LITTLEBITS LESSON

# INVENT AN ART MACHINE

## LESSON OVERVIEW

Students will use the littleBits Invention Cycle, and an understanding of the basics of circuitry and motion, to construct an art machine that draws on its own. Students will manipulate Bits and materials, and use their creativity and collaboration skills, to build unique solutions and replicate patterns that they like best. Conclude the activity by challenging students to match their classmates' Art Bots to their respective masterpieces.

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## LESSON TAGS

### GRADE LEVEL

elementary

### SUBJECTS

Engineering
art/design

### DIFFICULTY

beginner

### DURATION

60 minutes (minimum)

### PREREQUISITE KNOWLEDGE

Introducing littleBits
Introducing the Invention Cycle

## SUPPLIES

### BITS

Battery and cable
p1 power
DC motors (x2)
pulse

### ACCESSORIES

wheels (×2)
mounting board purple
screwdriver

### OTHER MATERIALS

markers/drawing utensils
drawing surface/arena
see list of commonly used materials on pg. 119 of the STEAM Student Set Teacher's Guide

### TOOLS USED

scissors Glue Dots®
rubber bands
masking tape

littleBits education

## DESCRIPTION

### LESSON OBJECTIVES

By the end of the lesson, students will be able to:

- Create and test a circuit containing a power source, inputs and outputs
- Construct a prototype of an autonomous art machine using littleBits and other materials
- Test their prototypes and make improvements
- Self-assess their work based on the outlined success criteria and constraints
- Demonstrate their ability to Create, Play, Remix and Share an invention through the littleBits Invention Cycle by recording their processes in the Invention Log
- Apply knowledge of the Bit functions and pattern recognition by participating in a gallery viewing; matching classmates' Art Bots to their respective drawings

### ASSESSMENT STRATEGIES

The Invention Log checklist (Invention Log pg. 18) can be used to assess your students' understanding of the Invention Cycle, use of the Invention Log and ability to attain the objectives of the lesson. For formative assessment while students work, you can use this checklist to ask questions about their current task and ensure that they are on the right track. The checklist can also be used as a self-assessment tool by students as they move from phase to phase. For summative assessment, you can use this checklist to review students' entries into their Invention Log and assess their understanding of the challenge and the invention process as a whole.

## STANDARDS

NGSS

**3-5-ETS1-3**
Engineering Design: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

To meet this standard, students are explicit about the need or want being designed for, and call it such, as well as criteria for success and constraints of materials, time, cost etc. that they're willing to work within.

**MS-ETS1-3**
Engineering Design: 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 solutions to better meet the criteria for success.

To meet this standard, students test their prototypes and make improvements. Set all but one variable as fixed, and change just one parameter in attempts to maximize the agreed upon criterion for success. Students may also be allowed to "borrow" the best aspects from one another's designs during this process.

Students will need to fill out information in the REMIX section of the Invention Log (pg. 11 and 12) every time a variable is changed and tested. Be sure to print additional copies of these pages before the lesson begins.

*For other curricular connections, see the "Extension" section at the end of this lesson.

## VOCABULARY

power
input
output
circuits
magnetism
clockwise
counterclockwise
constraints
criteria for success

## RESOURCES

**ATTACHMENTS**

littleBits Invention Log
STEAM Student Set (SSS) Teacher' Guide

**INSPIRATIONAL LINKS**

Creative littleBits Art Bots in Action
Robots that Create Art: Harvey Moon's Drawing Machines

**TIPS & TRICKS**

Guided challenges can pair with the Invention Log for the Play, Remix and Share phases of the Invention Cycle. The Create Phase has already been outlined for students in their Invention Guides.

Attaching wheels to the DC motor: have students pay close attention to pg. 27 in the Invention Guide. You may want to walk younger students through the steps to avoid misaligning the wheel on the motor axle (and damaging the plastic!), or attach the parts for students prior to starting the lesson.

## INSTRUCTIONAL STEPS

### STEP 1: SETUP - Prior to Class

This lesson can be done individually or in small groups (2–3 students). Each group will need at least one STEAM Student Set and Invention Guide, plus one Invention Log and Assessment Checklist per student. We suggest handing out the Bits in the Create phase to keep students focused on initial instructions and review activities. For more experienced users, you may want to provide access to additional Bits in the Play and Remix phases to provide a greater diversity of circuit combinations.

