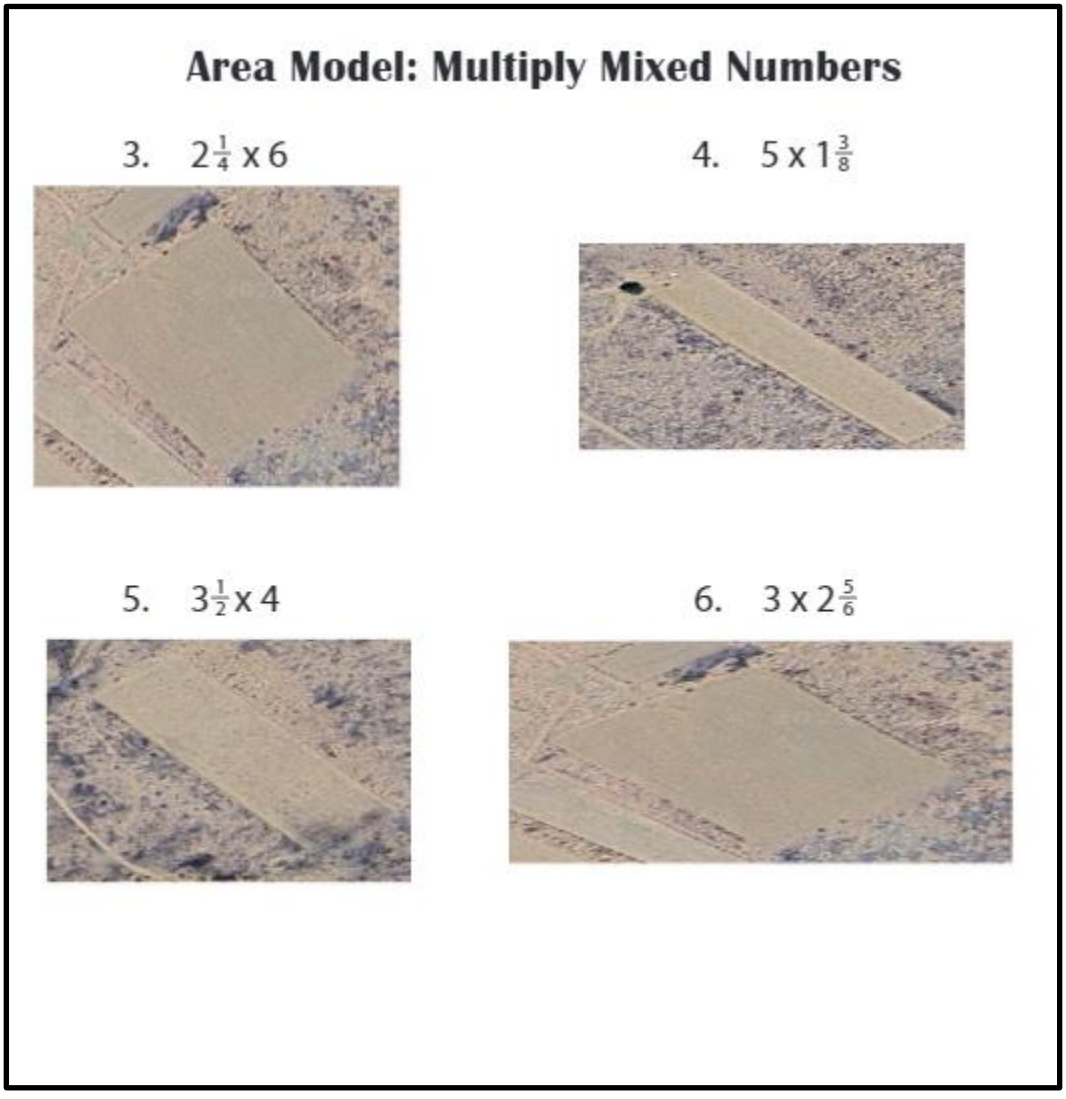
25 =20 +5
115=100+10 +5

1




Classroom Activities

Now the have a problem: they need the exact measurements except that the d




First, be sure students understand that the dimension of each side of the square is 1. (The square represents 1 square mile, so the dimensions of the sides must be 1.) Next, point to the top half of the left side. What is this dimension? What fraction of the land is it showing? I'll label this dimension 1_ 2. Point to the shaded portion of the top side of the square. This entire dimension is 3_ 4. What is the dimension of each part? I'll label each of these parts 1_ 4. Look at this first little rectangle. Its

