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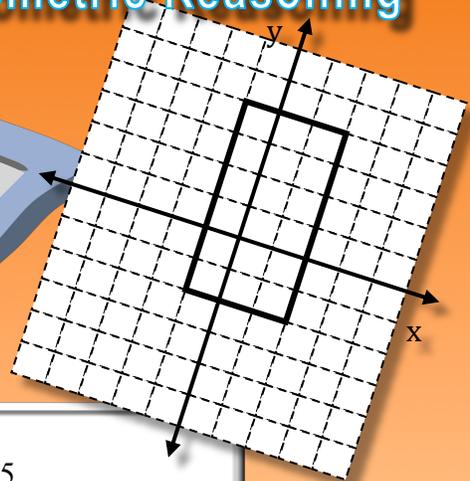
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3 GREAT GAMES

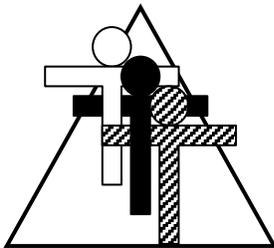
• TREASURE HUNT • TARGET NUMBER • PINS AND POSTS

Engaging Strategies for Teaching Numbers Sense,
Order of Operations, and Geometric Reasoning

LET'S PLAY!
LET'S LEARN!



By Brad Fulton
Educator of the Year, 2005
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Known throughout the country for motivating and engaging teachers and students, Brad has co-authored over a dozen books that provide easy-to-teach yet mathematically rich activities for busy teachers while teaching full time for over 30 years. In addition, he has co-authored over 40 teacher training manuals full of activities and ideas that help teachers who believe mathematics must be both meaningful and powerful.

Seminar leader and trainer of mathematics teachers

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Brad 

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Treasure Hunt

The great game of graphing

Overview:

Students will so enjoy this engaging activity they won't realize they are learning about coordinate graphing. Moving the "buck" allows you to teach graphing in the first (positive) quadrant or in all four. You can even rotate the buck so students can practice working with slope and reciprocals.

Required Materials:

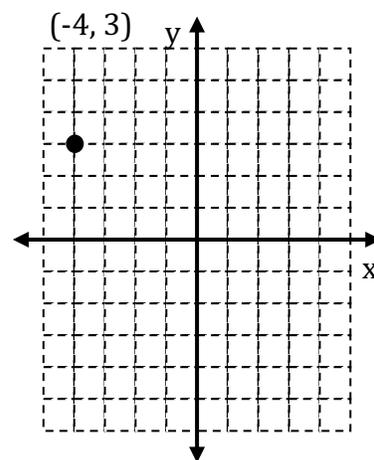
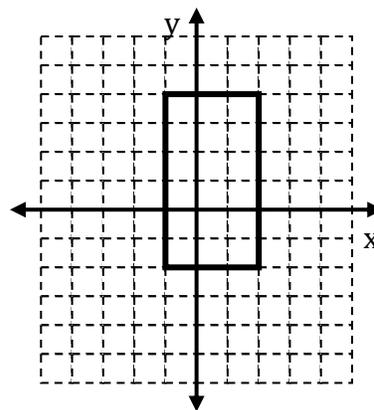
Graph paper

Optional Materials:

Copies of bucks

Procedure:

1. This game is played like the popular game, Battleship. However, students call out coordinate points to find the treasure. Each student will need a copy of grid paper or ideally, graph paper from one of the four masters provided. You may choose to use the first quadrant graph paper if you intend to use only positive numbers or the four quadrant graph paper that allows the use of both positive and negative coordinate pairs for older students. The graphs with the larger squares will result in a faster game.
2. On your hidden copy, draw the outline of a "buck." Although bucks may be of different sizes, the students should know that the length of each buck is twice its width. An example of a 3 x 6 buck is shown.
3. Tell the class that you have hidden a buck somewhere on the paper. To get it, they must correctly identify the location of all four corners. If you wish, you also can tell them what the buck will buy. This might be a snack, a homework pass, or a free seating pass.
4. Explain that to guess a location, they must first tell you how many spaces to move left or right along the x-axis. Positive numbers will move right from the origin (the intersection of the x- and y-axes), and negative numbers will move left. The second number they state will move them up or down along the y-axis. Positive numbers move upward and negative numbers indicate downward movement. The point $(-4, 3)$ is located four spaces to the left of the origin and three spaces above it as shown.



5. A good way to practice this is by displaying to the class a buck set on a grid. Show them how to name the four points that mark the corners of the buck. Then let them try your example.
6. Let each student or team of students guess a coordinate pair. You should respond in one of three ways:
 - “miss”–signifies that the buck has been missed entirely
 - “hit”–denotes that the buck has been hit, but not on a corner
 - “corner”–means that a corner has been hit.
 - If you wish, you can also call “edge” when the buck has been hit on the edge, but not on a corner. This will speed up the game a little bit.
 Players may wish to mark the miss, hit, and corner in three different colors on their graphs.
7. If a miss occurs, the turn proceeds to the next student or team. A hit or corner gives an additional turn to the player.
8. The winner is the student or team that correctly guesses the coordinates of the final corner, thus finding the treasure.



Journal Prompts:



Two corners of a buck have been located at $(-4, 2)$ and $(4, 2)$. Where might another corner be located? Explain your reasoning.

Two corners of a buck have been located at (a, b) and $(-a, b)$. Where might another corner be located? Explain your reasoning.

Homework:



Students can play this game with a parent or sibling. Another option is to give them the coordinates of some bucks and have them graph them. Here are coordinate sets for six bucks.

1. $(8, 5)$ $(8, 1)$ $(0, 1)$ $(0, 5)$
2. $(3, 5)$ $(3, 1)$ $(-5, 1)$ $(-5, 5)$
3. $(2, 7)$ $(2, -1)$ $(-2, -1)$ $(-2, 7)$

4. (-1, -5) (-1, 1) (-4, 1) (-4, -5)
5. (0, 0) (0, 7) (3.5, 7) (3.5, 0)
6. (-1, -2) (0, 1) (6, -1) (5, -4)

A more challenging homework assignment would be to ask the students to design a simple picture and list the coordinate points in consecutive order like a dot-to-dot. This can be a difficult assignment even for advanced students. Examples should be practiced in class first.

Good Tip!

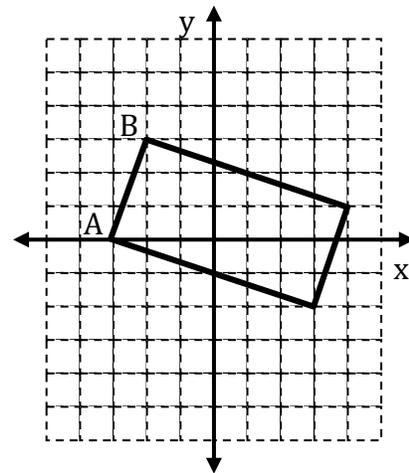


Once students understand this game, they can be allowed to play it in pairs or teams. One student hides the buck while the other tries to find it. Then they switch roles. This option will allow you to provide one-on-one help to students who are having trouble.

Taking a Closer Look:



Rotating the buck as shown will make the game more challenging. Remember to keep the 2:1 ratio of length to width. This orientation will help students understand the idea of slope and reciprocals. If they discover that corner B is “up three and over one” from corner A, then they may realize that the next point will be “down two and over six.” The former slope was $\frac{3}{1}$ and the second one was $-\frac{2}{6}$ or $-\frac{1}{3}$. These two slopes are opposite reciprocals; their product is negative one. This will always occur when lines are perpendicular.



