Lab Framework

Text:CORD Classic
Unit number and title:Unit 11 - Using Signed Numbers and Vectors
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Lab Title

Vector Addition and Subtraction

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Short Description: This lab illustrates how using a dynamic geometrical representation can help students develop an understanding of vectors and their properties, as described in the Unit 11 CORD. Students manipulate a two vectors to control the movement of a plane in a gamelike setting using an online tool. Students extend their knowledge to further investigate the system of vectors.

LAB PLAN

TEACHER: Teacher Prep/ Lesson Plan

- **Lab Objective**
  Use a dynamic geometric representation to develop an understanding of vectors and their properties
- **Statement of pre-requisite skills needed** (i.e., vocabulary, measurement techniques, formulas, etc.)
  Students must understant signed numbers and angles, coordinate systems, working with lines and angles, internet and computer keyboard.
- **New Vocabulary**
  Vector, scalar, direction, magnitude.
- **Materials List**
  This lab must be taught in a classroom which has computers and an internet connection. In addition, it helps immensely if the computers are integrated using a system such as the Vision Classroom Management System (www.genevalogic.com). In addition, the lab requires the use of the Java applet at http://illuminations.nctm.org/ActivityDetail.aspx?ID=43.
- **GLEs addressed**
  Math:
  1.2.2 - Understand and apply rate and other derived units of measure.
  1.3.1 - Understand the properties of and the relationships among 1 dimensional, 2 dimensional, and 3 dimensional shapes and figures. W
  1.3.2 - Use the properties of and relationships among 1 dimensional, 2 dimensional, and 3 dimensional shapes and figures including prisms, cylinders, cones, and pyramids. W
  1.3.3 - Use geometric properties to determine and plot points on a coordinate grid. W
  1.3.4 - Apply multiple transformations – translations, reflections, and/or rotations to 2 dimensional figures. W

  Reading:
  2.2 Understand and apply knowledge of text components to comprehend text.

  Writing:
  3.3 Knows and applies writing conventions appropriate for the grade level.

- **Leadership Skills**
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1.4 The student will be involved in activities that require applying theory, problem-solve, and use critical and creative thinking skills while understanding outcomes of related decisions.

2.1 The student will communicate, participate, and advocate effectively in pairs, small groups, teams, and large groups in order to reach common goals.

- **SCAN Skills**

Writing

B. Records information completely and accurately.

Arithmetic

A. Performs basic computations

B. Uses basic numerical concepts such as whole numbers and percentages in practical situations

Mathematics

C. Expresses mathematical ideas and concepts orally and in writing

Listening

A. Receives, attends to, interprets, and responds to verbal messages and other cues such as body language in ways that are appropriate to the purpose

Reasoning Skills

Creative Thinking- Uses imagination freely, combines ideas or information in new ways,

makes connections betwe

- **Set-up information**

Ensure that the students are able to connect to the Internet. Building on the experiences students had with a single vector in the lesson, this lab introduces a second vector, representing the velocity and direction of the wind, and asks them to consider how the two vectors combine to affect the movement of a plane.

Students are allowed a more formal look at vector addition by showing the vector representing the sum of the two velocity vectors. Students can see how changes in one of the summands affect the sum; for example, as the angle of the red vector is increased, the angle of the sum vector also increases. However, the relationship between the summands and the sum is not easily seen unless the summands have the same angle measure (in which case the lengths are added) or inverse measures (in which case the lengths are subtracted).

Students will also be able to notice that vectors with opposite directions and the same magnitude cancel each other out. In other words, when added, they result in the identity, implying that they are inverses of each other. Likewise, students should note that if the values of the two vectors are interchanged, the same sum results. Thus, vector addition is commutative.

To begin the lab, say to students, "Today, you will be directing an airplane, much as you directed the car in the previous lesson. You will use the Dual Vector Investigation Tool from Illuminations. In this applet, you will notice a red vector representing wind on the screen. Use the blue vector to direct the airplane to catch the hurricane. How does having a wind vector change the game?" [The wind pushes the plane off-course, so that its speed and direction are not determined by the blue velocity vector alone.] Allow students some time to play the game a few times.

