LITTLEBITS LESSON

INVENT A CHAIN REACTION CONTRAPTION

LESSON OVERVIEW

Inspired by Rube Goldberg, this lesson challenges students to explore a variety of mechanical interactions and solve a very simple problem in a wacky and complex way. Students will brainstorm ideas and then use the littleBits Invention Cycle to perform a simple task with a chain reaction contraption. Then they will build and test multiple prototypes of their favorite idea, making improvements and measuring each against their criteria for success. At the close of the lesson, students will create videos or cartoons of their chain reaction contraption in action.

LESSON TAGS

GRADE LEVEL	SUBJECTS	DIFFICULTY	DURATION
elementary, middle	engineering art/design	intermediate	120 minutes (minimum)

PREREQUISITE KNOWLEDGE

Introducing littleBits
Introducing the Invention Cycle

SUPPLIES

BITS	ACCESSORIES	OTHER MATERIALS	TOOLS USED
any Bits	any accessories	see list of commonly used materials on pg. 119 of the STEAM Student Set Teacher's Guide	see list of commonly used tools on pg. 119

DESCRIPTION

LESSON OBJECTIVES

- Brainstorm ideas for meeting the designated challenge
- Create and test a circuit containing a power source, inputs, outputs and wires
- Construct a prototype of a two-step (minimum) contraption that uses Bits and

other materials
• Test their prototypes and make improvements
• Self-assess their work based on the identified 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
• Summarize their process and share the results by creating videos of their chain reaction contraption in action

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 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-ETS1-1 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 fulfill 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.

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, students explicitly compare multiple solutions on the basis of the success and criteria constraints.

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 fulfill 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.

MS-ETS1-1 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 fulfill this standard, students set various criteria for success, as well as constraints for the successful completion of the design problem.

MS-ETS1-2 Engineering Design: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

To fulfill this standard, students create different solutions to the problem and explicitly compare them on the basis of their ability to meet the goal within the constraints.

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.

Students test their prototypes and make improvements. Set all but one variable as fixed, and change the amount of 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.

To meet these standards, 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
constraints
criteria for success

RESOURCES

ATTACHMENTS	Invention Log STEAM Student Set (SSS) Teacher' Guide
INSPIRATIONAL LINKS	Rube Goldberg Cartoon Gallery Six Rube Goldberg Machines OK Go Rube Goldberg Machine* *This video contains a lyric that may not be appropriate for all ages
TIPS & TRICKS	For Open Challenges, we recommend that the teacher create an example invention, which may or may not be shown to students at the beginning of the lesson. Taking the challenge through the Invention Cycle will better equip teachers to successfully conduct the lesson and be more knowledgeable about where the class, or specific students, may need a bit more time or support.

INSTRUCTIONAL STEPS

littleBits education

STEP 1: SETUP

This lesson can be done individually or in small groups (2–3 students). For an advanced challenge, have the whole class collaborate to invent a massive contraption!

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. Place a variety of construction materials and tools in a central location in the room.

STEP 2: INTRODUCE

Duration: 15-20 minutes

Introduce the lesson objectives and the concept behind the challenge:

"Rube Goldberg was a cartoonist who liked to draw really complicated solutions to very simple problems. For example, to turn the page of a book, you might roll a ball down a ramp that hits a box. Then the box falls over and scares a hamster that starts running on its wheel, that winds up a string that turns the page. In this challenge, you're going to design your own multi-step machines. Before you start inventing, there are two important rules: 1) Once you start your machine, it needs to be able to run without any help from you. Each step must be triggered automatically by the step before it, and 2) Your machine should have at least two steps (bonus points if you can create more!)"

Share videos and/or cartoons of Rube Goldberg machines to provide context and inspiration.

Most design challenges focus on how life can be made easier by an invention. This challenge is a fun exploration in the opposite direction. How complicated can we make a very simple task? To this end, you may work in a little absurdity and whimsy.