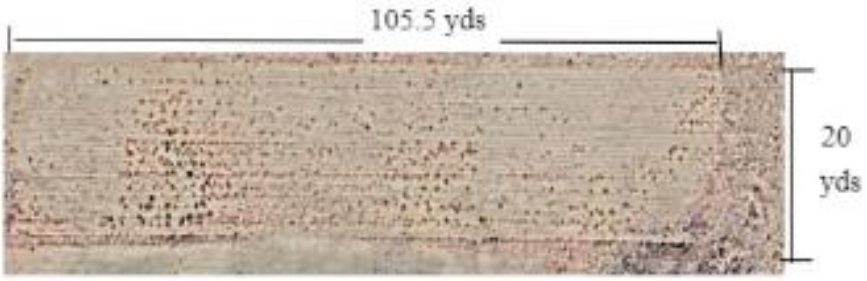
dimensions are 1_ 2 by 1_ 4. What's its area? I'll label this rectangle 1_ 8. If we look at the area of the land planted with potatoes, we see that 1_ 2 by 3_ 4 is 3_ 8.

**Student Assessment Plan**

Complete, check and turn in as exit ticket

Kele and Yokie are getting to plant. They want to figure the area of their Clans Cornfield and predict how many stocks of corn they have. They have 3 corn fields. Please set the fields accordingly.

The first corn Corn Field is 10 yds by 25 yds
The second corn field is 105.5 yds by and 20 Yds
The Third cornfield 10 ⅓ yds km by 27 2/9 Yds

| Exit Ti |  |
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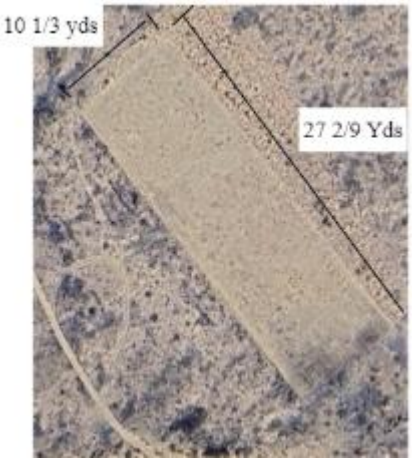
| Exit Ti |  |

