LITTLEBITS LESSON

INVENT A SELF-DRIVING CAR

LESSON OVERVIEW

Students will use the littleBits Invention Cycle, and an understanding of the basics of circuitry and motion, to construct a self-driving, two-wheeled car. Students will demonstrate their creativity and collaboration skills to remix their prototypes to improve upon and customize their inventions. Conclude the activity with a class car show to allow students to explain and show off the best features of their designs.

LESSON TAGS

GRADE LEVEL	SUBJECTS	DIFFICULTY	DURATION
elementary, middle	engineering art/design	beginner	60 minutes (minimum) *For tips on how to break up your lesson over multiple class periods, see STEAM Student Set Teacher's Guide, pg. 117

PREREQUISITE KNOWLEDGE
Introducing littleBits
Introducing the Invention Cycle

SUPPLIES

BITS	ACCESSORIES	OTHER MATERIALS	TOOLS USED
battery and cable p1 power slide dimmer DC motors (x2) wire	wheels (x2) mounting board	construction paper recycled materials	scissors Glue Dots® rubber bands tape

DESCRIPTION

LESSON OBJECTIVES

By the end of the lesson, students will be able to:
• Create and test a circuit containing a power source, inputs, outputs and wires
• Construct a prototype of a self-driving vehicle using Bits 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
• Communicate their process and reflections by participating in a "car show"

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 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
wire
circuits
constraints
magnetism
parallel
perpendicular
clockwise
counterclockwise
criteria for success

RESOURCES

ATTACHMENTS

- Invention Log
- STEAM Student Set (SSS) Teacher' Guide
- Build Instructions (video)
- Remix prompts (video)

INSPIRATIONAL LINKS

- TED Talk: How a driverless car sees the road
- Teen’s Inexpensive Self-Driving Tech Takes Home $75K Intel Prize

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

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 and tools that students will use to customize their vehicles.

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 (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 a car that has specific futuristic features or mechanics, and constraints could include only having two wheels and incorporating at least four Bits. While the first prototype will be guided, your students will be able to customize their vehicles in the Remix phase of the Invention Cycle.

STEP 3: CREATE

Duration: 20-30 minutes

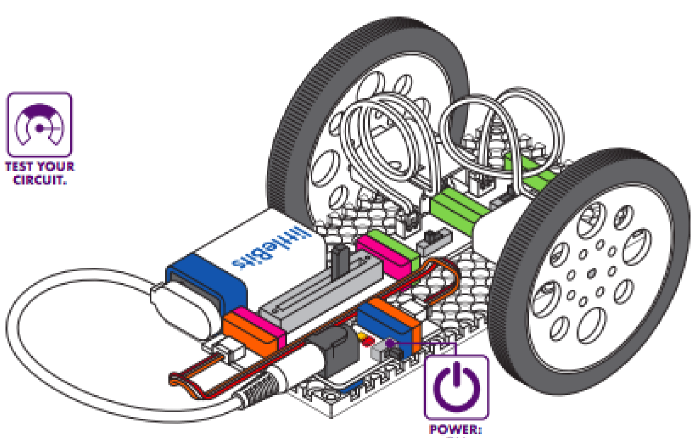
A. CREATE IDEAS

What will the car of the future look and function like?
Engage your students in a 5 minute brainstorm and record student responses on the board. Consider features, mechanics, and aesthetics. Self-driving cars will be the focus of the initial build, but students can use some of these other ideas to enhance their vehicles in the Remix phase of the Invention Cycle.

B. CREATE PROTOTYPE

Students will follow the instructions in their Invention Guide to build prototypes of two-wheeled, self-driving vehicles. Allow 15 minutes for the initial Create phase.

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: 10-15 minutes

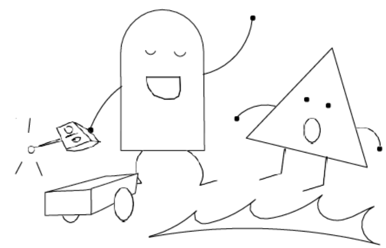
As you move through the Play prompts, be sure to have students record their process and reflections in the Invention Log (starting with "How did your testing go?").

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)

• Without touching the wheels, hold the car in your hand or place it on a flat surface. Turn the power Bit on.
• Set the speed with the slide dimmer.
• Check the direction of the spinning wheels. Make adjustments as needed.
• Tip on DC motors: Control the direction your car drives by flipping the mode switch. Because the motors face opposite directions, they need to be set in opposite spin mode to drive forward. Setting the motors to the same direction mode will create a car that spins around in circles.



2. HOW IT WORKS

P1 POWER sends a signal through the circuit.

The W1 WIRE recieves the signal from the power and sends it along to the slide dimmer.

The I5 SLIDE DIMMER controls how much power goes into the motors.

The first O25 DC Motor uses the signal from the slide dimmer to determine its speed. Then it passes this signal on to the second motor.

The second O25 DC Motor reads the signal from the first motor and also uses it to determine its speed.

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 move the slide dimmer all the way up? (increases speed)
• The DC motors are both set on clockwise mode? (the car spins in circles)

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:

• Switch it up: Use different input Bits, other than the slide dimmer, to control the car. Options include:
  • Using the light sensor to control the car by shining a flashlight on it, using the temperature sensor to change the speed of the car in cold or hot temperatures, or stringing two wires together with a button to have a "remote" control.
  • Is one method more reliable than others? Faster? Lighter?

• Supe it up: Change the design aesthetic/add features to the vehicle. Options include:
  • Add indicators or special features, e.g. sirens (buzzer, lights), speedometer (number), cooling systems or propellers (fan). What inputs could be added to affect these outputs?
  • What materials could be used to add a body to the vehicle? Do these changes affect how fast the car moves forward, turns, stops? What makes a car look futuristic?

REMIX TIPS:

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

• NGSS 3-5-ETS1-3 and MS-ETS1-3 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: 10-15 minutes

Host a car show for students to share their final remix results and explorations. Students will explain and show off the best features of their designs. If time allows, let other students in the class test drive each other's models. Tips on how to share inventions on SSS Teacher's Guide, page 18.

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: EXTENSIONS

Incorporate one (or more!) of the following extensions in the Remix section of this challenge to bolster your lesson's NGSS applications:

> 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, students must systematically categorize the energy of the car for different settings of the slider dimmer (e.g. add a number Bit set to value or volts mode after the slide dimmer). Students' intuitive ideas about how to define the car's energy 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.

For the Share phase: Have students compete on a pre-laid race track with a set distance. Time how long it takes for the vehicles to cross the finish line. Have students discuss why they think some vehicles were able to move faster or slower based on the engineering changes that were made.

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 fulfill 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 example, looking at how changing wheel sizes and/or treads impacts the speed of the car over a set distance.

MS-PS3-1 Energy: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

To meet this standard, use burst image capture of the motion of the car to calculate some distance over time measure (speed) and plot its kinetic energy for cars of different mass.

MS-ETS1-2 Engineering Design: 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.

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 example, looking at how changing wheel sizes or treads impacts the speed of the car over a set distance.

OTHER REMIX IDEAS:

BUILD A TRAILER TOW:

• Do students have a specific use case in mind? You may want to help students define the challenge.
• How much stuff and/or how far can the vehicle move? These parameters can be fixed if you plan to have students compete against each other.
• How do these changes affect the speed or maneuverability of the vehicle?
• How does the weight or positioning of the material impact the speed of the vehicle?

CHANGE THE SCENERY: Prompt your students to consider how their designs could be altered to improve performance on various surfaces and inclines.

• What are the limits of the designs?
• What materials/features could make the car move faster or be more aerodynamic?