SPIRIT 2.0 Lesson:

Amazing Consistent Ratios

==========**Lesson Header** ==========

Lesson Title: Amazing Consistent Ratios
Draft Date: June 11, 2008
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Algebra Topic: Trig Functions
Grade Level: Secondary
Cartoon Illustration Idea: **A robot driving up a triangle with trigonometry jargon floating about?**

Outline of Lesson

Content (what is taught):

- Application of Trigonometric Functions
- Measurement, creation, and analysis of data
- Using mathematical modeling to make predictions using recognized/learned patterns

Context (how it is taught):

- The robot is driven up a ramp
- Measurements are taken relating to the robot's position
- Data collected is analyzed and patterns are discerned

Activity Description:

The robot will drive up a ramp at a set angle creating a triangle formed by the ground, a vertical leg from the ground to the center of the axle, and the ramp. The horizontal and vertical distances will be measured and the sloping side (hypotenuse) can be measured or calculated using the Pythagorean Theorem ($a^2 + b^2 = c^2$). These measurements will be recorded. The process will be repeated until sufficient data is collected. The data will be analyzed and the concept of consistent trigonometric ratios for similar angles will be derived.

Standards: (At least one standard each for Math, Science, and Technology - use standards provided)

Math
D1, E1, E2, E3

Science
A1, A2, F5

Technology
D1, D2, D3

Materials List:

Robot	Ramp
Meter Sticks/measuring tools	Calculators
String	Data Sheet

ASKING Questions (Amazing Consistent Ratios)

Summary: Students will be asked if there are any patterns or relationships in the triangles and how potential relationships could be measured and calculated.

Outline:

- Present several similar triangles on the chalkboard or overhead and ask students if there are any relationships present in them, guiding the discussion toward ratios of sides for the purpose of trigonometry
- Drive the robot up a ramp and show the triangles that it creates
- Ask students to design an experiment to collect data to explore possible relationships

Activity:

Discuss how the sides of similar triangles could be related by using templates or models of triangles. Drive a robot up a ramp and look at how if you stop it, the robot forms similar triangles.

Questions	Answers
What relationships are present in the sides of similar triangles?	The ratios of any 2 sides are the same as the ratio of the corresponding sides in any similar triangle.
How can you measure the sides of the triangles formed by driving the robot up the ramp?	The sides can be measured by using a meter stick. The vertical distance can be measured by using a string and then measure the string (non-elastic).
How can data relating similar triangles be created using a robot?	Drive the robot up a ramp with a fixed angle. Stop it several times along the ramp and measure each time.
What is important to consider in this experiment?	Measurement error, consistency in measurement, sufficient data points.

Image Idea: Picture of robot on the ramp with the right triangle that is formed highlighted.

EXPLORING Concepts (Amazing Consistent Ratios)

Summary: Students will drive the robot up the ramp stopping multiple times at different points to measure and record the sides of the triangles formed by the horizontal, vertical, and hypotenuse of the ramp.

Outline:

- Students will drive the robot up a ramp stopping it and measuring the sides of the triangle created.
- Students will record the data collected.
- The ramp angle can be changed and the process redone as many times as deemed necessary by the group (teacher)

Activity:

Working with the robot, students will build a ramp with a fixed angle to the ground. They will measure the angle and then drive the robot up the ramp varying the distance. Students will measure the horizontal and vertical components (and measure or calculate) the hypotenuse. The robot needs to be driven and measurements taken multiple times up the same ramp angle, creating data for several similar triangles. The wheels on the robot can be modified to increase traction, so it can climb steeper angles. The experiment can be repeated with different ramp angles to find multiple sets of similar triangles.

Students will analyze the data collected and consider what types of relationships are present in the similar triangles found in each experiment. They can investigate the quantity and quality of the data collected, and then begin to think about the validity of the experiment. To provide assessment of the quality of student work, ask yourself these questions:

1) Did students try different ramp angles to see if there are consistencies in many different groups of similar triangles?
2) Did students think clearly about how the data will be collected and how to measure properly, keeping in mind measurement error?
3) How did students measure the ramp angle and record the data collected relative to each group of triangles?

Image Idea: Picture of robot on ramp with possible ways to measure the sides of the triangle demonstrated.

Instructing Concepts (Amazing Consistent Ratios)

Filled in by math content writing team

ORGANIZING Learning (Amazing Consistent Ratios)

Summary: Students use data tables that show the angle, measured sides of the groups of right triangles, and the ratios of the sides.

Outline:

- Analyze the data collected previously
- Calculate the trig ratios of the sides of all triangles
- Explore and generalize about the nature of trig ratios in groups of similar triangles

Activity:

The data collected in the experiments designed by students will be organized in a chart in groups. The trig ratios learned will be calculated and labeled as sine, cosine, and tangent. This will need to be done for each set of similar triangles that were created and measured. The results need to be discussed and generalizations made about trig ratios in any set of similar triangles. An extension can be to look at the angle and how the trig ratios change as the angle increases or decreases. This would be a good time to explore the concept of percent error and allowable error in this type of experiment.

sara 6/23/08 3:24 PM

Comment: Will students already have an understanding of SohCahToa? YES That is the "I" piece.

Include sample chart to organize data (How is this?)

Angle of Ramp	Horizontal Measure	Vertical Measure	Hypotenuse Measure	Sine	Cosine	Tangent

UNDERSTANDING Learning (Amazing Consistent Ratios)

Summary: Students write a lab report to explain the experiment conducted and the relationships found.

Outline:

- Formative assessment of trig functions
- Summative assessment of trig functions

Activity:

Formative Assessment

As students are engaged in the lesson ask these or similar questions:

1) Are students able to apply trig ratios and explain how they relate to each other?
2) Can students explain the meaning of sine, cosine and tangent?

Summative Assessment

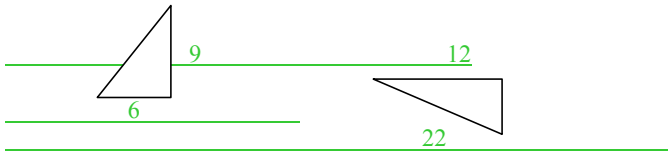
Students will be asked to write a formal lab write-up with the experimental procedure, the data, and the relationships calculated. They will then be given the sides of a right triangle and one side of a right triangle similar to the given triangle and calculate what the other two sides would be utilizing the trig ratios that have been learned.

Students will answer the following writing prompt:

1. Explain how the sides of similar right triangles are related using the concepts and mathematical terms learned in the lesson.

Students could answer these quiz questions:

1. The robot climbs a 5.7 feet along a ramp to a height of 3 feet. Calculate the sine, cosine, and tangent of the triangle.
2. Use the visual representation below to find the trig ratios for the triangles.



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sara 6/23/08 3:27 PM
Comment: Does Trig have to be right triangles? Or just any similar triangle? Yes and no Right triangle trig (sine, cosine and tangent) only work with right triangles but you can do trig in other triangles it is harder……

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