“Pizza & Perpendicular Lines”

**Authors Name(s):** Anthony Finelli, Heather McNeill

**Teaching Partner(s):** Anthony Finelli & Heather McNeill

**Date of Lesson:** 3/18/2011 – 3/21/2011

**Length of Lesson:** 100 minutes (2 periods)

**Grade:**  9-12

**Course:** Algebra 1A

**Difficulty of Lesson:** Remedial

**Topic:** Perpendicular Lines

**Source of the Lesson:** N/A

**FLORIDA SUNSHINE STATE Math STANDARDS (SSS) ADDRESSED:**

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| **Benchmark Number** | **Descriptor** |
| MA.912.G.1.4 | Use coordinate geometry to find slopes, ~~parallel lines~~, perpendicular lines and the equations of lines. |
| MA.912.A.3.10 | Write an equation of a line given any of the following information: two points on the line, its slope and one point on the line, or its graph. Also, find an equation of a new line ~~parallel~~ to a given line, or perpendicular to a given line, through a given point on the new line. |

The process skill that will be addressed in this lesson is communication. Students will be expected to communicate with each other and the teacher throughout the two-day lesson.

**Concept(s):** When two linear equations have slopes whose product is -1 then the two lines are perpendicular. A more common way of saying this is when the slopes are opposite reciprocals of one another. The point at which these two lines cross will be the intersection point of the two lines and the lines will make a 90° angle with one another. If the slope of a line is m, then the slope of all perpendicular lines to the original line will be -1/m. The y-intercepts of perpendicular lines are not related or dependent on each other in any way. Something to note is that because lines are infinite two lines can still be perpendicular even if they don’t visibly intersect on the graph if their slopes are opposite reciprocal. Additionally, since this above description does not cater the case of horizontal and vertical lines, the definition also includes that all horizontal and vertical lines are perpendicular to one another even though their slopes are not opposite reciprocals.

Page, John. "Perpendicular Lines. (Coordinate Geometry) - Math Open Reference." *Table of Contents –*

*Math Open Reference*. 2009. Web. 31 Mar. 2011. <http://www.mathopenref.com/coordperpendicular.html>.

**Materials List and Advanced Preparation:**

Smart Board

Smart Board documents for each of the student worksheets and entrance and exit slips.

PowerPoints for Smart Board

24 sheets of graph paper for practice problems. (1 per student)

8 copies of “Factory Slices” (Engagement) (1 per group)

24 copies of “Pizza by the Slice” (Exploration) (1 per student)

24 copies of “Additional Factors?” (Explanation) (1 per student)

24 entrance and exit slips for each day. (1 per student)

24 game packets. (1 per student)

Name tags with students’ names written on them

Groups of students need to be created prior to the class period. (groups of 3)

The desks need to be arranged in clusters, keeping in mind the location of the students who returned waivers to be off camera.

Journal (1 per student)

**Performance Objectives:**

Students will be able to:

- Identify graphs of perpendicular lines.

- Formulate the equation of a line perpendicular to a given line at a given point.

- Communicate ideas to one another professionally.

