

Grade: 8th

Date: 7/14/08

Teacher: Mr. Tom Robertson

Unit: Mathematics

SCOS: Competency goals 3 and 5; non-routine problem solving

3.01 Represent problem situations with geometric models.

5.01 Develop an understanding of function.

Translate among verbal, tabular, graphic, and algebraic representations of functions.

Identify relations and functions as linear or nonlinear.

Find, identify, and interpret the slope (rate of change) and intercepts of a linear relation.

Interpret and compare properties of linear functions from tables, graphs, or equations.

Objectives:

Students will use Alice to help them describe, visualize, and solve a problem dealing with spheres. Students will explore the relationship between the circumference of a circle, distance a ball travels, and the number of rotations the ball must make in order to travel a certain distance. Students will develop a formula, which will allow a ball to "realistically" roll in the Alice world.

Resources & Materials:

PCs or MACs, data projector, computer lab sheet (attached), pencils, calculators, beach balls, lesson reflections

Key Terms:

circumference of a circle, diameter of a sphere/circle, π

Focus and Review:

Use a beach ball to talk about the different parts of a sphere. Have students recall the parts of a circle and how they relate to a sphere. They will need to know, diameter, radius, circumference of a circle, π . Briefly, have students roll the beach balls around the classroom, paying particular attention to the relationship between the distance a ball moves and the rotation of the ball.

Prior Alice Knowledge:

Students will need to be able to add an object, move, turn, roll, and resize an object, create a method and a function with teacher assistance.

Presenting the Problem:

Have students open an Alice world and place the toyball1 object in their world. Make sure that they pick a ball that will help them to visualize a rotation. Tell that the goal of this lesson is to make the ball roll as realistically as possible. Have students explore on their own the methods: move, turn, and roll. After a sufficient amount of time has passed, have students articulate the problem:

We want to create a method that will move the ball forward and have it rotate at the same time.

The movement of the ball must look as realistic as possible.

The method should work for any size ball and any distance we wish the ball to move.

Instructional Activities:

Overview of Lesson.

- students explore the movement of a toy ball using Alice
- students determine that **distance traveled** by the toy ball = **circumference of the circle X the number of complete revolutions** the toy ball makes
- students determine the algebraic equation, $t = \pi d \times v$, where t is distance traveled, πd is the circumference of the circle, v is the number of complete revolutions the toy ball makes
- students rewrite the algebraic equation to be used in Alice,
 $v = t \div (\pi d)$
- using our new formula in an Alice function to make the toy ball roll realistically.

Detail of Lesson.

Whole group-

The Teacher guides the students in creating a method called **realisticRoll**. The method should be created at the **toyball** class level. The method will allow the ball to **move forward 2 meters (as seen by ground) and turn forward 1 revolution**.

Independent or in Pairs-

Have students complete the attached computer lab worksheet page 1.

Whole group-

Have students share their results from the computer lab page 1. Students may or may not discover a constant ratio but they should notice a relationship between the distance moved forward and the number revolutions the toy ball must make. They should also notice that as the diameter of the ball increases, the number of revolutions decreases in order to cover the same distance. As the diameter of the toy ball decreases, the number of revolutions will need to increase in order to cover the same distance. Students need to understand the relationship between the circumference of the circle ($\pi \times \text{diameter}$), the distance the toy ball travels, and the number of rotations the toy ball makes. In other words, **distance traveled** by the toy ball = **circumference of the circle X the number of complete revolutions** the toy ball makes. (Please note: A sphere is a 3D object. A circumference relates to a 2D object, a circle. The intersection of a plane with a sphere is a circumference if the plane intersects the sphere: this circumference can have different diameters depending on the distance between the plane and the center of the circumference; the greatest circumference is obtained when the plane contains the center of the sphere. In this case the diameter d of the circle is the same diameter d of the sphere.) If students have trouble relating these concepts then have them work with the actual toy balls.

In Pairs or small groups-

Have students complete the attached computer lab worksheet page 2. This activity does not include Alice. Please note that some students may have trouble with understanding how to use the variables in the last entry of the table. You may want to let them know that the variables are simply a short

hand for writing distance traveled, number of revolutions, and the diameter of the toy ball.

Whole group-

Have students share their results from the computer lab. Students should see the distance the ball travels is the circumference of the circle (through the center of the sphere) times the number of revolutions the toy ball makes or $t = \pi d \times v$.

Remind the students the goal of the lesson: to create a "realistic" simulation in Alice of a ball rolling regardless of the diameter of the toy ball or the distance traveled. The method we create should calculate the number of revolutions the toy ball must make in order to travel a given distance and then turn forward that number of revolutions. In order to do this, the equation needs to be rewritten showing the number of revolutions (v) as a function of the diameter of the toy ball (d), π , and the distance traveled (t).

Have students work in small groups to rewrite the equation: $v = t \div (\pi d)$.

Closure:

Now that the students have determined the equation to use, the teacher should model how to use the equation in a function that will simulate, as realistically as possible, a ball rolling in an Alice world. (see attached alice world).

Assessment:

Teacher observation, lab sheets, completion of Alice world, lesson reflection.

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Toy ball computer lab page 1.

- Practice changing the number of meters to move the ball forward and the number of rotations. When you find a pair of numbers that shows a "realistic" roll, then enter the information in the table below. Find at least five pairs of numbers that seem to work. Be sure to include non-integer rational numbers.

Distance Forward (meters)	Number of Revolutions	Ratio of Number of Revolutions to Distance Moved

What do you notice about the ratio of revolutions to distance?

- Resize your toy ball by making it twice as large. Again, complete the table below with the larger toy ball.

Distance Forward (meters)	Number of Revolutions

How does increasing the size of the toy ball affect the number of revolutions and the distance forward?

- Resize your toy ball by making it $\frac{1}{4}$ as large. Again, complete the table below with the larger toy ball.

Distance Forward (meters)	Number of Revolutions

How does decreasing the size of the toy ball affect the number of revolutions and the distance forward?

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Toy ball computer lab unit 2 of 2. Please show all work.

- If the diameter of my ball is 10 cm and the ball revolves 1 times, how far has the ball traveled?

If the diameter of the ball is 10 cm and the ball revolves 2 of the way, how far has the ball traveled?

Complete the following table. Show all work:

Diameter (cm)	Number of Revolutions	Distance Traveled (cm)
10	1	
10	2	
10	.25	
15	1	
$20 \frac{1}{2}$	1	
4.5	3	
<i>d</i>	<i>v</i>	<i>t</i> =