## *Coordinate Graph Curriculum ©2010*

### *Age(s): Lower Elementary & Upper Elementary (7-12 years)*

### *Description:*

The Coordinate Graph Curriculum was designed to introduce students to the basic concepts of the coordinate graph (i.e., coordinates) to the more complex concepts of the linear equation (i.e., solving, writing, and graphing equations). The 3-Level Command Cards (with varying shades of green to indicate the Level) allow for multiple lessons and activities of work. Students begin plotting simple coordinates and work their way through the identification of quadrants, y-intercepts, positive & negative slopes, the formula for lines and slope, and the elementary basics of algebra (linear equations and inequalities).

### *Materials Included:*

- 19"x 19" Coordinate Graph
- 3-Level Command Cards (56 cards)
- Nomenclature Cards
- 24 colored wooden markers (10 red, 10 teal)
- Drawstring Bag
- Cord ( 2- 20" length cords)
- Curriculum Guide

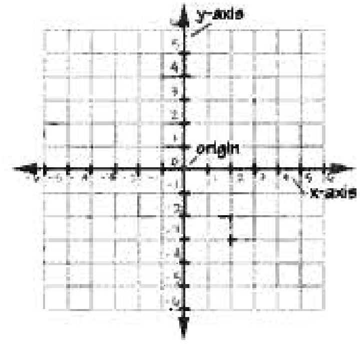
### *Presentation I: Introduction to Coordinate Graph & Plotting Coordinates*

***Begin the Introduction to Coordinate Graph Curriculum*** by introducing student(s) to the history behind the Coordinate Graph. Please feel free to your own "story"- Montessori style.

*The idea of graphing with coordinate axes dates all the way back to Apollonius in the second century B.C. Rene Descartes, who lived in the 1600s, gets the credit for coming up with the two-axis system we use today. The story goes that as he lay in bed one evening, he began watching flies crawl over the square tiles on the ceiling. He realized that he could describe a fly's position using the intersecting lines of the tiles. The system is often called the "Cartesian coordinate system" in his honor. The development of the Cartesian coordinate system enabled the development of calculus by Isaac Newton and Gottfried Wilhelm Leibniz.* There have been m*any other coordinate systems developed since then, such as the polar coordinates for the plane, and the spherical and cylindrical coordinates for three-dimensional space.*

*When working with equations that have two variables, the coordinate plane is an important tool. It's a way to draw pictures of equations that makes them easier to understand.*

*To create a coordinate plane, [have students draw the parts of the coordinate graph system on their own graph paper and label] start with a sheet of graph or grid paper.*




*[1] Draw a horizontal line. This line is called the x-axis and is used to locate values of x. To show that the axis actually goes on forever in both directions, use small arrowheads at each end of the line. Mark off a number line with zero in the center, positive numbers to the right, and negative numbers to the left.*

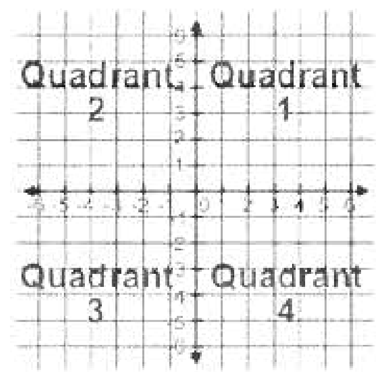
*[2] Next draw a vertical line that intersects the x axis at zero. This line is called the y-axis and is used to locate the values of y. Mark off a number line with zero in the center, positive numbers going upwards, and negative numbers going downwards. The point where the x and y axes intersect is called the origin. The origin is located at zero on the x axis and zero on the y axis.*

*[3] We can locate any point on the coordinate plane using an ordered pair of numbers like the example shown here, the ordered pair 3 and 1 (point P). We call the ordered pair the coordinates of the point. The coordinates of a point are called an ordered pair because the order of the two numbers is important.*

*The first number in the ordered pair is the x coordinate. It describes the number of units to the left or right of the origin. The second number in the ordered pair is the y coordinate. It describes the number of units above or below the origin. To plot a point, start at the origin and count along the x axis until you reach the x coordinate, count right for positive numbers, left for negative. Then count up or down the number of the y coordinate (up for positive, down for negative).*

*For example, to graph the point P above, with the ordered pair (4, 2) we count right along the x axis 4 units, and then count up 2 units. Be careful to always start with the x axis, the point (4,2) is very different than the point (2,4).*

*[4]To make it easy to talk about where on the coordinate plane a point is, we divide the coordinate plane into four sections called quadrants.*




***Activity Follow-Up & Extentions:***

1. Have students read through the Coordinate Graph Nomenclature Cards and practice matching Nomenclature (3-Part) Cards.
2. Either with Coordinate Graph or graph paper, call out some coordinates for them to plot. Ask the students to name the quadrant the coordinate is located in.
3. Have Students begin Command Cards Level A (light green).

