**Lesson Title:** Slope of Perpendicular and Parallel Lines in Geogebra

**Unit Title:** Slope of Linear Equations

**Teacher Candidate:** Elizabeth Huff

**Subject, Grade Level, and Date:** Algebra 1, 9th Grade, 10/23/2014

**Placement of Lesson in Sequence**

This is the lesson after the students learn about slope and graphing linear equations. The students have just learned how to find slope by counting out the units for rise over run and using the y-intercept. They know how to get an equation into function form *y=mx+b*. In the previous lesson, the students learned how to pick out the slope as *m* and the y-intercept is *b*, and then graph using that information.

**Central Focus and Essential Questions**

In this activity the students will be able to practice plotting more y-intercepts and slope and then find out if the slopes of two equations are perpendicular, parallel, or neither. The students will use the online technology Geogebra to further their understanding of perpendicular and parallel lines. The central focus of the lesson is to have the students get more practice in manipulating equations into slope-intercept form, and with that learning about the properties of lines. The students will work together to determine whether two lines are perpendicular or parallel by graphing their lines in Geogebra.

**Content Standards**

* Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
* Students use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. Students recognize equations for proportions (*y*/*x* = *m* or *y* = *mx*) as special linear equations (*y* = *mx* + *b*), understanding that the constant of proportionality (*m*) is the slope, and the graphs are lines through the origin.

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| **Learning Outcomes** | **Assessment** |
| The students will need to be able to apply their knowledge of using the slope-intercept form to graph an equation of a line. They will learn the definition of perpendicular and parallel lines and graph them on a single coordinate plane. Students will use the online program Geogebra to model their understanding of slopes of a system of linear equations. | The formative assessment will be assessed using the Geogebra program and the worksheet that accompanies the activity. The teacher will move around the classroom to check on the pairs of students to confirm that they understand the properties of perpendicular and parallel lines. The teacher will ask inquiring questions about how they know if lines are parallel or perpendicular and ask the students to justify their answers. Students will do work in pairs, each taking turns controlling the Geogebra program to get practice using the technology. Each student will have their own worksheet to turn in with their own justifications. During the last few minutes of class the students will turn in an exit slip that asks them to create their own system of equations. They will need to create a set of perpendicular lines and a set of parallel lines. The students creating their own equation shows that they are able to put their knowledge of linear equations together rather than just looking at something already in front of them. The exit slip will determine if the students are ready to move on to the next section of the chapter. |

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| **Learning Targets** | **Student Voice** |
| I can find the slope and y-intercept of a linear equation. I can use technology to graph a linear equation using slope and a y-intercept. I know what parallel and perpendicular lines are. I can create my own equations for parallel and perpendicular lines. | The teachers will state the learning target on the classroom’s white board. Students will confirm that they have met the learning target by having their Geogebra graphs checked off by the teacher and printed; their worksheets will turned in to be graded also. When the teacher comes around to check on the pairs, they will ask facilitating questions to give the students the chance to use student voice. The students should be able to explain their reasoning for how they know if lines are parallel or perpendicular. The worksheet will give the students the opportunity to justify their reasoning of whether they think what kinds of lines they are graphing. This gives them the chance to use mathematical syntax. |

**Prior Content Knowledge and Pre-Assessment**

The students have worked on graphing slope and y-intercepts by hand in the previous lesson. They know the slope-intercept form for linear equations as *y=mx+b*. They know that the slope is *m* and the y-intercept is *b.* In the introduction of this lesson, the students will get the chance to learn how to graph linear equations in Geogebra. The linear equations will be in slope-intercept form to assess their knowledge of the previous content.

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| **Academic Language Demands** | | |
| **Vocabulary & Symbols** | **Language Functions** | **Precision, Syntax & Discourse** |
| * Slope * Y-Intercept * Parallel * Perpendicular * Coordinate Plane * Linear | * Be able to explain verbally how they know a system of equations is parallel * Be able to explain verbally how they know a system of equations is perpendicular * Justify by writing reasoning using correct mathematical syntax | **Mathematical Precision:** Students must be able to correctly apply their mathematical knowledge. Students will first get the linear equations into function form and then find the slope and y-intercept. The students will make sure to plot the points correctly on the coordinate plane in Geogebra. The system of linear equations is graphed on one coordinate plane.  **Syntax:** Students must be able to use the correct mathematical terminology in their verbal and writing explanations. Discover the definitions of perpendicular and parallel and relate them to a graph.  **Discourse:** Discuss what each pair found out about each system of equations. Explain their reasoning of why they think that the lines are parallel, perpendicular, or neither. |

