

# **BRISTLEBOT LAB**

## Middle School Lesson Plan

### **KEY LEARNING OUTCOMES**

Learners will be able to distinguish between variables.

Learners will be able to apply the scientific method to answer a question.

### **TIME REQUIRED**

2 45-minute periods (plus additional time for a formal lap report).

### **STANDARDS**

#### NEXT GENERATION SCIENCE

##### CROSSCUTTING CONCEPTS EMPHASIZED

1. Patterns
2. Cause and Effect: Mechanism and Explanation
7. Stability and Change

##### SCIENTIFIC AND ENGINEERING PRACTICES

1. Asking questions (for science) and defining problems (for engineering)
3. Planning and carrying out investigations
4. Analyzing and interpreting data
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

##### DISCIPLINARY CORE IDEAS

##### MS-ETS1 Engineering Design

*Students who demonstrate understanding can:*

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

## READING

College and Career Readiness Anchor Standards for Reading (6-12)

7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.
8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

## WRITING

College and Career Readiness Anchor Standards for Writing (6-12)

1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

## MATH

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
4. Model with mathematics.

## **ENGAGEMENT**

### 1. Bristlebot Demo

Introduce students to the Bristlebots via a demonstration. Some ideas for discussion questions:

- What do you think propels the Bristlebot?*
- What do you notice about the movements?*
- Are the movements random or similar?*

### 2. Introduce Inquiry Question

Pass out the Activity Page  
Read the Testable Question together as a class

3. Variables Mini-lesson

Review the differences between Dependent and Independent.

What is a controlled variable?

4. Write a Hypothesis using an 'If \_\_, then \_\_, because \_\_' statement.

## **EXPLORATION**

5. Groups construct Bristlebots using the Instruction provided here.

6. Read the Procedure and explain the data collection process. There are six variations between a leg being pointed down, folded flat on the surface or bent off the ground.

{INSERT SKETCHES/DIAGRAMS HERE}

7. Groups should sketch the Bristlebot leg positions as well as the movement it undertakes in 10 seconds.

## **EXPLANATION**

8. After collecting data and recording their observations, students should answer the conclusion section questions.

## **ELABORATION**

9. Students who complete can advance on to the Elaboration Page. Students should use their observation sketches to be able to predict the movement of the Bristlebots.

## **EVALUATION**

10. Have students use the Lab Checklist and Self-Evaluation to reflect on how well they did on the lab activity.

11. Come back together as a class and discuss the following:

Was your hypothesis correct about how the leg positions would impact movement?

What potential errors did you make?

How would you potentially change this lab to test something slightly different?

*Which leg position did you choose for the target assignment?*

*Why did you choose that one?*

*In what way did your group work well together?*

*In what way does your group need to improve?*

12. You could also expand the Target Page into a competition of which group can most consistently hit the targets on a variety of different pages.