**Safety Considerations:** There are no safety considerations for this lesson.

**5E Lesson:**

**Entrance Slip Time: 5 minutes**

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| **Engagement Time: 12 minutes** | | |
| **What the Teacher Will Do** | **Probing Questions and Directions** | **Student Responses/Possible Misconceptions** |
| As the students enter the classroom the teacher will instruct the students to find their name tag on their desk and to sit with their “company”. (The desks will be in groups.) The groups need to create a company name they will use throughout the lesson.  The teacher will catch the class up with what has happened and what decisions have already been made in the unit plan regarding the creation of their pizza joint. Inform the class that there is only one decision left to be made, figuring out how our chefs will need to slice the pizzas when they come out of the oven.  Let’s think about other food items and how they are sliced. Ask the class for different food items and how they get sliced.  Distribute “Factory Slices” worksheet to each company. Instruct the companies that they are to each come up with a way to cut their pizza into four slices (don’t mention the word equal). Each student will slice their own pizza. (Inform the students that they all have to cut differently from one another.) Then as a group the company will jointly decide on a different way to slice the pizza. Instruct the students that they have 5 minutes to complete this task. Instruct the students that once each group member has cut their pizza the group is to turn the paper over and decide on one way they want to cut their pizzas. (The most efficient, most creative, etc. way)    The teacher will then call on one student from each group to present one way they decided to cut their pizza. The student may choose to present any of the four ways on their group’s paper. While looking at the different cuts start a discussion about advantages and disadvantages to different cutting techniques. | What foods can you come up with that people cut or slice?  How are these items cut? (Besides with a knife!)  Why do we cut different foods differently?  Is it that it is more efficient? More appealing to the eye?  Easier to serve?  Why did you decide to slice your pizza this way?  What’s the advantage of cutting it this way? (point to example of perpendicular cuts) | Oranges, cake, pizza, pan of brownies, pie, tomatoes, casserole dish, apples  Into square pieces, wedges, slices, etc.  Varied answers.  It looks cool.  That’s how it’s always done.  Equal size, the slices can be sold at the same price. |
| **Exploration Time: 20 minutes** | | |
| **What the Teacher Will Do** | **Probing Questions and Directions** | **Student Responses/Possible Misconceptions** |
| Pass out “Pizza by the Slice” to each student and instruct the students that they have some of the most popular pizza sizes on their paper and they need to figure out from the one cut already given where they should make the second cut. As a class we will discuss the medium pizza. [It is centered at (3,4) and has a slope of 3.]  Tell the class that the first cut across the entire pizza is given and they need to make the next cut to give the pizza four equal slices.  [Opportunity for a mini lesson if the students need reinforcement with slope, lines or graphs. Devote potentially 5 minutes to this.]  Now you are going to work on the small pizza. Try to find a cut that is perpendicular. If you need help ask a fellow employee. If you still can’t get it raise your hand. Once you have found the cut that is perpendicular, find the equation of both.  Leave the students to work on their own as the teacher circulates throughout the classroom helping individual students.  If time permits, instruct students to attempt the large pizza.  Once the students think they have cut each pizza evenly ask them to look at the equations they came up with and to look for any similarities, patterns, differences. Have students work with each other in their company. | How should we make our second cut? Why?  Why do you think those slices are of equal size?  What is the equation of our given slice?  What is the equation of our new slice?  What do you notice about these lines, these points?  How do we use the given information to find out where to cut our next slice so that all our pieces are equal? | Perpendicular to the first slice, that way they will be equal.  Because they look like it, the lines are perpendicular.  y= 3x -5  y= -1/3x + 5  We can find the slope of the line and the equations of the lines.  Find the slope of the first slice and then create another line that is perpendicular. |
| **Explanation Time: Day 1: 15 min + Day 2: 30 minutes = 45 minutes** | | |
| **What the Teacher Will Do** | **Probing Questions and Directions** | **Student Responses/Possible Misconceptions** |
| Get the attention of the class and begin a whole class discussion about what each person found. Ask specific people in different groups to share what equations they decided to use when dividing their pizza.  Question students (want students to discover that the slopes of perpendicular lines are negative reciprocals.)  Pass out exit slip. 10 min.)  Collect name tags.  Instruct students to take a few minutes to write in their journal, reflecting on the day’s lesson. The teacher then collects the journals. (Since it’s Friday.)  **END OF DAY ONE**  Day 2: 100% dependent on how far the teacher got in Day 1. The teacher may have to back track to an earlier part in the explanation.  As students walk in hand them their entrance slip and ask that they go sit in their groups and put on their name tag. Students will be assessed on their knowledge of the equations of horizontal and vertical lines. (Allow 5 minutes for entrance slip.)  As a class go over the entrance slip and collect the papers.  Have a class discussion/debate on the answers and explanations for questions 2 and 3.  [Insert a mini lesson if need be regarding the equations of horizontal and vertical lines and the idea that lines are infinite.] (5 min.)  The teacher will pull up the PowerPoint with a slide of examples and non-examples of equations of perpendicular lines. (7 min.)  Go to the next PowerPoint slide and have students write down their current definition of way to see if two lines are perpendicular. The teacher will then ask for student volunteers to help with the next slide, graphing two perpendicular lines.  The teacher is to now instruct the class that they are going to put their newly formed definition to the test.  The teacher will pass out “Additional factors?” which covers horizontal and vertical cuts.  Students are to find what equation they should use to cut a pizza into four even pieces when the first cut is a horizontal line.  Ask the class about what they found on “Additional Factors?”.  (13 min.)  The teacher goes to the next slide on the PowerPoint and has students come to the SmartBoard to demonstrate on the graph of the pizza.  On the next slide of the power point the teacher asks the class for their modified definition of the equations of perpendicular lines. | What company would like to share with the class where they decided to divide their small pizza? (Draw a line on the document on the Smart Board.)  And why did you decide to slice your pizza there?  What are the two equations of your lines?  Address the class – Did any other company choose to cut this way?  What do you guys think about this choice? Why?  What are the equations for the two slices?  Looking at both our small and medium pizzas, what do you notice? Any patterns?  What is your slope for each line?  What is your y-intercept for each line?  Is the slope ever the same? What can we say about the slopes?  Is the y-intercept ever the same? What can we say about the y-intercepts?  So how do we know if two lines are perpendicular?  I am now passing out an exit slip; spend the rest of the period filling this out.  **END OF DAY ONE**  Who would like to answer the first question on the entrance slip?  What did you come up with? Why do you say that?  What do you notice?  What are the slopes?  What are the y-intercepts?  Must the slopes/y-intercepts be the same for the lines to be perpendicular?  What do you notice about the slopes? Why do you say their similar?  From this activity, what can we say about perpendicular lines? How might we define it?  Who would like to answer the first question on “Additional Factors?”  When dealing with horizontal and vertical lines are we able to make perpendicular cuts? Why or why not?  What was our definition, again?  Does this (horizontal and vertical lines) line up with our definition of perpendicular lines? How did we define perpendicular lines?  Well what is the slope of our horizontal line?  What is the slope of our vertical line?  Are these two slopes opposite reciprocals? But you told me they look perpendicular… Actually, there is one more part to the definition of perpendicular lines and it relates to this very scenario. All horizontal and vertical lines are perpendicular to each other. | Varied answers.  Varied answers.  Yes/No.  Students could think that there is only one ‘right’ way to slice the pizza.  The slopes.  [m= 3 m= 1, etc. Students could present incorrect answers.  [b= 5 b= -5, etc.] Students could present incorrect answers.  Nope. They are similar. One is always positive and the other is always negative.  Yes, sometimes.  It changes.  The slopes of the two lines are negative reciprocals.  **END OF DAY ONE**  y=2, y= -5, x= -4  The lines look similar.  Varied answers.  Varied answers.  No, the slopes look similar, but aren’t the same. The y-intercepts are the same sometimes and not the same other times.  They are opposite sign and the fraction is flipped.  Perpendicular lines are lines whose slope is opposite reciprocal.  Perpendicular lines are lines that intersect.  The slopes must be opposite reciprocals and the y-intercepts must be the same.  x = 1  Yeah, why not?  The slopes of the two lines are negative reciprocals.  Ohh, I guess it doesn’t. The slopes of the two lines are negative reciprocals.  Zero.  Undefined.  Yes/No. |
| **Elaboration Time: 5 minutes** | | |
| **What the Teacher Will Do** | **Probing Questions and Directions** | **Student Responses/Possible Misconceptions** |
| The teacher will distribute a game packet and provide written and verbal instructions. After each bracket the students will switch papers.  The teacher will allow one and a half minutes for each part of the question. When students are waiting until it is time to switch papers, they are to sit quietly. Teacher will put instructions for the game on the board. |  |  |
| **Evaluation Time:10 minutes** | | |
| **What the Teacher Will Do** | **Probing Questions and Directions** | **Student Responses/Possible Misconceptions** |
| Pass out section assessment (disguised as an exit slip).  The teacher will pass out student journals and instruct students to take a few minutes to write in their journal, reflecting on the day’s lesson. |  |  |