Assessment:

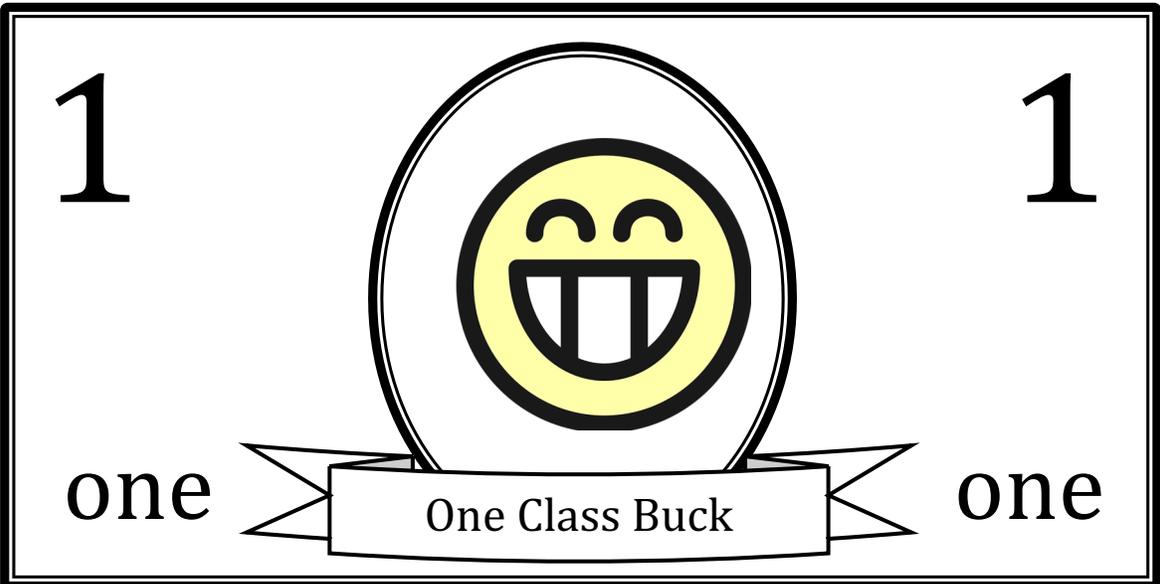
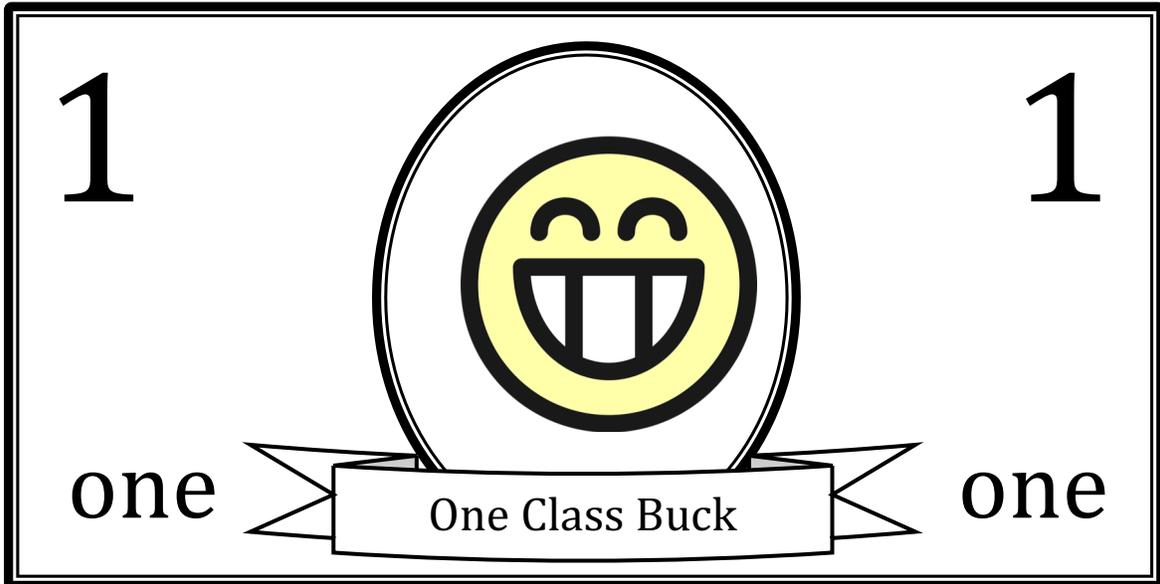


It is fairly easy to assess whether students understand the relationship between a point’s location and its coordinate pair. Frequently students will say, “over three and up two”, or “left three and up two”, instead of saying, “negative three, two”. By only graphing points that are correctly stated, students will quickly learn to modify their statements.

You may also notice some misunderstanding once the location of a corner of a buck is known. For example, for a horizontally or vertically oriented buck, if one corner is located at (-3, 2), then an adjacent corner must be at (-3, y) or at (x, 2). On the other hand, if a student guesses (5, -7), it is obvious that they haven’t yet discovered the vertical and horizontal association of adjacent points.

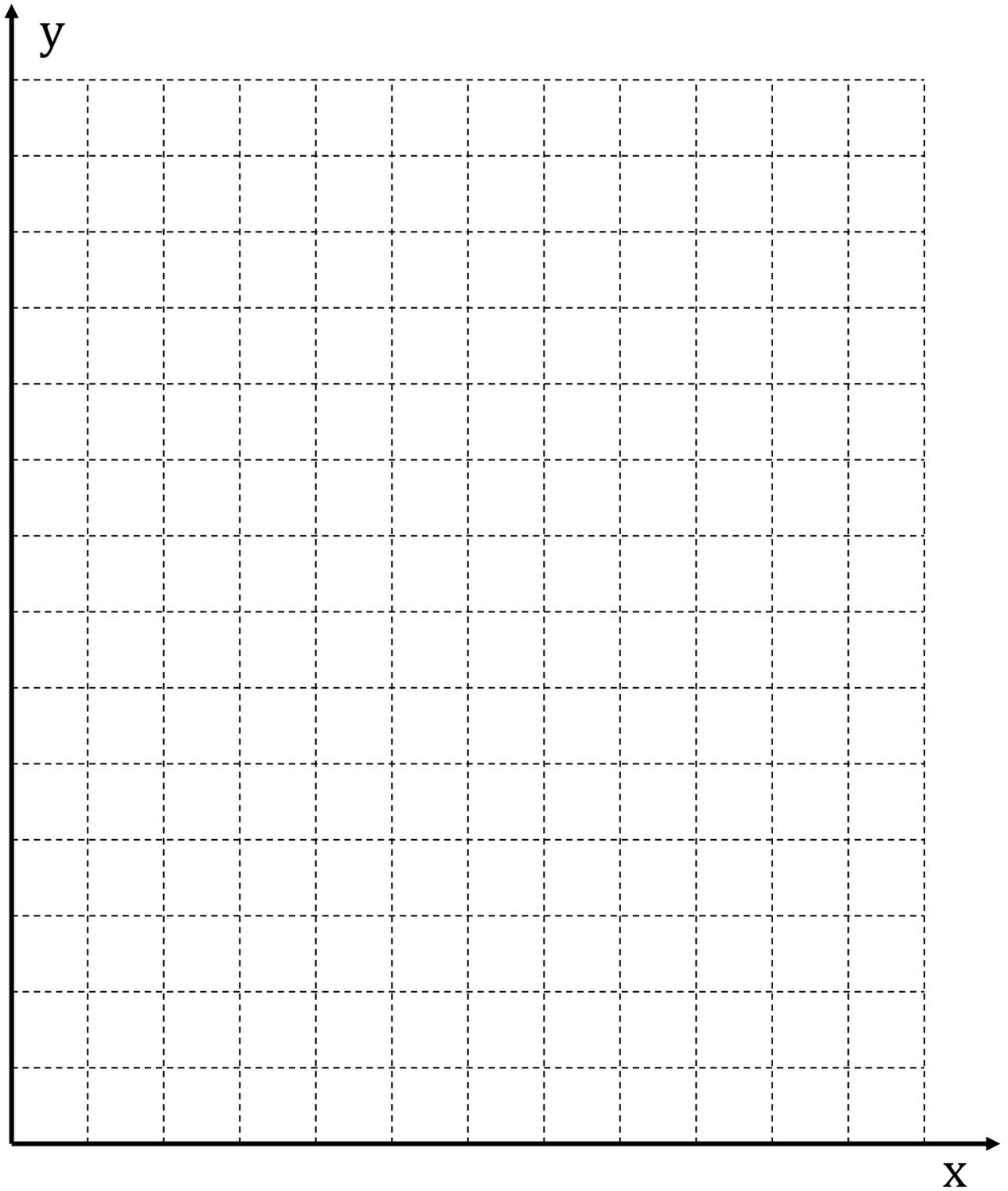
To assess the homework, have pairs of students set their grid paper atop one another and hold them both up to the light. The bucks of one student should perfectly overlay those of another.