## *Presentation II: Graphing Equations*

*In the previous lesson, you learned how to graph points on the coordinate plane. We can connect two points with a straight line.*

*To graph the equation of a line, we plot at least two points whose coordinates satisfy the equation, and then connect the points with a line. We call these equations **"linear"** because the graph of these equations is a straight **line**.*

*There are two important things that can help you graph an equation, slope and y-intercept.*

### ***Slope***

*We are familiar with the word "slope" as it relates to mountains. Skiers refer to "hitting the slopes." On the coordinate plane, the steepness, or slant, of a line is called the slope. Slope is the ratio of the change in the y-value over the change in the x-value. Carpenters and builders call this ratio the "rise over the run." Using any two points on a line, you can calculate its slope (its steepness or slant) using this formula. :*

$$m = \frac{\text{change in y-value}}{\text{change in x-value}}$$

*[1] Have students choose 2 points on the coordinate graph. Tell the students that these 2 points can be connected to create a line. Have the student(s) connect the 2 points (either using a ruler with graph paper or the cord with the Coordinate Graph). Remind students that lines can go on forever, and that as such, we should indicate this with arrows at the end of each line.*

*Let's use these two points to calculate the slope m of this line. We will call one point A, and the other B.*

1. *Subtract the y value of point A from the y-value of point B to find the change in the y value.*
2. *Then subtract the x value of point A from the x value of point B to find the change in x.*
3. *Now divide the change in y-value by the change in the x-value.*

*[2] Have students use the equation and process above to calculate the slope of their 2 coordinates. Have them use the slope to complete more points on the line.*

*When a line has **positive slope**, like this one, it rises from left to right. **A negative slope**, falls from right to left.*

*[3] Have students note whether or not their line has a positive or negative slope.*

### ***Y-Intercept***

*There's another important value associated with graphing a line on the coordinate plane. It's called the **"y intercept"** and it's the y value of the point where the line intersects the y- axis. [4] You can locate the y-intercept by looking at the graph and* *seeing which point crosses the y axis. This point will always have an x coordinate of zero. This is another way to find the y-intercept, if you know the equation, the y-intercept is the solution to the equation when $x = 0$.*

***Equations***

*Knowing how to find the slope and the y-intercept helps us to graph a line when we know its equation, and also helps us to find the equation of a line when we have its graph. The equation of a line can always be written in this form, where m is the* ***slope*** *and b is the* ***y-intercept****:*

$$y = mx + b$$

*To find the equation for this line you must locate the y-intercept and the slope. We have already discovered the slope and located the y-intercept. [5] Have students input their slope and y-intercept into the equation.*

*The line shows the solution to the equation: that is, it shows all the values that satisfy the equation. If we substitute the x and y values of a point on the line into the equation, you will get a true statement. [6] Have student(s) try this. Choose a coordinate from the line and see if the numbers make the equation a true statement.*

*You can graph a linear equation two ways. (1) You can find the y-intercept and the slope within the equation. So if you plot the y-intercept, you can use the slope to plot another coordinate and graph the line. Or (2) you can solve for x.*

*To solve for x, it can be useful to utilize a chart like this:*

| $x$ | $y$ |
|---|---|
| | |
| | |
| | |

*[7] Have student(s) graph the equation both ways:* $y = x + 1$

## *Activity Follow-Up & Extentions:*

4. Have students begin Command Cards Level B (medium green)
5. Have students create their own coordinates, plot them, connect them, and write an equation for the line.

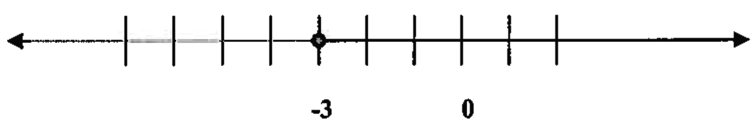
***Presentation IV:*** ***Solving Inequalities***

*Inequalities can be graphed on both number lines and coordinate graph systems. In mathematics, an* ***inequality*** *is a statement about the relative size or order of two objects, or about whether they are the same or not.*

- The notation $a < b$ means that $a$ is **less than** $b$.
- The notation $a > b$ means that $a$ is **greater than** $b$.
- The notation $a \neq b$ means that $a$ is **not equal to** $b$, but does not say that one is greater than the other or even that they can be compared in size.
- The notation $a \leq b$ means that $a$ is **less than or equal to** $b$ (or, equivalently, **not greater than** $b$)
- The notation $a \geq b$ means that $a$ is **greater than or equal to** $b$ (or, equivalently, **not smaller than** $b$)

On the number line we can graph the inequality like this:

$x < -3$



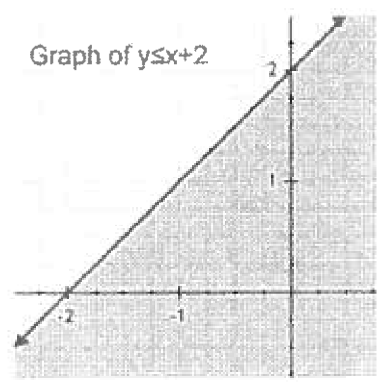

*On the coordinate graph, we can also graph this inequality. [1] Have student(s) use graph paper or the Coordinate Graph to plot several points whereby the inequality statement remains true.*

***First*** *you must solve the inequality for y. Pretend that the inequality sign is equal to =.*

$y - x \leq 2$ becomes $y - x = 2$

*****Only y and x cannot be on the same side of the equal sign.***

$y = x + 2$




***Second,*** solve *the equation and graph.*

***Finally,*** *determine where to shade on the graph. Choose a point on either side of the line and plug it back into the original equation. If you simplify and end up with a true inequality shade on this side of the line. If you get a false inequality shade on the other side of the line.*

***Activity Follow-Up & Extentions***

1. Have students complete Command Cards Level C (dark green). Have students use colored paper to shade the appropriate side on the inequality line graph.
2. Have students make up their own inequalities and graph on graph paper, shading in the areas.