Set up a central location in the classroom for assorted materials, including various drawing tools (pens, pencils, markers, paint brushes etc.) and drawing surfaces (rough paper, glossy paper, white boards etc.). Setting up arenas, or barriers around the drawing surface, will help wandering Art Bots from doodling too far.

During the Create phase, students will construct their first prototypes according to instructions in the Invention Guide. You may want to construct your own example prototype before the lesson begins. Seeing a working model of what they are building can help the students understand the goal of their Create phase and will allow you to quickly demonstrate it working in the Play phase.

### STEP 2: INTRODUCE

**Duration:** 10-15 minutes

Begin the activity by leading a short review of key vocabulary (see above) and the littleBits basics (e.g. magnetism, order matters, color-coding).

If this is the first time your students will be engaging in a challenge using the Invention Cycle framework and the Invention Log, take 5–10 minutes to review each stage (see SSS Teacher's Guide, pg. 11).

Introduce the lesson objectives and define criteria for success and constraints that are appropriate for your students. For example, your criteria for success could be creating an art machine that draws specific patterns on its own and constraints could include drawing within an area with set dimensions. While the first prototype will be guided, your students will be able to customize their art machines in the Remix phase of the Invention Cycle.

## STEP 3: CREATE

**Duration:** 20-30 minutes

### A. CREATE IDEAS

Refer to pg. 39 of the Invention Guide to show students the intended construction of the first prototype. Using their knowledge of the Bits, spend 5–10 minutes as a class making predictions about how this art machine will move based on different variables. Examples include using different:

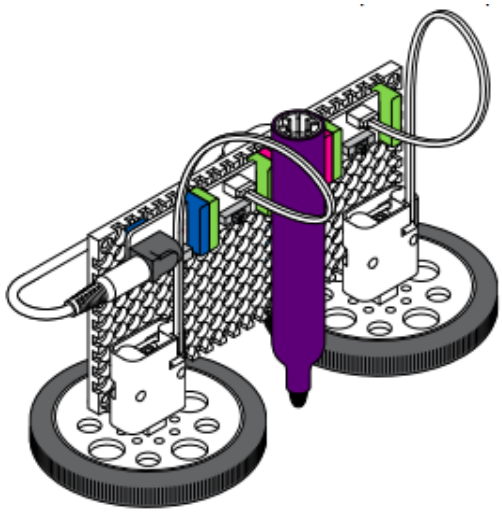
- Outputs: DC motor, servo
- Inputs: pulse, slide dimmer, light sensor, temperature sensor
- Materials: thick or thin drawing utensils, rough or slippery surfaces

Students will be able to test out some of these ideas in the Remix phase of the Invention Cycle.

### A. CREATE PROTOTYPE

Students will follow the instructions in their Invention Guide to build prototypes of the art machine.

Encourage students to reference the Bit Index (pg. 7–27 in their Invention Guides) if they get stuck or want to learn more about a particular Bit or accessory. For younger students, you may want to pause the class after each step to troubleshoot any common problems, as well as share successful build strategies amongst the groups.



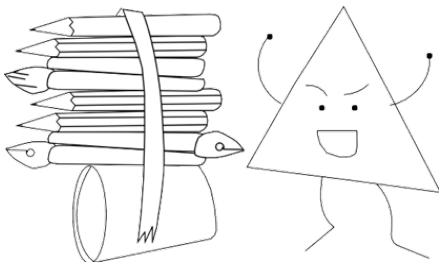
## STEP 4: PLAY

**Duration:** 10-20 minutes

As you move through the Play prompts, be sure to have students record their process and reflections in the Invention Log (starting with "How did your testing go?").

## How did your testing go?

Once the models have been constructed, students should test their prototypes to make sure they work and to explore the circuit functionality.



### 1. TEST THE CIRCUIT (STUDENT PROMPTS):

• Place the Art Bot on flat surface; wheels down. Turn the power Bit on.

• Both wheels should spin. One will spin continuously, while the other will alternate between spinning and stopping (because of the alternating signals from the pulse Bit)

### 2. HOW IT WORKS

p1 POWER sends a signal through the circuit.

The first o25 DC MOTOR receives that signal and spins at full speed in one direction.

The signal passes through the motor and on to the i16 PULSE. The pulse only lets the signal through in short bursts.

When the second o25 DC MOTOR gets a signal from the pulse, it spins, but when the pulse switches off, the motor stops.