If you asked students to create their own simple pictures, you can ask student pairs to exchange their coordinates to see if they can graph their partner’s picture.



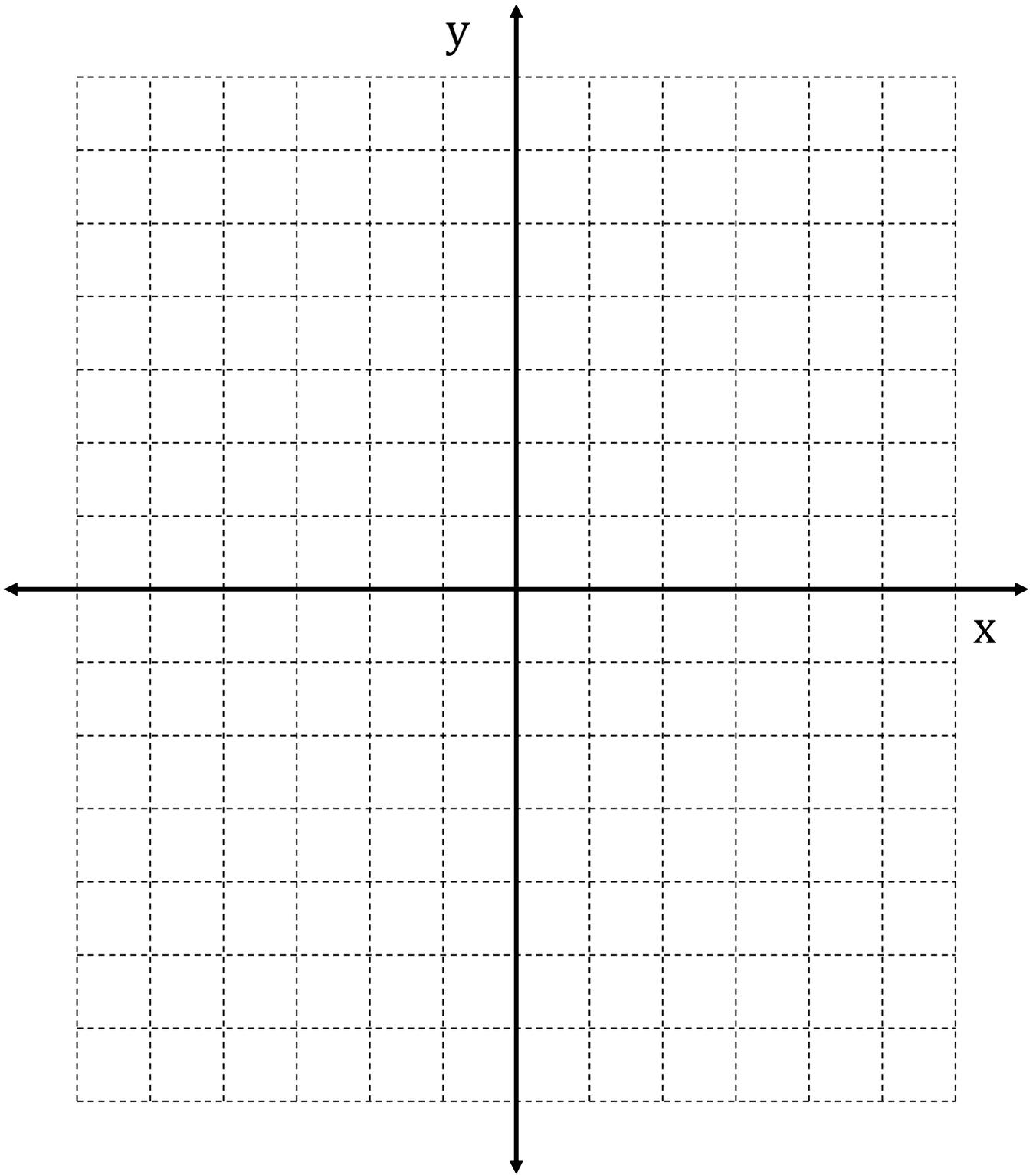
Treasure Hunt

Name _____



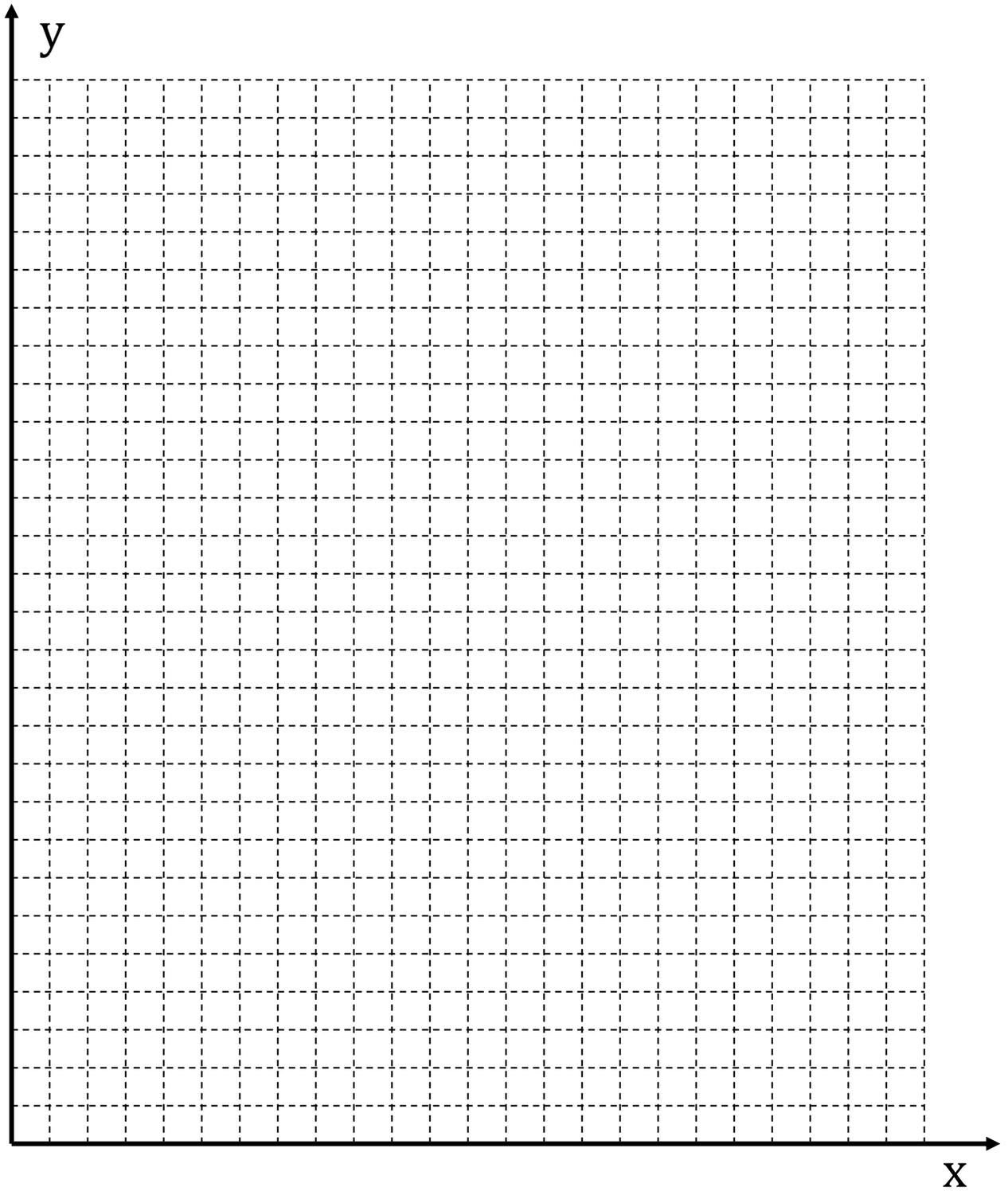
Treasure Hunt

Name _____



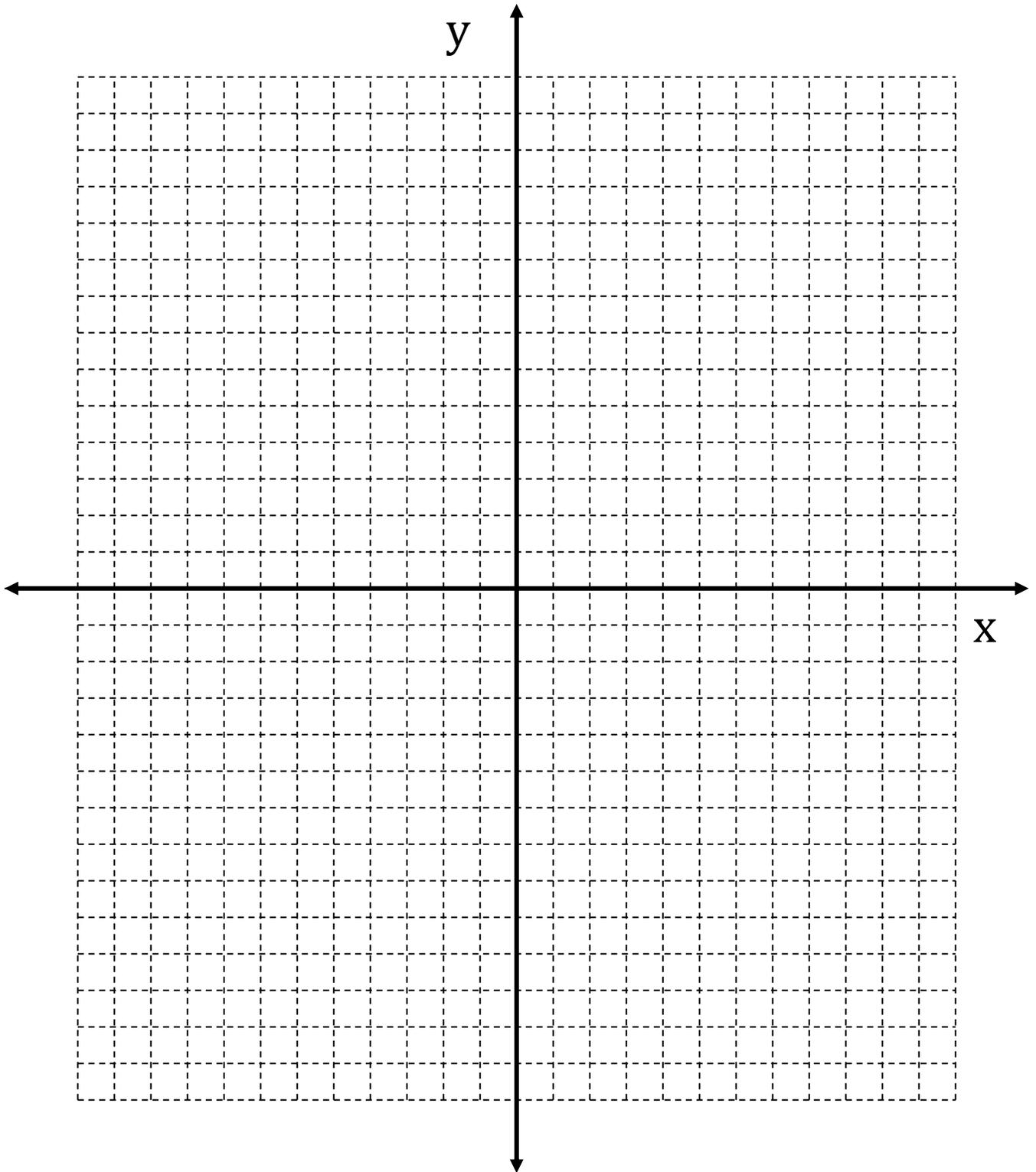
Treasure Hunt

Name _____



Treasure Hunt

Name _____



Target Number

A game to promote proportional reasoning and precision

Overview:

This game can be a warm up, an end of class filler, or a full lesson plan. Students effortlessly develop an understanding of decimal place value, number magnitude, and proportional reasoning. You can vary the complexity to adjust to the skill level of your class. Students can also work with integer division and develop a sense of irrational numbers.

Procedure:

1. You will need a calculator that can be displayed. Transparent calculators for overhead projectors are available. You can also find them online. Make sure that the calculator will do steps 2 – 6. Some will not reference the original number you entered as is required for this lesson. Here is an online calculator that will work fine: <https://www.online-calculator.com>. This can be projected on to the board.
 2. Enter any number into the calculator *without showing the students* (8 for example).
 3. Divide the number by itself.
 4. Press the equal key. The calculator displays the answer, 1.
 5. Show the calculator to the students. Allow them to try to guess your number.
 6. Enter their guess (6 for example) into the calculator and press the equal key. The calculator will *divide their guess by your number*. In this case, the calculator will display 0.75, ($6 \div 8$).
- Note: If your calculator does not display 0.75, either the constant function is not enabled, or your calculator does not have one. Consult your calculator's manual for more instructions.
7. If the display is less than 1, as in this case, the guess was too low. If the calculator displays an answer greater than 1, their guess was too great. Have them record their guess and the word "low" or "high". (You may wish to have them record the calculator's answer, 0.75 also.)