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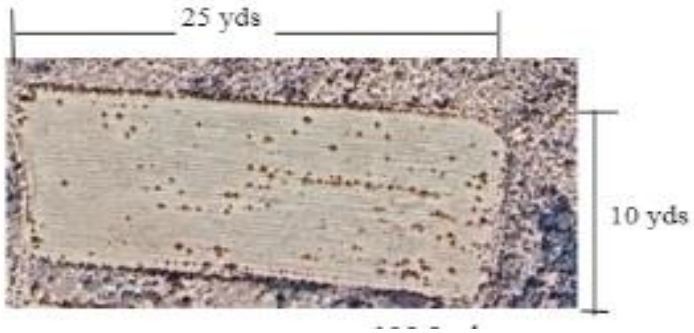
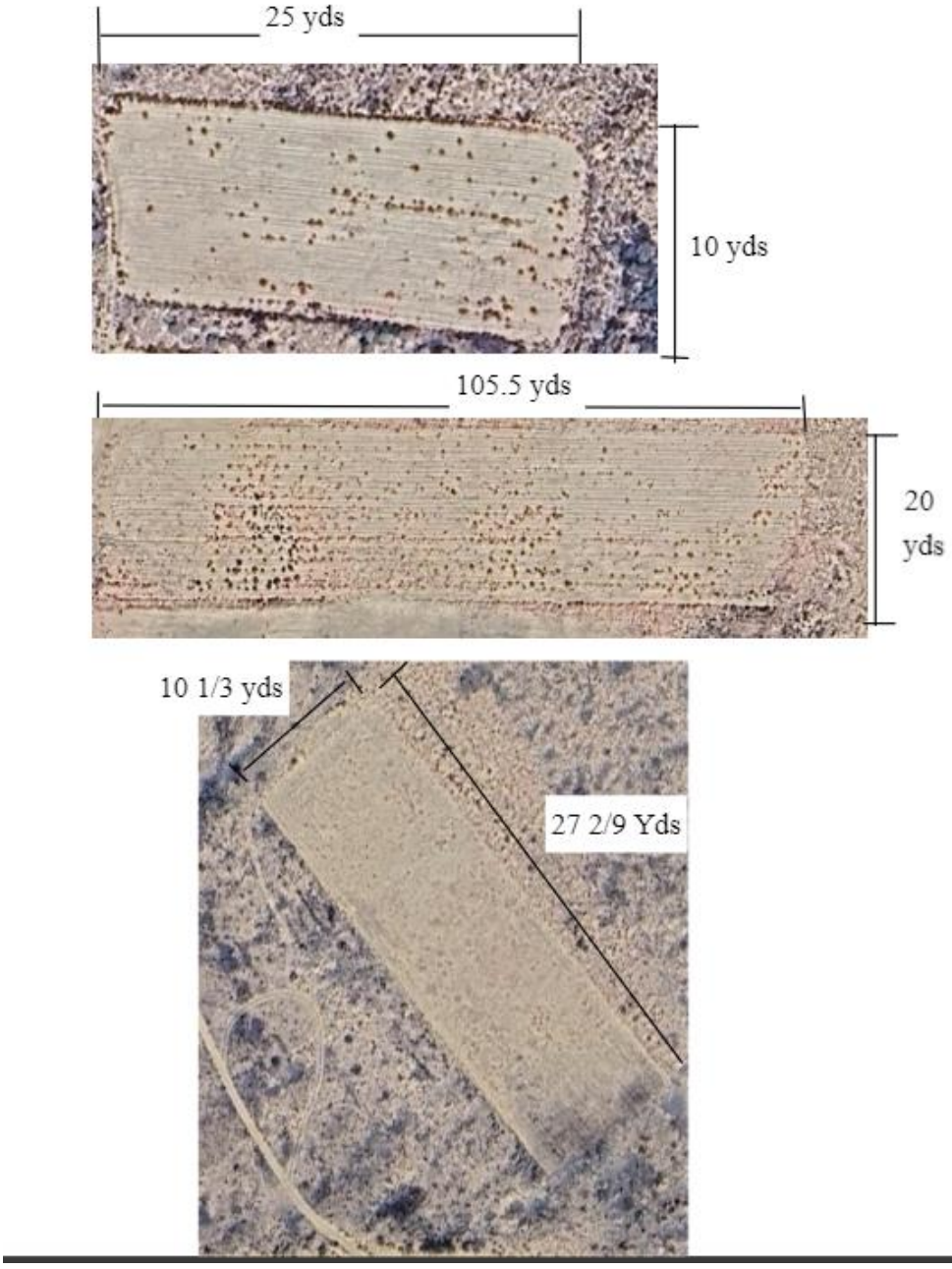
| Exit Ti |  |


25 yds
10 yds
105.5 yds
20
yds
10 1/3 yds
27 2/9 Yds

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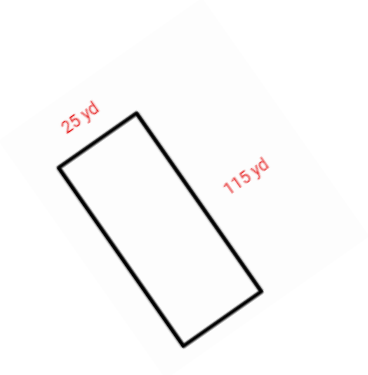


Decompose the measurements

25 =20 +5
115=100+10 +5

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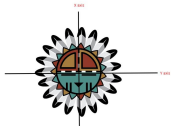
# Lesson 2.TAWA:Hopi Sun



Traditional Hopi Elders teach that the sun spirit (Tawa) created the First World, in which insect-like creatures lived unhappily in caves. With the goal of improvement, Tawa sent a spirit called Spider Grandmother to the world below. Spider Grandmother led the first creatures on a long trip to the Second World, Tawa, the sun spirit. Tawa is the creator according to Hopi's oral history, and he formed the "First World" out of Tokpella, or endless space.The sun symbol is one of the most important symbols in Hopi culture. It represents life, growth, and warmth- Vecsey, C.

