How far does the robot go?

Subject Area(s): Algebra

Associated Unit: Numbers and operations, Measurement, Problem Solving

Activity Title : How far does the robot go?

Image 1

ADA Description: The image shows railroad tracks going into the distance

Caption: Railroad tracks going into the distance

Image file name: train track going off into distance perspective.jpg

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Grade Level: 4 (2-4)

Activity Dependency: None

Time Required: 45 mins

Group Size: about 10 people

Expendable Cost per Group: none

Summary

In this activity, the students practice their multiplication skills using a robot with wheels built from Legos. First, the students are encouraged to think of ways to determine the distance travelled by the robot without physically measuring the distance from the starting location to the final location. After the students are allowed to brainstorm for some time, they try to determine the distance by measuring the circumference of the wheels, and multiplying the circumference of the wheel by the number of revolutions that the robot was programmed to do. Once they do this, they can physically measure the distance travelled and compare it to the one they obtained by multiplication. They get to practice multiplication and develop measuring skills, as well as are encouraged to come up with a creative solution to the problem.

Engineering Connection

Mathematics is an essential component of engineering. Without a fundamental understanding of such basic concepts as multiplication and measuring, it becomes impossible to progress into more advanced mathematical concepts (i.e. differential equations, linear systems) related to engineering. Another advantage of this activity is that the students are first encouraged to figure out a way to estimate a parameter other than physically measuring it. This is often encountered in real world. For example, in nanotechnology, it becomes very challenging to measure the actual distances at this scale, therefore, the distances must be estimated using known geometric or algebraic relations. Also, in many engineering applications such as renewable energy sources, minimization of hazardous waste products in chemical plants, and many others, creative thinking is essential to make the processes both efficient and environmentally friendly.

Engineering Category

(#1) relates math concepts to engineering

Keywords

Circumference, distance, measurement, multiplication, revolution

Educational Standards
State math: 4.PS.1-3; 4.PS.16; 4.PS.20; 4.PS.23

Learning Objectives

After this activity, students should be able to:

- Understand that distance can be determined in alternative ways
- Relate the distance to the product of circumference of the wheels and the number of revolutions
- Develop a scientific method to approach real world problems

Materials List

Each group needs:

- A flexible measuring tape
- Long sheet of paper
- Meter stick (can be replaced by the measuring tape)
- Marker

Introduction / Motivation

Lets become scientists and engineers for the duration of this class. What do scientists and engineers do? Allow the students to respond. In more general terms, they try to create solutions to real world problems. Now, since you are guys are only in 4^{th} grade and don't have a lot of experience being engineers, I'm going to give you a simple problem. I have this robot that I built from Legos and I want to know how far does it travel. How can we tell the distance the robot travels without physically measuring the distance between the starting and final locations of the robot? Here is an example of a real world version of this problem: lets say you built and sent a robot to explore Mars. While it is on Mars you want to know the distances that it travels. You obviously cannot go there and measure them, so what are some other ways to estimate the distances that the robot travels? (encourage the students to respond; if they cannot get the expected answer: ok, well we know that the robot uses wheels to travel, so the length of wheels can help us out! If we measure the length of the wheels, *circumference*, and multiply it by the number of complete turns, *revolutions*, they make, we can get the distance! So now that we have proposed a solution to the problem lets test this solution to see if it is working.

Vocabulary / Definitions

Word	Definition
circumference	length of a circle ($2\pi r$)
revolution	one complete turn of the wheel
distance	space between two specified points
measurement	obtaining a numerical value of a parameter

Procedure

With the Students

1. Gather the students in a group
    1.1. The number of groups can vary depending on the class size and/or availability of the robots and computers
2. Have each student measure the circumference of the wheel
    2.1. If time or students' abilities permit, take the average of the students' measurements (who's measurement is correct? Students need to understand that measurement depends on the person's perception and could be different from one person to the next. Therefore, average of many data points is a good way to estimate the measured parameter)
3. Place the long sheet of paper underneath the robot
    3.1. The long sheet of paper is for marking the starting and ending locations of the robot
4. Set the number of revolutions to a certain number in the MindStorms^{tm} software
    4.1. When doing this, take into consideration how long is the paper and make sure the robot does not go farther then the sheet's end
5. Have one student mark the starting location of the robot on the long sheet of paper
6. Run the program
7. Have another student mark the final location of the robot
8. Have each student separately on a piece of paper calculate the distance travelled
9. Have each student measure the distance travelled by the robot
    9.1. Once again, take the average of the values reported by the students
10. Repeat for different number of revolutions (go back to step 4)

Investigating Questions

- How does the calculated distance compare to the measured distance? Is multiplying the circumference of the wheel by the number of revolutions a good way to estimate distance travelled?

    - Sometimes, due to mechanical issues, the calculated distance may not match the measured distance. This is a very real phenomenon that is frequently encountered in the science and engineering fields. Discuss this with the students.

Assessment

Pre-Activity Assessment
See introduction/motivation section

Activity Embedded Assessment
Student/teacher interaction

Post-Activity Assessment

Have a discussion with the students after the activity. Ask questions and involve scientific method:

a. Identify a problem (how far does the robot go?)
b. State a possible solution/hypothesis (the distance travelled is the product of the circumference of the wheel and the number of revolutions)
c. Conduct an experiment (measure the circumference, program the robot for a number of revolutions, and multiply the circumference of the wheel by the number of revolutions)
d. Verify results (measure the distance with a measuring tape)
e. Conclusions (does experimental evidence match the real situation?)

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