

# SMART LAB ACTIVITY GUIDE

## DRAWING ROBOT

### DESIGN CHALLENGE

Create a robot that draws a picture.

### DIFFICULTY LEVEL

Medium – requires learning motor control

### MATERIALS

LEGO MINDSTORMS EV3

Tape, markers, cardboard, paper, and scissors

### INDONESIAN HIGH SCHOOL CORE COMPETENCIES

This activity can be used to introduce, explain or explore the following concepts:

Circular equations and coordinate geometric transformations (Mathematics - Mandatory, Year XI, 2.5 – 2.6)

Properties of geometric shapes (Mathematics - Concentration, Year XI, 3.3)

Area under a curve (Mathematics - Mandatory, Year XI, Calculus)

Circular motion (Physics, Year X, 3.3)

Angular momentum (Physics, Year XI, 3.6)

Parabolic motions (Physics, Year XI, 4.4)

DC Current (Physics, Year XII, 3.4) – motors

### SMART LAB DISCIPLINES

**Science**  
Velocity

**Math**  
Geometry

**Art**  
Drawing

**Technology &  
Engineering**  
Tool design

## STUDENT OUTCOMES

- **Engineering Design Process** – a method of problem solving.
- **Failure is okay!** Students are encouraged to try to new things and not be afraid to fail
- **Iterative Design:** The designs may not work out perfectly at first, but students learn how to evaluate and improve their design
- **Diversity of solutions:** students learn that there is no right answer. When sharing designs, students can learn from the each other and build collective knowledge.
- **Geometry and velocity:** through exploration students learn about velocity, lines, angles, distance between points and planes.

## DETAILED OBJECTIVE

Write a program that uses:

- Motor(s) to move markers across paper
- A loop to repeat the program

## EXAMPLE SESSION – 90 MINUTES

### Introduction: 10 minutes

Put students into small groups (preferably groups of two)

Explain the engineering design process:

- Identify problem
- Brainstorm ideas
- Create solution
- Test & evaluate
- Refine/Redesign

Structure the class to follow the process

### Identify Problem: 5 minutes

Explain challenge and detailed objectives

Show students examples of drawing robots (see Example Solutions section)

### Brainstorm: 10 minutes

Have students brainstorm ideas about the following questions: what picture will the robot draw? How should the robot be built for it to draw the picture?

### Program: 10 minutes

Explain motor blocks and loops

### Build, Test, Evaluate & Refine: 30 minutes

Have students construct their drawing robot

Have students build their drawing robot by using the materials provided

Encourage students to continue to follow the engineering design process by testing, evaluating and refining their robot

### Present: 10 minutes

Have students present their designs

**Share: 15 minutes**

Groups should take videos of their design being used and post the video and a short description of their drawing robot to the website. The description should include an explanation of how the robot works.

**POSSIBLE MODIFICATIONS**

After students brainstorm ideas, each group can present their ideas to the class (10 minutes)

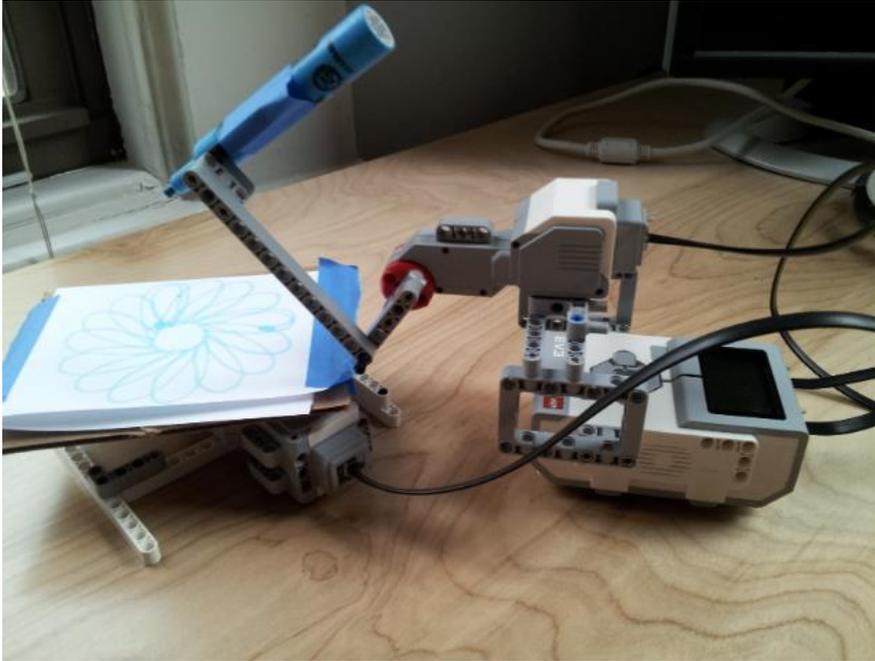
This activity can be used to teach the core competencies. Students can present or write about the different topics in the core competencies that relate to their design.

