

Arctic Animal Robot

Subject Area(s) Life Science, Measurement

Associated Unit None

Associated Lesson None

Activity Title: Arctic Animal Robot

Header

Picture of Experimental Setup

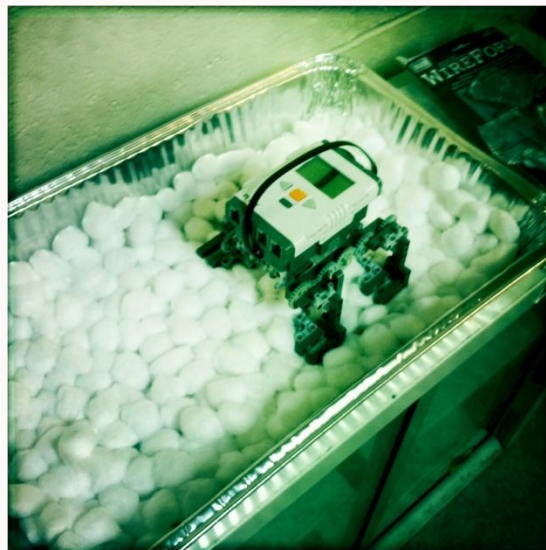


Image 1

ADA Description: Walking mammal with claws

Caption: None

Image file name: adaptation bot.jpeg

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Grade Level 4 (3 - 5)

Activity Dependency: None

Time Required: 120 mins.

Group Size: 3

Expendable Cost per Group: US \$5

Summary

In this activity students will create a four-legged walking robot and measure how far it travels across different types of land surfaces. Students will modify the feet and observe the effect of their modifications on its net distance across the different types of surfaces. The activity will illustrate the manner in which different species might have specialized locomotive features which allow them to survive or thrive in their habitat environments. Students typically observe the difference between the control walker and the walker with prescribed modifications and record the results; if there is sufficient time and interest students can design and test their own modifications. Students compare the distance covered in 30 steps for each modification. Students are encouraged to use their imagination or look to real life creatures that thrive in similar types of landscape for inspiration.

Engineering Connection

Robot engineers often look to the animal kingdom to imitate the way different animals move, swim or fly through their environment. Biomimicry is the term used by robot engineers to describe this practice.

Engineering Category

2. Engineering Analysis or Partial Design

Keywords: Adaptation, Locomotion, Lego Mindstorms NXT, Life Science, Biomimicry

Educational Standards

New York Science Core Curriculum

Standard 1: Analysis, Inquiry and Design: Engineering Design

Key Idea T1.3 Generate ideas for possible solutions, individually and through group activity; apply age-appropriate mathematics and science skills; evaluate the ideas and determine the best solution; and explain reasons for the choices

Standard 4: The Living Environment,

Major Understanding 3.1a: Each animal has different structures that serve different functions in growth, survival and reproduction

Pre-Requisite Knowledge

Measuring with a ruler, familiar with terms used in the Scientific Method

Learning Objectives

After this activity, students should be able to:

- Gain experience in recognizing a problem, then designing and testing a solution
- Understand the concept of variations in animal species across different environments
- Investigate the special abilities and structures of animals in their niche environment

Materials List

Each group needs:

1. Aluminum foil baking pan filled with cotton balls (“snow”)
2. Optional: any other strange or difficult to navigate material to fill the baking pan
3. NXT Motor, NXT Brick and Lego pieces to make the walker robot
4. Any variety of opaque and easy to remove tape; for best results, use the arrow-shaped adhesive-backed notes
5. Ruler or measuring ribbon

Introduction / Motivation

One of the reasons why life on earth is so extraordinary is that there are organisms able to live in so many different types of environments. Even among four legged mammals, there are species that have carried on in the extreme cold of the arctic, the desert, and jungle ecosystems. The animals thriving in each environment almost always have something special about them such as claws, wings or other features; what different features can you think of?

These features are called adaptations and have developed over long periods of time to give the animal an advantage in surviving in its surroundings, allowing it to reproduce and keep the species from becoming extinct. An **adaptation** is defined as “a change in structure or function that makes an organism better suited to its environment.”

Vocabulary / Definitions

Word	Definition
Biomimicry	the examination of nature, its models, systems, processes, and elements to emulate or take inspiration from in order to solve human problems
Adaptation	a change in structure or function that makes an organism better suited to its environment
Locomotion	How an animal moves itself around its environment
Trait	A genetically determined characteristic of a living thing
Heredity	The passing of traits from one set of parents to their offspring

Procedure

Before the Activity

1. Assemble the four-legged robot using the free instructions found at nxtzoo.com. The pieces do not have to be strictly the same, as long as the function of walking is preserved.
 - a. Link: http://thenxtzoo.com/4legwalk_gears.pdf
2. Write and upload a program using NXT-G or other available language that moves the single motor forward 30 rotations and stops.
3. Create a set of feet out of the flexible metal mesh commonly found at art stores. Be creative, and try to get something that resembles snow shoes. The main idea is to test them so there is no right or wrong design. A picture of the feet used in this experiment is provided below. It helps if you have enough pieces is to make another set of feet with the modification because the Lego bricks are more easily removed and re-attached. However this is not required.
4. Fill the aluminum pan with one standard bag of cotton balls, and pat them down and arrange so as to create a layer one cotton ball thick. If the cotton balls are piled too high or inconsistently the robot will have difficulty moving no matter what is done to the feet.