Either as a class or in groups, ask students to discuss/explain how the circuit works. A clear understanding of how it works will help them explore and experiment during the Remix phase. Make sure students understand how each component in the circuit functions. Note: your students will have access to the answers above in their Invention Guide. Demonstrating how the circuit works and asking probing questions will help assess their understanding of the material.

For example, you could ask: What happens when...

• You turn the purple screwdriver clockwise in the pulse's speed dial? (increases speed)

• The DC motors are switched between clockwise and counterclockwise? (the drawing pattern changes)

• You move the art machine onto a smooth surface? (with less friction it does not move as much, so lines

are shorter and more condensed).

Be sure to have students record their notes and processes in the Invention Log.

## STEP 5: REMIX

**Duration:** 10-20 minutes

To meet the outlined NGSS standards, instruct students to fill out a new Remix section in their Invention Logs (pg. 11 and 12) every time a variable is changed and tested. If you do not plan to adhere to the NGSS standards, allow students more flexibility and exploratory pathways during this phase of the design process.

### PROTOTYPE # 2 (AND MORE...)

Now it's time to flex your students' Engineering Design skills to enhance their car of the future. For this lesson, we are focusing on REMIX A and B in the Invention Guide, but you may choose to extend the lesson to meet additional curricular requirements (be sure to check out the Extension section for more ideas). You can find more advice on how to conduct the Remix phase in the Invention Advisor section (SSS Teacher's Guide, pg. 13). As students make changes to their inventions, make sure they are documenting how their prototypes are changing and the results (good and bad) in their Invention Logs.

### REMIX PROMPTS:

Adjust it: Adjust the Bits to create a unique drawing style.

- How does changing the speed of the pulse or direction of themotors make the drawings different?
- Do students prefer certain drawings? What features of the patterns appeal to them?

Mix it up: Incorporate other materials

- Use different drawing tools, like chalk, crayons, pens or pencils
- Attach multiple drawing tools to the machine at once
- Try the machine on different drawing surfaces

Change the circuit: Add new Bits

- What happens when a servo is added to Art Bot?
- What happens when an input is added, or swapped out for another?

### REMIX TIPS:

- As you walk around the room, ask students to explain their remix choices and the resulting change in functionality and outcomes.

- NGSS 3-5ETS1-3 and MS-ETS-1-3 Connection: Allow students to "borrow" the best aspects from one another's designs, setting all but one variable as fixed, and changing the amount of just one parameter to see how to maximize the agreed-upon criterion for success.

## STEP 6: SHARE

**Duration:** 10-20 minutes

Collect the Art Bots and put them in a central location, while students hang their artwork on the board. Can students make connections between the types of marks made on paper and the motion and mechanics that might have made them? Go around the class and see if students can identify which Bits were used to create the patterns/designs within each drawing. Students can also try to match drawings with the respective Art Bots. As an extension, students could then be assigned to one of their classmate's drawings and challenged to recreate their masterpiece.

## STEP 7: CLOSE

**Duration:** 5 minutes

At the end of the lesson, students should put away the Bits according to the diagram on the back of the Invention Guide, clean up their materials and hand in their Invention Logs.

## STEP 8: EXTENSION

3-PS2-2 Motion and Stability: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

To meet this standard, systematically categorize some quality of the motions (for this age, these could be drawings or pictures, or even a way to categorize the scribble itself) and how this quality changes e.g. when the pulse is changed systematically (e.g. sped up or down).

4-PS3-1 Energy: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

To meet this standard, systematically categorize the energy of various pulse settings on some basis they systematically categories (for this age, these could be drawings or pictures, or even a way to cut out and categorize the scribbles themselves from less to more "energy"). Slide dimmers could also be added to adjust the speed control. Students' intuitive ideas are appropriate for this grade.

3-5-ETS1-1 Engineering Design: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

To meet this standard, allow students to come up with an agreed-upon criterion for success of their car (everyone should have the same goal) and constraints on them, e.g. "cost" of materials or "weight" in terms of number of Bits or materials added to their vehicle. An imagined, but motivating, scenario could be provided.

3-5-ETS1-2 Engineering Design: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

To meet this standard, allow students to come up with different solutions to a problem and explicitly compare them on the basis of their ability to meet the goal within the constraints. For challenges with wheels, ideally additional wheel sizes and treads are available.

littleBits Lesson Extensions

- Turn the art machine into an open-ended challenge
- Turn the art machine into a geometry lesson (appropriate for middle school)