**POSSIBLE EXTENSIONS**

This activity can be extended by having students draw letters or a message.

## EXAMPLE SOLUTION

The below is an example of a robot that draws a Spirograph. It is drawn by the combination of the marker moving forward and backward across the paper while the base rotates. The jointed arms (with marker attached) turn the circular movement of the motor into forward and backward linear movement. The second motor spins the base at a constant speed.



Film of example:

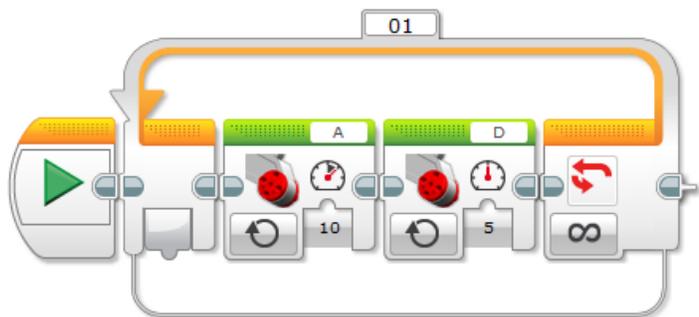


Spirograph Example.mp4

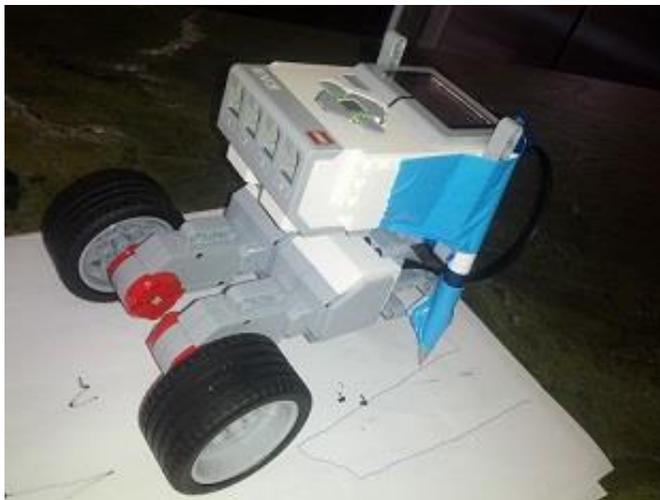
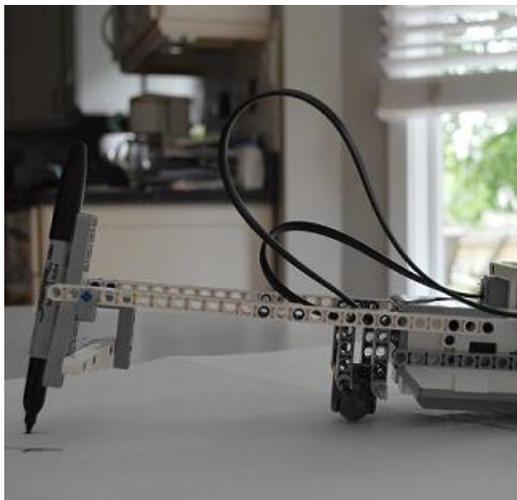
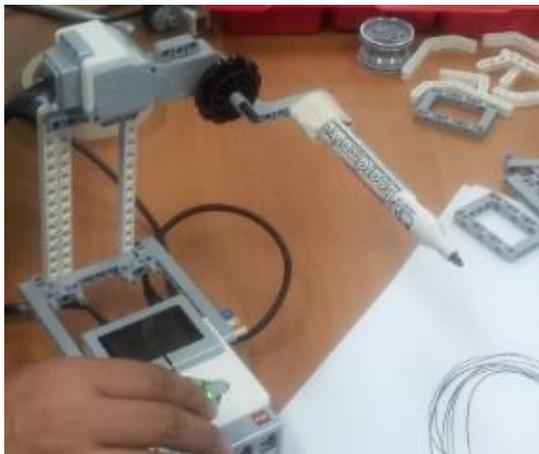
\*Double click on icon to play