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| **Language Target** | **Language Support** | **Assessment of Language Target** |
| I can justify why two lines are parallel, perpendicular, or neither. | I can share my why I think two lines are parallel, perpendicular, or neither. I can explain the difference in the slope of parallel lines and perpendicular lines. | I can explain how I know two lines are parallel, perpendicular, or neither by telling the teacher and my partner and writing it on the worksheet. |

**Lesson Rationale (Connection to previous instruction and Objective Standards)**

In the previous lesson the students were introduced to the slope-intercept form, *y=mx+b*. Since the next units in the book rely heavily on graphing linear equations, a good knowledge base is needed. The students in Algebra A are low achieving in mathematics, so they need more time working on certain topics. Using Geogebra will give the students the chance to do something different in class besides just taking notes and doing homework. Working on the computers will keep them from being bored. The students will be able to add to their previous knowledge of slope by learning about parallel and perpendicular lines. Graphing linear equations on a computer will make the graphing process faster and they will solidify their concept knowledge by getting to do more problems.

**Differentiation, Cultural Responsiveness and/or Accommodation for Individual Differences**

The lesson is for the Algebra A class. Algebra A is constructed at a slower pace to give low achieving students the chance to better learn math concepts. One year of Algebra 1 is spread out over two years in Algebra A and B for these students. The students have the opportunity to spend more time on certain concepts. The students need to be reminded of definitions and core concepts constantly. The students gravitate to working on homework in pairs, so when working on the computer, they will also work in a pair. Directions need to be explicit and written on the board. Students get distracted easily and it will help the teacher to not have to keep repeating the activity’s directions. To keep the students on task the teacher needs to visit each pair of students to make sure they are working on the appropriate assignment. The parent of one of the students has asked for more individual attention because they have a hard time focusing. So, to help this student, it would be beneficial for them to sit at the front of the room.

**Materials – Instructional and Technological Needs (attach worksheets used)**

For this lesson, the teacher must have access to a computer lab. There must be enough computers for each pair of students. The computers must have the mathematical program, Geogebra, installed on them. The computer lab needs to have access to a printer. Each student needs a worksheet and a pencil.

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| **Teaching & Instructional Activities** | | | |
| **Time** | **Teacher Activity** | **Student Activity** | **Purpose** |
| 10 Mins | Entry Task | The students will work individually to solve these problems by finding the slope and y-intercept. The teacher will then show the students how to graph the equation using the slope and y-intercept using Geogebra. The students will work along with the teacher on graphing the line in Geogebra.   1. y= 2x + 4 2. 4x – 3 = 2y | To review previous material.  The teacher will go over each problem and explain the steps on how to do each problem after asking if the students know the steps and answers. The teacher also will have the students follow along in Geogebra, learning how to plot points and connecting them with line tools. |
| 5 Mins | Directions to activity and getting into groups | The students will move into pairs while the teacher passes out one worksheet per student. The teacher will explain the activity to the students and have them print out all of their Geogebra constructions to turn in. Each student must work with a partner, but have their own worksheet and justifications to turn in. | To prepare for the activity and explain what the groups will be doing. |
| 20 Mins | Geogebra Activity:  Perpendicular and parallel lines worksheet | Students will work in Geogebra to complete the worksheet while the teacher moves around the room to facilitate groups.  Part 1:   1. *2x + 2y = 8*   y = -x +4  Slope: -1  y-intercept: 4   1. *-3y = 6 – 12x*   y = -2 + 4x  Slope: 4  y-intercept: -2   1. *2/3x = y – 5*   y = 2/3x + 5  slope: 2/3  y-intercept: 5  Part 2:   1. *4y = 2x + 4*   *-1/2x = 3 – y*  Parallel: The slopes of the two lines are the same.   1. *3y -1 = -12x*   *1/4x –y = 2*  *Perpendicular: One slope is the negative reciprocal of the other slope. The graph shows that the lines intersect at a 90 degree angle.*   1. *5x + 3y + 7 = 0*   *-x + 6 = y*  *Neither. The slopes cannot be compared and do not have the properties of perpendicular or parallel lines.* | To practice graphing linear equations and determining whether two lines are parallel, perpendicular, or neither. They also get more practice using Geogebra.  The teacher must move around the room to facilitate groups while they use Geogebra. With the students the teacher will ask the students what they have found out about the pairs of lines. This is to get them to explain their process and what they know about the properties of parallel and perpendicular lines. They must relate the numeric equations and the graphic representation to make connections. |
| 5 Mins | Exit Slips | The students will be asked to create their own pairs of perpendicular and parallel lines on their own sheet of paper. | The students will work individually on the exit slips, which will not be graded. The purpose is to see how many students know how what the properties of parallel and perpendicular lines. The teacher will be able to know if the students have achieved the learning objective fully. |
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