Before jumping into the challenge, provide a quick review of the Invention Cycle framework and the format of the Invention Log (STEAM Student Set Teacher's Guide, pg. 35). Ask students to share lessons learned about Bits, the invention process and things they enjoyed or struggled with from previous challenges..

STEP 3: CREATE

Duration: 45-55 minutes

A. CREATE IDEAS

For each of the prompt sections below, students will record their process and reflections in their respective Invention Logs.

What ideas do you have?

Prompt students to create a list (either as a class, or in groups) of everyday activities that only take one step. For example, dropping a can in the recycling bin, flipping on a light switch or opening a book. Refer to SSS Teacher's Guide, pg. 13 for brainstorming tips.

Which idea seems best?

After making a list of 5–10 ideas, have students choose the everyday activity that they want to accomplish. It could be the idea that sounds the most fun to solve or is the most accessible in the classroom. Students should frame their thinking in the following framework: I will invent a that because.

What's the "before" story?

What is life like now, before the proposed invention exists? Ask students to draw or describe the series of events before, during and after to show cause-and-effect scenarios. Be sure to consider the characters involved and the setting that the "story" takes place in.

What are the constraints?

Constraints are the limits and requirements that need to be considered in the invention process. Examples include time, materials, weight. Have students detail any constraints that they may need to keep in mind as they work. For younger students, you may choose to run this exercise as a class and have students record shared ideas.

What are the criteria for success?

How will students know if their invention works? Describe the number-one goal for the invention. What qualities are important for the invention to have?

B. CREATE PROTOTYPE

For each of the prompts below, students will record their process and reflections in their respective Invention Logs.

How could Bits help you solve your problem?

Instruct students to look through their available Bits and materials to see how they could (or couldn't) be combined to help solve your problem. For example, how could a servo trigger a slide dimmer? How could a DC motor trigger a light sensor? Could the inverter play a role? How could other materials (e.g. books, cardboard, cups) serve as triggers?

If students get stuck, try snapping a Bit into a circuit or read through the Bit Index (p. 7–27 in their Invention Guide).

What does your first prototype look like?

Students create a drawing(s) of their first prototype, labeling Bits and any important features. A description of how the prototype is supposed to work should also be included. This is a time for students to dig into the Bits and materials and start to bring their ideas to life.

STEP 4: PLAY

Duration: 10-15 minutes

Once the prototypes have been constructed, students should test the steps of their contraption to see if it works. Getting all of the moving pieces to work together is going to be a challenge; failure is part of the process. Encourage students to try running the contraption a few times, doing initial adjustments on angles, connections and materials. Students should take note of successes and things that still need to be improved in their Invention Logs.

STEP 5: REMIX

Duration: 15-25 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...)

This is the opportunity to experiment with fixes and improvements. As students make changes to their inventions, make sure they are documenting in their Invention Logs how their prototypes are changing and the results (good and bad).

If students need some inspiration, set the invention aside and look through the remaining Bits and available materials. Is it possible to complete a step with them? Try a few options and see how they compare to what has already been created.

Continue the Remix phase (and remind students to play with their updated inventions) until the prototype is able to meet the criteria for success, or until the allotted time runs out. If you need more advice on how to conduct and provide prompts in the Remix phase, read through the Invention Advisor section (SSS Teacher's Guide, p. 13).

STEP 6: SHARE

Duration: 30-35 minutes

Wrap up the challenge by reflecting and tying together the story of the invention. Have students take a video of the contraption in action and post it to your favorite social media channel. As an alternative, students can create their own Rube Goldberg cartoons to describe what their invention is used for and how it works.

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

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

MS-ETS1-4 Engineering Design: 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.

To fulfill this standard, students define and iteratively collect data to explore the explicit connection between the invention and a physical or environmental interaction that may impact the design. For example, modeling the impact of friction on the ability of a wheeled invention to climb a slope, or the impact of an invention on human behavior. The storyboard in the Invention Log should be used and updated throughout the lesson for each iteration tested.