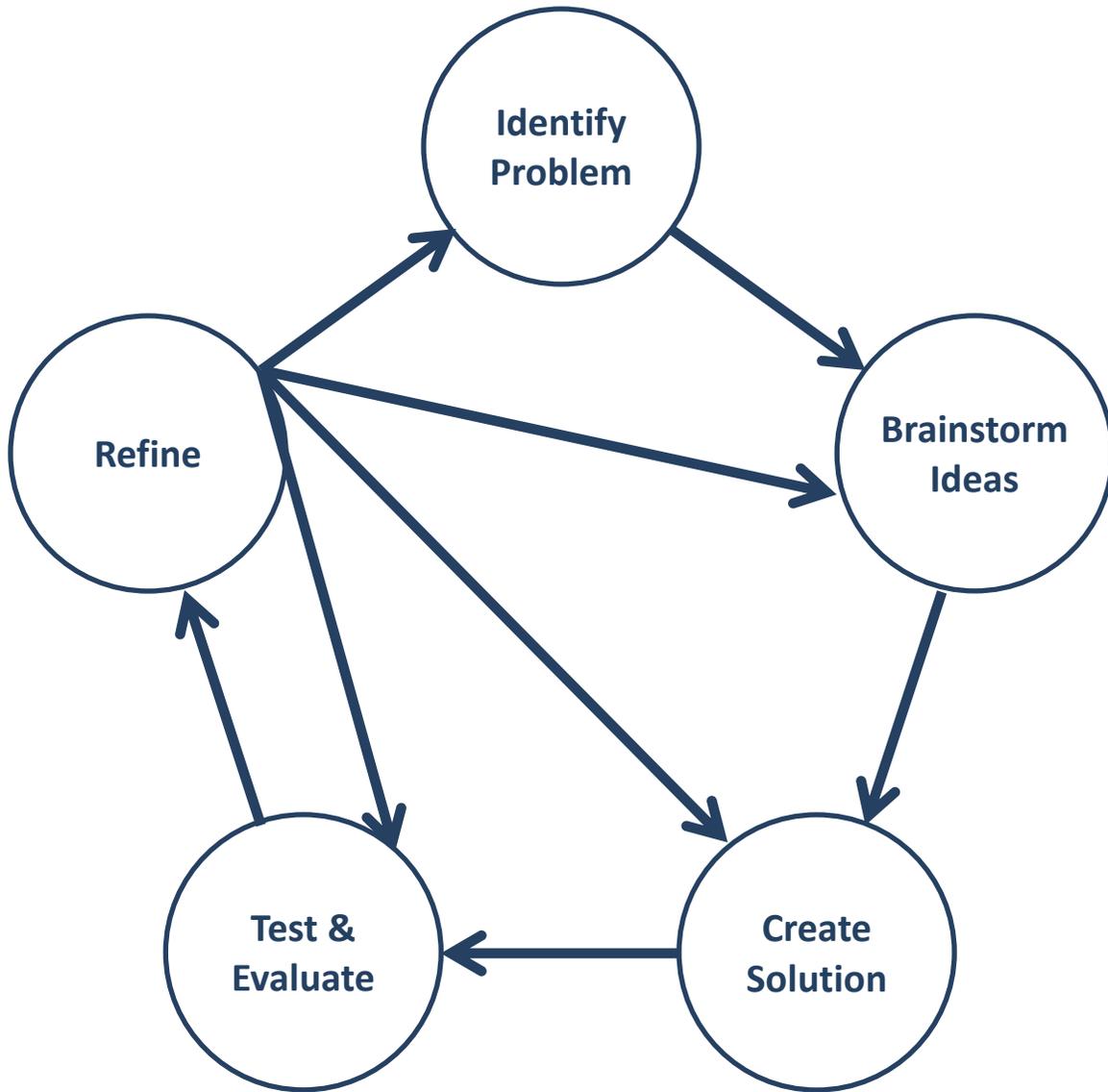


The motor that operates the marker is connected to port A, and is set to a power level of 10. The motor connected to the base is plugged into port D and is set to a power level of 5. Below is the program:



### ADDITIONAL EXAMPLES





## REFERENCE

### Units and Ranges

EV3 motor power range: -100 (backward) to 0 (off) to 100 (forward)

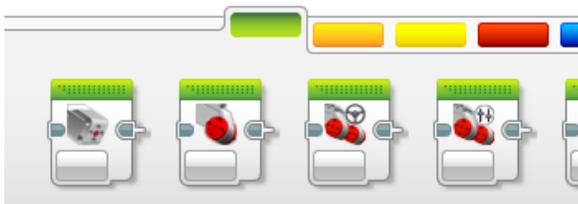
### Connecting to the EV3

The motor plugs into ports A, B, C, or D on the EV3 brick

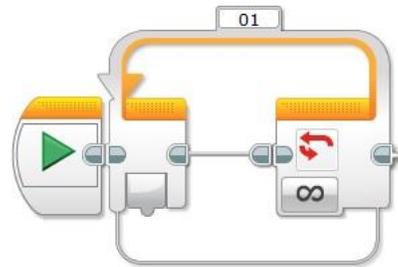
### Program Support



**Flow Tab:** contains loop block



**Action tab:** contains the motor blocks



**Loop:** blocks inside are repeated