Entrance Slip Day 1: Name:

With your fellow employees, create a company name for your pizza joint.

What number multiplied by 4 equals 1?

Hint – write this question using math letters, symbols and numbers.

What number multiplied by 2/5 equals 1?

Hint – write this question using math letters, symbols and numbers.

Exit Slip Day 1: Name:

List at least one question or thing you are unsure about from today’s lesson.

State what you know about the slope of perpendicular lines?

List a perpendicular line to this line. y= (-1/2)x+5

Explain why these two lines are perpendicular.

Describe how your experience was working with your group. What worked well and what was challenging?

Entrance Slip Day 2:

Write the equations of each of the three lines.

Does the blue line intersect the red line? Explain.

Does the red line intersect the green line? Explain.

“Additional Factors?” Name:

What must the next slice be to make four equal slices? Write the equation of the slice.

Does this fit our definition of what makes two lines perpendicular to one another? Explain.

Exit Slip Day 2: Name:



Are these lines perpendicular?

Explain with regards to the slopes of the lines.

Write 3 different equations of lines that are perpendicular to y = -3x – 7.

Explain how you can tell if two lines are perpendicular to each other if you are only given the equations of the lines.

The slope of all horizontal lines is zero and the slope of all vertical lines is undefined, are vertical and horizontal lines perpendicular to one another? Why or why not? Does this fit our description of the equations of perpendicular lines?

What do you know about the slopes of perpendicular lines?

Describe how your experience was working with your group. What worked well and what was challenging? Were you able to resolve your problems from the day before?

**“Factory Slices”**

**Company Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Each student must write their name on a pizza and then cut their pizza. Each pizza must be cut in a different way so that they each have 4 pieces.**



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’s

Pizza

**“Pizza by the Slice”**

**Your name, company name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 Small Pizza

Draw the second cut.

Write the equations of the two cuts.



Medium Pizza

Draw the second cut.

Write the equations of the two cuts.

Large Pizza

Draw the second cut.

Write the equations of the two cut.

**“Factory Slices” (Cont.)**

**Now as a company, decide one common way that the company wants to cut their pizzas. Use two cuts to create four pieces of pizza.**

y = - ⅔x – 2

1a.)What is the slope of the given line?

1b.)What will the slope be of a line

perpendicular to the given line?

2.) Write an equation of a line that is

perpendicular to the given equation.

3.)Graph the two lines.

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



y = 3x + 1

1a.) What is the slope of the given line?

1b.) What will the slope be of a line

perpendicular to the given line?

2.) Write an equation of a line that is

perpendicular to the given equation.

3.) Graph the two lines.

y = ½ x – 5

1a.) What is the slope of the given line?

1b.) What will the slope be of a line

perpendicular to the given line?

2.) Write an equation of a line that is

perpendicular to the given equation.

3.) Graph the two lines.