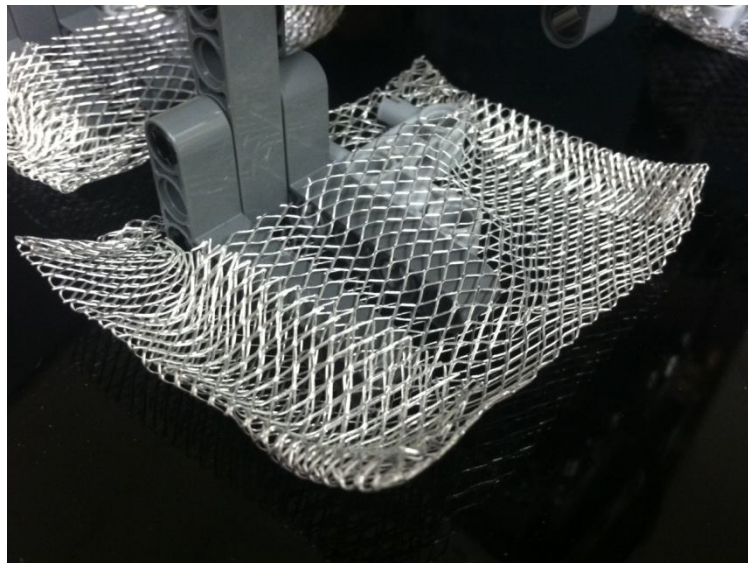


Image 2

ADA Description: Walking robot foot with mesh shoe

Caption: None

Image file name: photo of animal foot.jpeg

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With the Students:

Procedure:

1. Tell the students they will be learning about adaptation. They will be using a Lego Mindstorms robot to test their hypotheses using the Scientific Method.
2. Distribute the worksheets and explain how to complete. It may help with younger students to read questions aloud.
3. Present one or two graphically-oriented slides, or hand out the slides if no projector is available. This should briefly cover the concept of adaptation in biology, specifically the concept of specialized body parts. Include examples of specialized movement and feeding mechanisms. (Movement ex's= paws, wings, legs, glider squirrel webs) (Feeding examples: different types of beaks in birds). The idea here is not to be an introduction to adaptation but provide motivation for the activity to follow. The activity is best as an enrichment tool following a lecture-type lesson so the students are familiar with the concepts.
4. Hand out the activity worksheet to the class. This is to be completed during the experiment.
5. Demonstrate the walker robot walking across a flat even surface such as a table top. Explain that the robot takes the same number of steps for each press of the "run" button and then stops.
6. Show the pan full of cotton balls. Explain that they will be testing a 'foot' add-on for moving the robot across the cotton balls. Show them the 'feet' add-on. Instruct the students to form their hypothesis. Will the robot move further with the feet, without the feet or will it go about the same distance?
7. Divide the class into groups of 3. Each group gets measuring tape, and three different colored job tags or bracelets. The three job titles and roles are defined as follows:
 - a. **ROBOT OPERATOR:** Aligns the robot at start position. Follows verbal directions from the Robot Engineer (fellow) and allows the Robot Engineer to take over when repair is needed. Presses the Enter Button on the NXT Brick to start the robot AFTER the beginning point is marked by the LEAD MEASURER.
 - b. **LEAD MEASURER:** Marks where the trailing point of the Robot starts. Measures the distance traveled in inches and in centimeters. Gives the RECORDER his/her result.
 - c. **RECORDER:** Records the results from the measurer in the experimental table on the worksheet. At the end of experiment he shares the table with the group so they can fill out their table on the worksheet. He is the one who announces which trial the team is currently running and makes sure the team does the required amount of trials.
8. One robot is shared with the entire class. The teams must take turns running the experiment at the front of the classroom. When a team is not running their tests, they are

to complete the first part of the worksheet which is to sketch the robot freehand. Coloring the picture is an optional added component.

9. The experiment is run as follows:
 - a. The ROBOT OPERATOR aligns the robot without the added feet at the front of the pan so that it will go straight.
 - b. The LEAD MEASURER marks the rear of the robot as the starting point. Use opaque tape such as masking tape to mark the edge of the container for each run.
 - c. The ROBOT OPERATOR presses the orange enter button to execute the trial run.
 - d. When the run is over, the LEAD MEASURER will mark the end of the robot on the side of the container with a second piece of tape.
 - e. The LEAD MEASURER measures and reads aloud to the RECORDER the distance in inches from the right edge of the first tape to the right edge of the second tape. The RECORDER writes down the result and asks for the distance in centimeters. The LEAD MEASURER measures the distance in centimeters and reads it to the RECORDER who writes it down in the correct place on the worksheet.
 - f. These steps are repeated once for a total of 2 trials for the unmodified robot, and the robot is given the add-on feet by the ROBOT ENGINEER (fellow). The steps a-e are repeated two times for the robot with the add-on feet. The group should have two trials for each mode, with and without special feet.
10. Upon completion each team returns to their desks and gets the data from their team RECORDER. They write three sentences that summarize their observations and results, and another three conclusion sentences that re-state their hypothesis and state whether they believe the test supports or refutes their hypothesis.

Safety Issues

- Some metal wire mesh must be used with extreme care as the edges can poke and possible cut or pierce through skin

Troubleshooting Tips

- Troubleshooting tips

Assessment

Activity Embedded Assessment

Analysis

There are two criteria that students should be evaluated on:

Communication and teamwork

Problem recognition and ability to devise ways to solve the particular problem

Activity Extensions

Ask the students to design their own feet modifications. Have the students first create hypotheses as to whether their design will increase the distance traveled and why. Repeat the test procedure for each foot and compare to the control robot.

Additional Multimedia Support

None

Owner

Andrew Cave

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Supporting Program

AMPS Program, Polytechnic Institute of NYU

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