Our Goal : to learn Coordinate geometry Hopi Sun

Objective:

At the End of the lesson, I will be able to…

Understand how to learn Coordinate geometry Hopi Sun

Understand the Area and Perimeter of 2-dimensional Shapes

Alignment with Standards

3.MD.C.8 Solve real-world and mathematical problems involving perimeters of plane figures and areas of rectangles, including finding the perimeter given the side lengths, finding an unknown side length. Represent rectangles with the same perimeter and different areas or with the same area and different perimeters.

5.G.A Graph points on the coordinate plane to solve mathematical problems as well as problems in real-world context.

7.G.B Solve mathematical problems and problems in real-world context involving angle measure, area, surface area, and volume

**Classroom Activities**

1.Review the Vocabulary

Grid math visual method for showing relationships between numbers. The horizontal axis is the x-axis. The vertical axis is the y-axis. The relationships are shown on a coordinate grid. They make two perpendicular lines or axes labeled X and Y. The point where the x- and y-axis intersect is called the origin.

Go over the grid

2. Go over the bottom sentences.

Second Mesa Math
Hopi Sun

NAME _____ PERIOD____

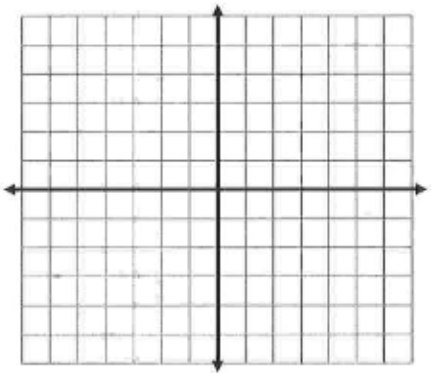
**Graphing and Labeling Ordered Pairs.** DATE _____

**Cartesian Coordinate System**: formed by the intersection of two lines, the horizontal and vertical axis.

**History:** The Cartesian coordinate system was developed by the French mathematician Rene Descartes during an illness. As he lay in bed sick, he saw a fly buzzing around on the ceiling, which was made of square tiles. As he watched he realized that he could describe the position of the fly by the ceiling tile he was on. After this experience he developed the coordinate plane to make it easier to describe the position of objects.

**X-Axes:** horizontal line

**Y-Axes:** vertical line



**Ordered Pair**: a set of numbers (coordinates) written in the form (x, y).

**X-coordinate**: x value that corresponds to the x-axis. It is the first coordinate in an ordered pair. Think: x comes before y in the alphabet.

**Y-coordinate**: y value that corresponds to the y-axis. It is the last coordinate in an ordered pair.

**Quadrants:** the x-axis and y-axis separate the coordinate plane into four regions. The axes are not located in any of the quadrants. Quadrant I starts in the upper right hand corner. Continue numbering quadrants in a counter-clockwise fashion. Use Roman Numerals!!

**Graph:** an ordered pair means to draw a dot at the point on the coordinate plane that corresponds to the ordered pair.

**Origin:** the center of the coordinate system. It has the ordered pair value of (0, 0).

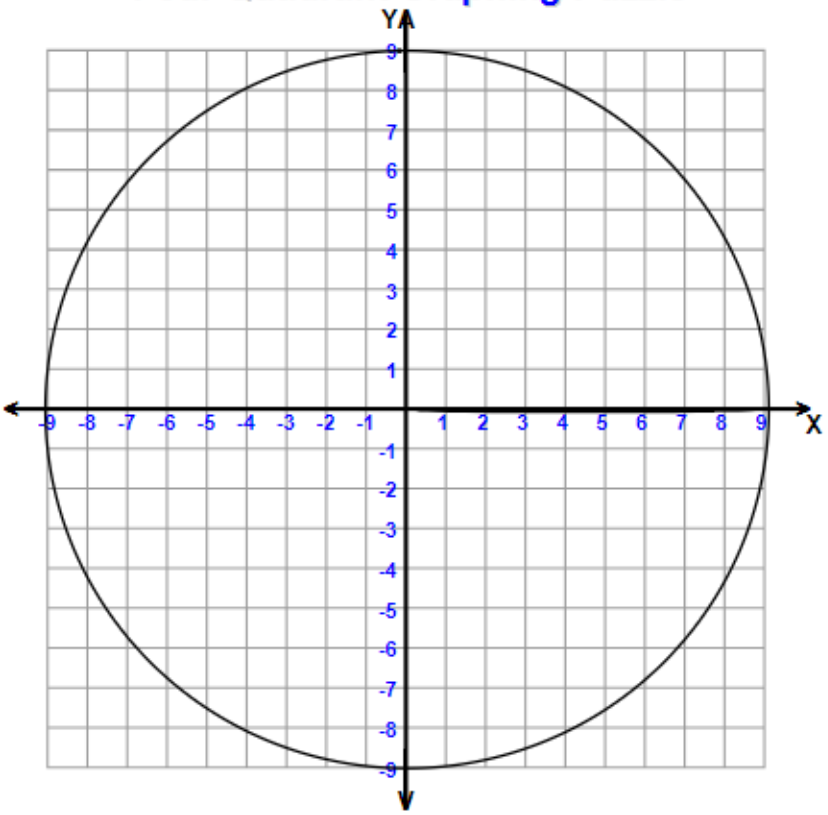
## IMPORTANT!!! In an ordered pair:

- The x-coordinate tells you to move left (if it is negative) or right (if it is positive) from the origin (center).
- The y-coordinate tells you to move up (if it is positive) or down (if it is negative).
- In the ordered pair (-3, 4) you would move _____ 3 spaces and _____ 4 spaces from the origin. The resulting ordered pair would be in the _____ quadrant.
- In the ordered pair (2, 0) you would move _____ 2 spaces and _____ 0 spaces from the origin. The resulting ordered pair would be on the _____ axis.

Name : _____ Score : _____

Teacher : _____ Date : _____

# Four Quadrant Graphing Puzzle




**Connect each sequence of points with a line.**

(2,-2) (2,-4) (6,-4) (6,-2) (2,-2) End of Sequence

(-2,-2) (-2,-4) (-6,-4) (-6,-2) (-2,-2) End of Sequence

(1,1) (1,8) Round line (8,1) End of Sequence

(-1,1) (-1,8) Round line (-8,1) End of Sequence

(-2,5) (2,5) (0,-8) (-2,5)

End of Sequence

What is the area of

both eyes_____

Mouth_____

What is the area of one for head?

**What is the shape ?** _____

Using Functions and Tables to draw a sun

Equation y=-2
Domain -6<x -2 2<x<6

Equation y=-3
Domain -6<x -2 2<x<6

Equation y= -2x-1
Domain 0<x<1

Equation y= 2x-1
Range -1<x<0

y= 0x-1
Range -1<x<1

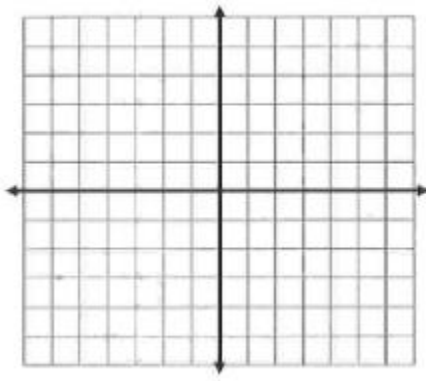
Table (Not a function Undefined slope) Draw a line

| X | Y |
|---|---|
| -2 | -2 |
| -2 | -3 |

| X | Y |
|---|---|
| 2 | -2 |
| 2 | -3 |

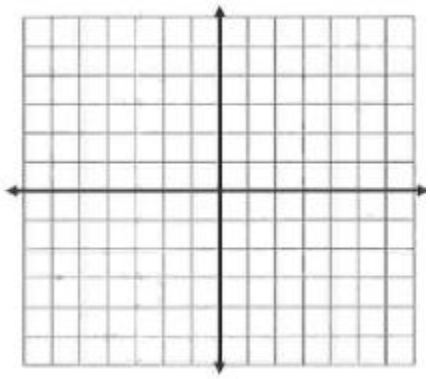
| X | Y |
|---|---|
| -6 | -2 |
| -6 | -3 |

| X | Y |
|---|---|
| 6 | -2 |
| 6 | -3 |



Equation x=-5

Range -3>y>1



Equation (not a function)

(x)^2+(y)^2=81

Domain -9 <x< 9

Range -9 <x< 9

6. Student Assessment Plan –

Daily Exit Tickets: Quick questions to check for understanding of key concepts covered in the lesson.
Whiteboard Check-ins: Randomly select students to solve a problem on the board to assess real-time comprehension

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