Required Materials:

- Online calculator or overhead projector calculator

Optional Materials:

- Copies of bucks from the previous game
- Scratch paper
- Calculators

8. Allow them to make another guess and record the result. Any time they make a new low or high guess that is closer than a previous one, they should cross out the old one. Eventually their list will look like this:

6	low
20	high
15	high
7	low

9. After a short time, students will guess eight. When they do, the calculator will divide their guess by your number, and since these numbers are equal, it will display 1.
10. Once they learn how to play the game, enter a decimal such as 12.3 without their knowledge. As they begin to zero in on the target number, students will be very surprised to discover that a guess of 12 is too small, and a guess of 13 is too great. This will show them that they need to use a decimal. When they make these guesses, you can require that they say, "Twelve and three tenths," instead of, "Twelve point three."
11. Next try a decimal in the hundredths place such as 14.38. The class will probably not be bothered when they realize they need to guess to the tenths place. However, many will be surprised when they see that 14.3 is too small and 14.4 is too great. Some will think that there are no numbers between 14.3 and 14.4. The idea of place value will become clearer to them when you write the numbers as 14.30 and 14.40.
12. The difficulty of the task depends on the number of decimal places in the number you choose. For example, if you have a pi key on your calculator, type $\pi \div \pi$. It may take over half an hour for a class to get an approximation of pi close enough for the calculator to show the answer 1. Typically, calculators round off after about eight or ten decimal places.

Good Tip!



This game works best with an overhead projector calculator. If you do not have one there are two options. One is to have a student volunteer record the calculator display on the board after each guess. Or you can demonstrate the game to the class and they can play in pairs or teams so they can see the display of their handheld calculators.



Journal Prompts:



When it was her turn, Andrea guessed 3.3. The screen showed 0.75. Two students discussed the next guess. Leslie said they should guess 2.5 next. Randall said they

should guess 6.5. If you were working with these students in a team, what guess would you suggest?

Homework:



Students can play this game with a parent if they have access to such a calculator at home. The parent can sign a note saying the game was played for 15 or 20 minutes.

Taking a Closer Look:



Enter a negative number divided by itself. The calculator still displays 1, but if they make a positive guess, they will see a negative answer displayed.

The margin shows an algebraic way to solve these problems.

Assessment:



Check to see that students are making sensible guesses within the correct range. In this case, you will be assessing the students as they play.

Here's the Algebra!

Let a variable represent the teacher's number:

$$\frac{n}{n} = 1$$

When students make a guess, such as 5, they are creating this equation in which d represents the calculator's display after the guess has been entered.

$$\frac{5}{n} = d$$

Multiplying each side by the denominator gives:

$$5 = nd$$

Dividing each side by the displayed number gives:

$$\frac{5}{d} = n$$

Thus the mystery number is the students' guess divided by the display.

Pins and Posts

An empowering game to build geometric vocabulary and skill

Overview:

This is a thought-provoking game that helps students build their understanding of the properties of polygons while promoting geometric vocabulary. Each problem has many solutions, and students will be challenged to improve their score by improving their geometry skills.

Procedure:

1. Display a transparency of the Activity Master and give copies to the students. They will also need to see a copy of either of the Polygon Keys. Two are provided, one for younger learners and one for more advanced students. Use the one most appropriate for your class.
2. Select two numbers randomly using spinners or dice. Two six-sided dice of different colors make this simpler. Use the Polygon Key to determine which polygon will be drawn. For example, if a three is selected first, and a two is selected second, the player must make an obtuse triangle.
3. The player then tries to draw the polygon on the Activity Master using the points as vertices. The opponent must verify that the polygon satisfies the conditions. An example is shown.
4. Scoring is based on the number of "pins" and "posts" in the polygon. A post is defined as a vertex. A pin is any point inside the polygon. To determine the score, the player subtracts the number of posts from the number of pins as shown in the first example.

$$\begin{aligned} \text{pins} - \text{posts} &= \text{score} \\ 0 - 3 &= -3 \end{aligned}$$

This is obviously not a very good score. Here are two other obtuse triangles that get better scores. The second example gets a score of

$$4 - 3 = 1$$

The third triangle is even better. Its score is

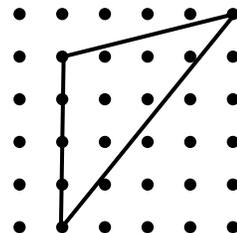
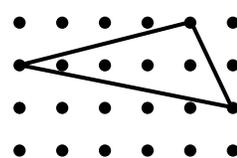
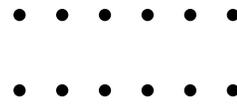
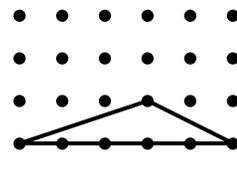
$$6 - 3 = 3$$

Required Materials:

- Display of the activity master
- Student copies of the activity master
- Two differently colored dice or a spinner
- Polygon key

Optional Materials:

- Geometry boards



5. After drawing the polygon, the student writes the name of the polygon and the score on the arrow next to the grid on the Activity Master.

6. The second player or team now selects two new numbers and draws the polygon determined by the Polygon Key. Again, the goal is to maximize the score by including the greatest number of pins inside the polygon. However, the number of posts is always determined for the student by the Polygon Key. Again the student writes the name and score for the polygon.

7. Students play the game for ten rounds or as time allows. After ten rounds, the students total their scores and the highest score wins.

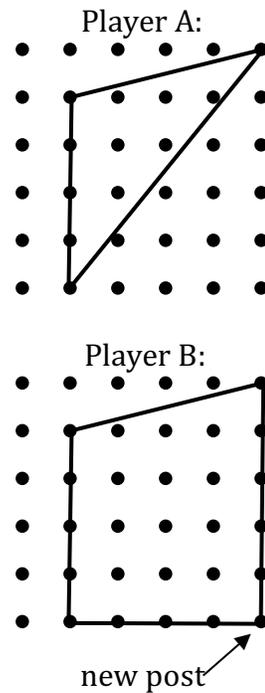
Good Tip! 

There is a math tool called a “geoboard” that has nails arranged in a grid on a board. Students can use rubber bands to make polygons on the nails. These geoboards offer a paperless version of the game. Check a mathematical supply catalog for these tools.

8. This game can promote so much critical thinking that you may wish to impose a time limit for each round.

9. The game can be customized many ways to adapt to different levels of students.

- For younger students, any time the number of posts is greater than the number of pins, the score is zero. There are no negative scores.
- Lowest score wins instead of the highest score.
- Students aim for a target score such as five. Sometimes they will exceed this score and then try to come back to it in the next round with a negative score.
- Students must build their polygon by transforming the polygon of the other player. Scoring is based upon the number of new posts (vertices) created. Low score wins. An example is shown in the margin. Here player A has formed an obtuse triangle. Player B has selected numbers 1 and 3 and must transform this shape into a right trapezoid. Player B does this creating only one new post for a score of 1.



10. A blank Polygon Key is provided for you to customize to the needs of your class.



Journal Prompts:



Rachel has just made a parallelogram. Danielle now has to make a trapezoid. She says that she should not have to make any changes to Rachel's shape and should therefore get the same score. Write a note to her telling her if you agree or disagree and why.

Homework:



Students can play this game at home with a parent or sibling.

You may also give them a list of six to ten shapes from the Polygon Key. They can then try to get the best score with these shapes at home.