Then, have them turn off the Show Hurricane feature befor exploring the questions below. (You can display these questions on the overhead projector; or, you can simply read the questions aloud to students one at a time.)

ß Turn on the Show Vector Sum option. A black sum vector will appear that cannot be directly controlled. Start the plane and move it around the screen using the red and blue vectors.

ß Look at various lengths and angles of the three vectors.

ß Using their midpoints, arrange the three vectors so that they form a triangle. Adjust the length of one of the vectors and again form a triangle. What does the triangle that is formed tell you about the relationships among the three vectors?

ß Adjust the red and blue vectors so that the plane is stationary. What do you notice about their directions and magnitudes? Find other values for the two vectors that keep the plane stationary.

To develop a conceptual understanding of vector addition, students can attempt the following investigations. During these explorations, students should notice that vector addition is commutative—that is, if the magnitude and direction of the red and blue vectors are interchanged, the magnitude and direction of the black vector stays the same; and, that if the red and blue vectors have equal magnitude but opposite direction, the plane is stationary.

ß Adjust the red vector so that its magnitude is 5 and its direction is 45°. Adjust the blue vector so that its magnitude is 3 and its direction is 90°. (Note that clicking the mouse inside each box will highlight the number, and students can enter a specific value for the magnitude or direction. Alternatively, students can approximate the values by dragging the vectors.) What are the magnitude and direction of the sum, displayed at the lower right of the screen?

ß Reverse the values so that the blue vector has magnitude 5 and direction 45°, and the red vector has magnitude 3 and direction 90°. Now what are the magnitude and direction of the sum?

ß Try interchanging other values for the red and blue vectors and make an observation. What do you observe? How does it relate to another property you've seen before?

Questions for Students

Pretend that you are able to control the wind. By adjusting the red wind vector, "blow" the airplane to catch the hurricane. Make one or more observations.

[The magnitude and direction of the red wind vector affect the path of the plane. If the wind is in the same direction as the blue vector, the plane travels in the same direction with increased speed. If the red and blue vectors point in different directions, the plane's speed is reduced and the direction of the plane is a result of some combination of the directions of the red and blue vectors.]

1. What relationship does the sum vector have to the plane? How does adjusting the red and blue vectors affect the sum vector?

[The magnitude and direction of the sum vector is a combination of the magnitude and direction of the red and blue vectors.]

2. Can you find a pattern? What happens when you increase the length of one of the vectors? Increase its angle? In what cases can you exactly predict the values for the sum vector from the values for the red and blue vectors?

[If the length of either the red or blue vector increases, the length of the sum vector will also increase. Likewise, if the angle of either the red or blue vector increases, the angle of the sum vector will also increase. If the direction of the red

and blue vectors is the same, then the magnitude of the sum vector will be equal to the sum of the magnitudes of the red and blue vectors; and if the direction of the red and blue vectors is exactly opposite, the magnitude of the sum vector will be 0.]

3. In what way does the sum vector represent a sum?

[It is equal to the combination of the red and blue vectors. That is, the horizontal dimension of the black vector is equal to the sum of the horizontal dimensions of the red and blue arrows. Likewise, the vertical dimension of the black vector is equal to the sum of the vertical dimensions.]

- **Lab organization**(-Grouping/leadership opportunities/cooperative learning expectations; -**Timeline required)**

  One class period 55 minutes long
- **Teacher Assessment of student learning** (scoring guide, rubric)

  Three questions.

  A - All questions answered correctly.

  B - Two questions answered correctly.

  C - One question answered correctly.
- **Summary of learning** (to be finished after student completes lab)

  -discuss real world application of learning from lab

  -opportunity for students to share/present learning

- **Optional activities**

  None.
- **Career Applications**

LAB TITLE:_____
STUDENT INSTRUCTIONS:

- **Statement of problem addressed by lab**

- **Grouping instructions and roles**

- **Procedures** – steps to follow/instructions

- **Outcome instructions**

- **Assessment instructions** (peer-teacher)

Lab Data Collection

Student: _____ Date: _____

Unit: _____

Lab Title:

Criteria: Write the problem/objective in statement form

Data Collection: Record the collected/given data

Calculations: Complete the given calculations to solve for an answer(s)

Summary Statement:

Other Assessment(s)