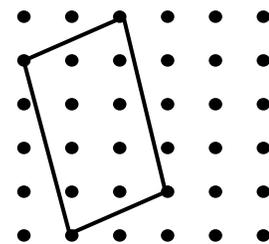
Taking a Closer Look:



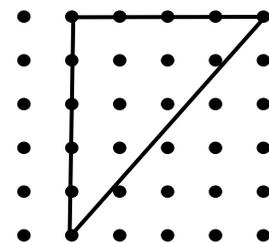
Austrian mathematician, Georg Alexander Pick (1859–1943), discovered a way to find the area of a polygon using the points inside and on the perimeter of the polygon. If you add the number of points on the inside of the polygon and half the number of points on the perimeter and then subtract one, you get the area of the polygon. Why this works is pretty advanced, but it's a very simple formula. We'll call the number of points on the inside n and the points on the perimeter p in this equation:

$$A = n + \frac{p}{2} - 1$$

Some examples are shown in the margin to illustrate this. This could be a more advanced way of keeping score in the game if you wish.



$$A = 8 + \frac{4}{2} - 1 = 9$$



$$A = 6 + \frac{7}{2} - 1 = 10$$

Assessment:



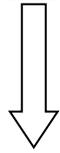
During play, this game is often self-assessing, as opponents will agree or disagree with a move.

If you wish, you can have students turn in their Activity Master so you can check that their shapes match their labels.

Polygon Key 1

Second
number

First number



	1	2	3	4	5	6
1	Isosceles Triangle	Quadrilateral	Scalene Triangle	Hexagon	Trapezoid	Square
2	Rectangle	Rhombus	Obtuse Triangle	Right Triangle	Pentagon	Parallelogram
3	Right Trapezoid	Obtuse Triangle	Irregular Quadrilateral	Right Triangle	Concave Hexagon	Triangle
4	Right Scalene Triangle	Concave Pentagon	Square Area = 4 un^2	Right Isosceles Triangle	Triangle Area = 3.5 un^2	Rectangle Area > 6 un^2
5	Parallelogram Area = 6 un^2	Isosceles Trapezoid	Scalene Triangle Area = 5 un^2	Square Area < 16 un^2	Isosceles Triangle	Concave Quadrilateral
6	Obtuse Scalene Triangle	Acute Triangle	Acute Isosceles Triangle	Octagon	Obtuse Isosceles Triangle	Acute Right Triangle

Polygon Key 2

Second number



First number

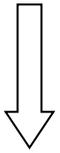
1 2 3 4 5 6

Even

	1	2	3	4	5	6
Even	Square	Octagon	Triangle	Concave Quadrilateral	Parallelogram	Hexagon
Odd	Trapezoid	Right Triangle	Rhombus	Quadrilateral	Rectangle	Pentagon

Blank Polygon Key

Second number



First number

1 2 3 4 5 6

1

2

3

4

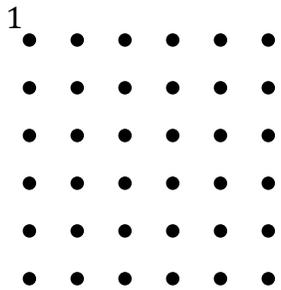
5

6

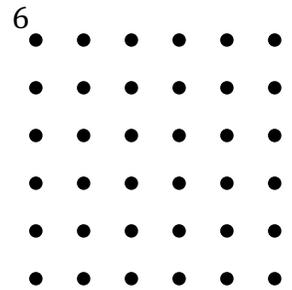
	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Pins and Posts

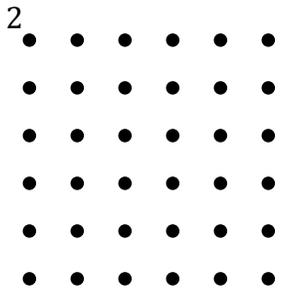
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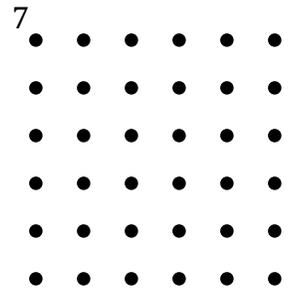
← Shape & Score



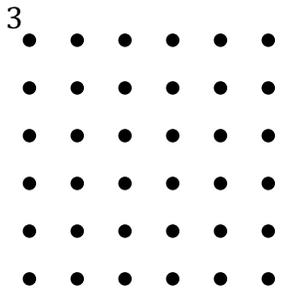
Shape & Score →



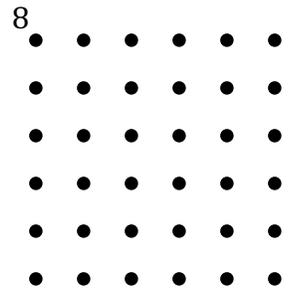
← Shape & Score



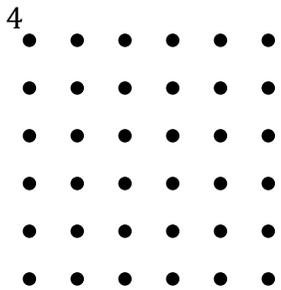
Shape & Score →



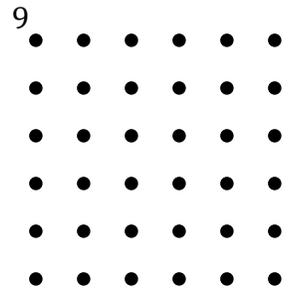
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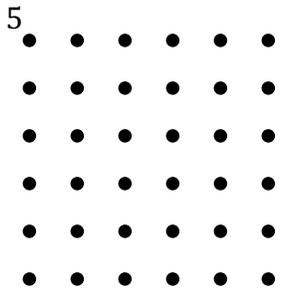
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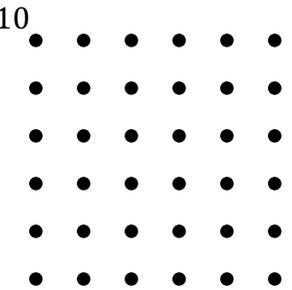
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Shape & Score →



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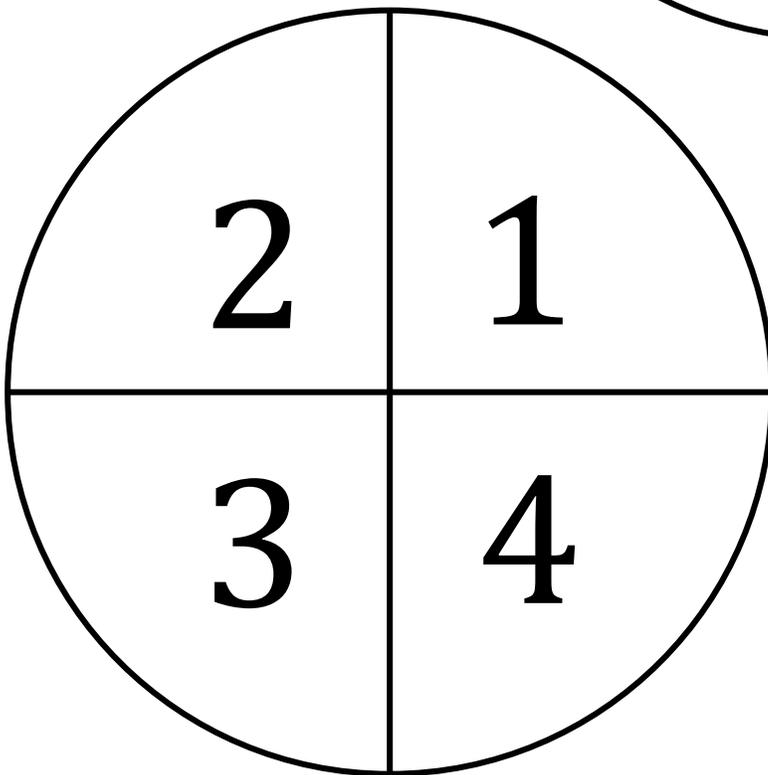
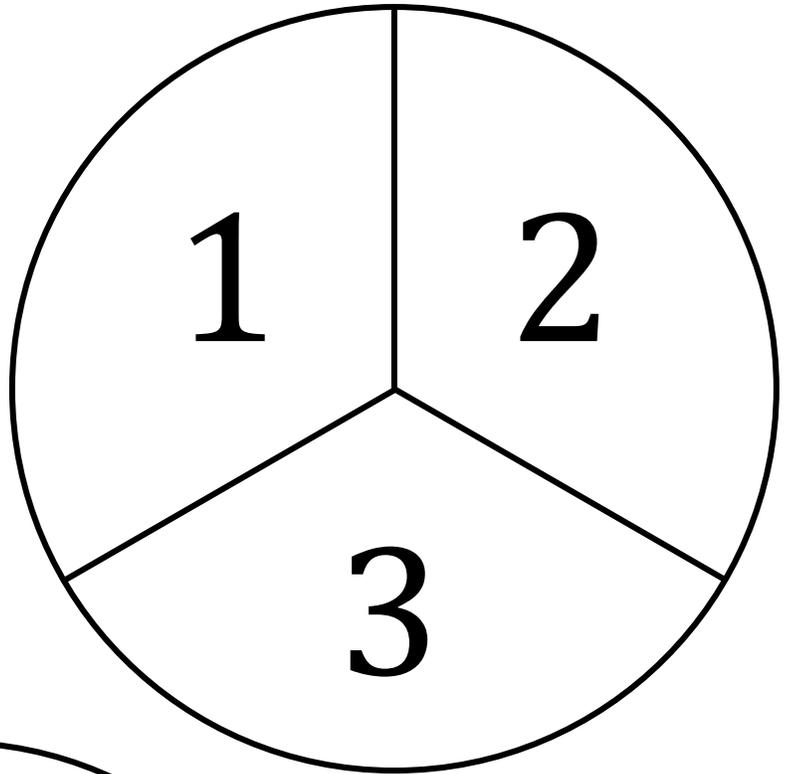
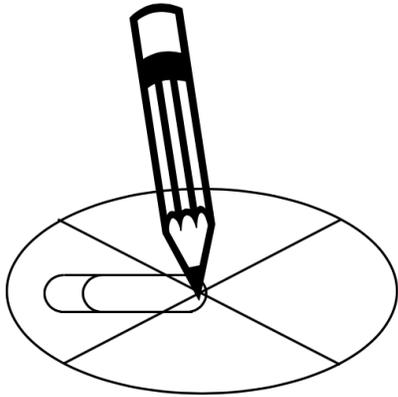


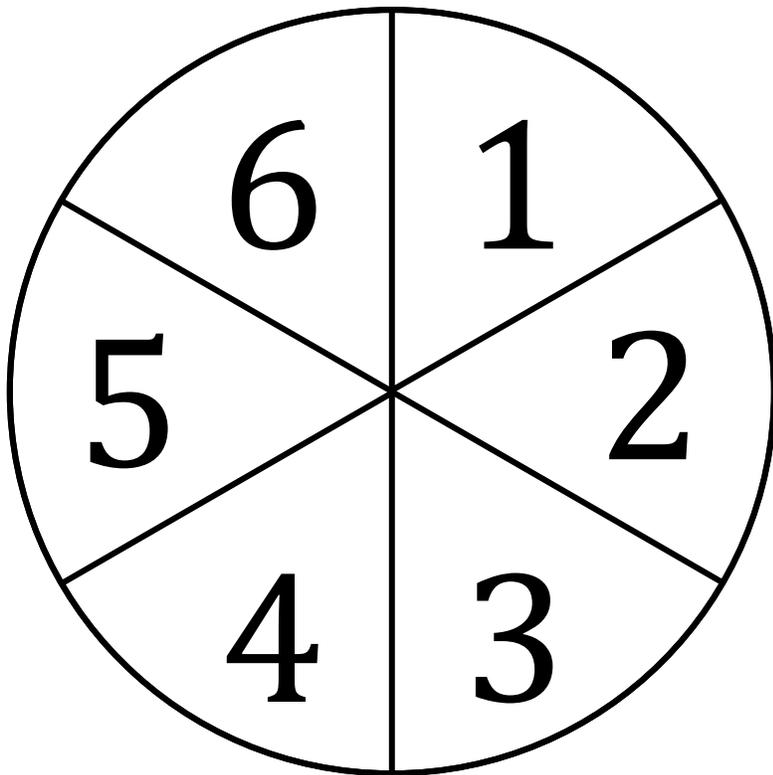
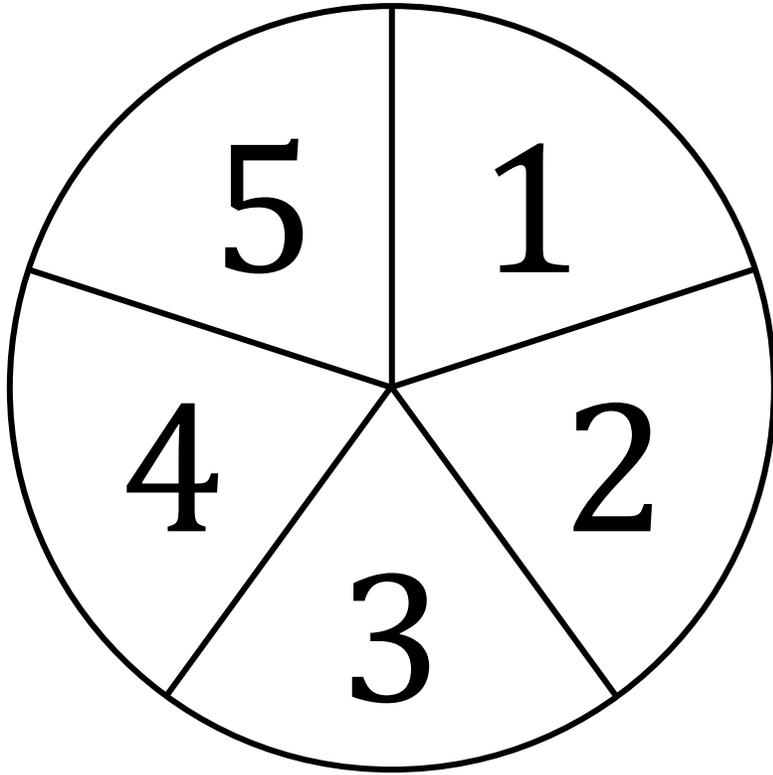
Shape & Score →

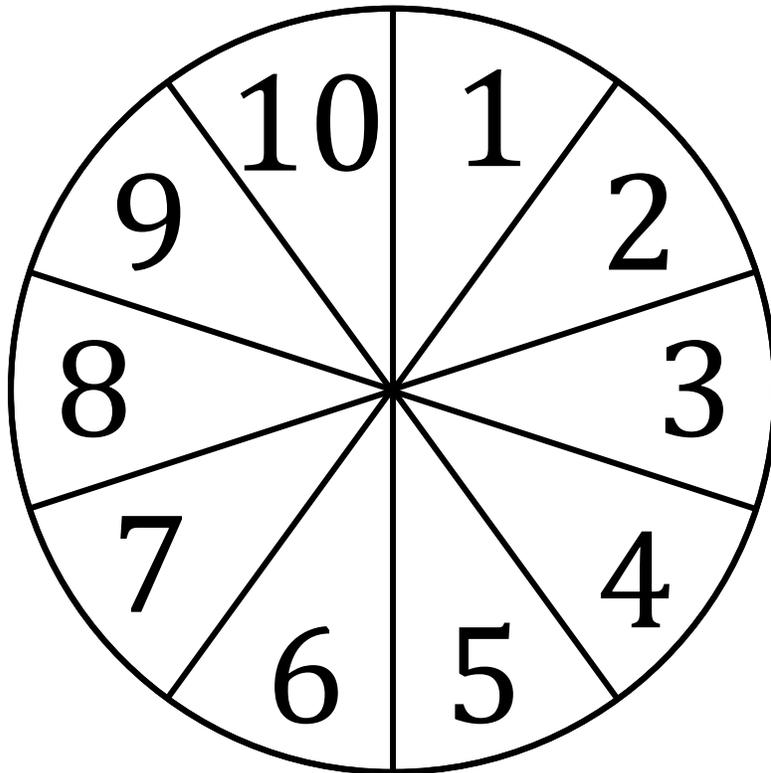
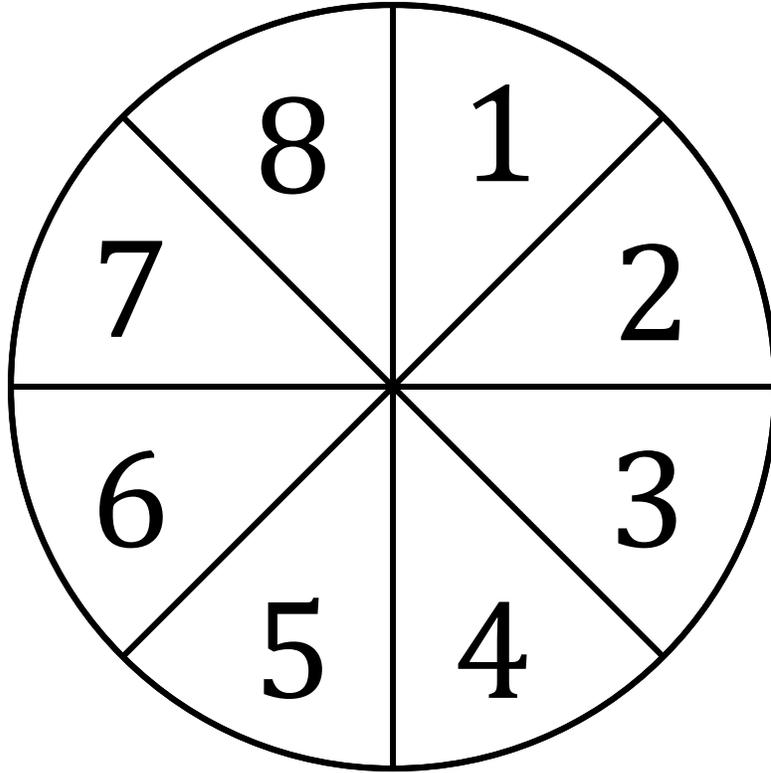
Total Score: _____

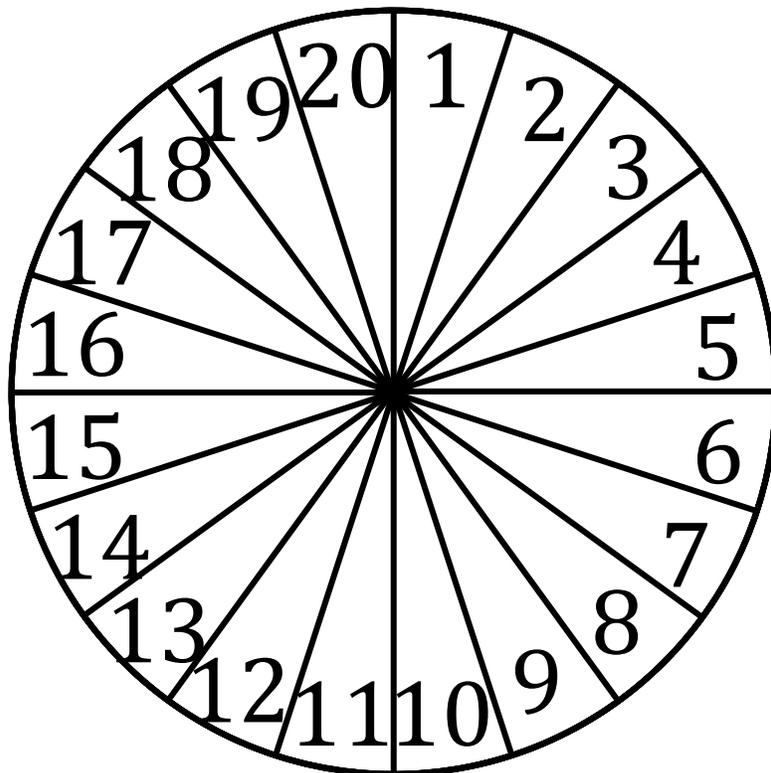
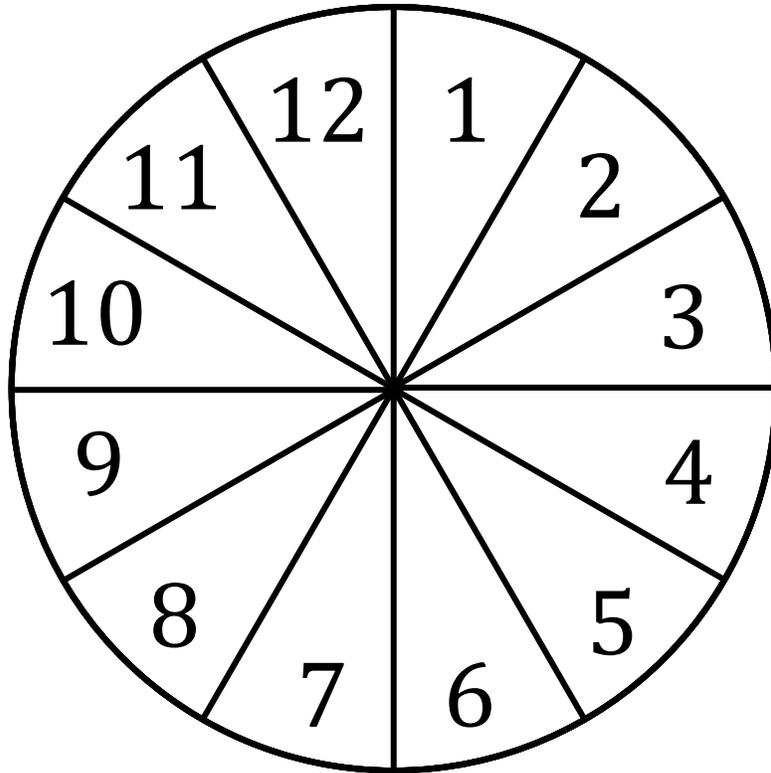
A large blue polygon is shown, which is a rectangle with a diagonal cutout at the top-left corner. The cutout is a right-angled triangle with its hypotenuse facing the top-right. The text is centered within the blue area.

This shape will not appear in
the purchased version









If you liked this activity, you might also like some of the other lessons available in my TeachersPayTeachers store. Simply search for "**Teacher to Teacher Press**". You can also find many free and inexpensive resources on my personal website, www.tttpress.com. **Be sure to subscribe to receive monthly newsletters, blogs, and FREE activities.**

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Feel free to contact me if you have questions or comments or would like to discuss a staff development training or keynote address at your site.

Happy teaching,
Brad