CAL RIPKEN, SR. Foundation

TRANSFORM COMMUNITIES
CHANGE KIDS' LIVES

Ripken Foundation STEM Center

Elementary School Curriculum Guidebook

Sixth Edition

CONTENTS

Introduction A1
- About the Cal Ripken, Sr. Foundation A3
- About the Cal Ripken, Sr. Foundation STEM Program A3
- Guiding Principles of the Cal Ripken, Sr. Foundation A4
- Keeping Kids Engaged A5

Educational Principles Behind STEM Education B1
- Hands-On Learning B3
- Inquiry-Based Learning B4
- Engineering Design Process B4
- Scientific Method B6

What is a Ripken Foundation Elementary School STEM Center? C1

Product Guide (products that could be included in your STEM Center) D1
- Bee-Bot D5
- Code Hopper D7
- littleBits D9
- Makey Makey D11
- Ozobot D13
- ROK Blocks D15
- Foundational Fluencies D17
- STEM Pathways Lab D19
- Snap Circuits D21
- Squishy Circuits D23
- LEGO® Coding Express D25
- LEGO® WeDo 2.0 ..... D27
- Sphero BOLT D29
- Sphero indi D31

Lessons E1
- Bee-Bot E5
- Code Hopper E13
- littleBits E15
- Makey Makey E17
- Ozobot E33
- ROK Blocks, Foundational Fluencies, and STEM Pathways E37
- Snap Circuits E55
- Squishy Circuits E69
- LEGO® Coding Express E73
- LEGO® WeDo 2.0 ..... E75
- Introduction to 3D Printing Concepts E77
- Sphero BOLT E79
- Sphero indi E147

STEM Resources F1

Annual Implementation Plans G1

INTRODUCTION

INTRODUCTION

ABOUT THE CAL RIPKEN, SR. FOUNDATION

During his 37-year career with the Baltimore Orioles organization, Cal Ripken, Sr. taught the basics of the game and life to players big and small. After he passed away, his sons Cal and Bill recognized that not every child is lucky enough to have such a great mentor and role model. In this spirit, the Ripken family started the Cal Ripken, Sr. Foundation, a national 501(c)(3) nonprofit organization, in 2001.

By teaching kids how to make positive choices no matter what life throws at them, the Cal Ripken, Sr. Foundation strives to help underserved youth fulfill their promise and become healthy, self-sufficient, and successful adults.

ABOUT THE CAL RIPKEN, SR. FOUNDATION STEM PROGRAM

The Cal Ripken, Sr. Foundation provides programs, resources, training, and support to community-based youth organizations across the country that directly impact the lives of underserved kids. When it comes to the fields of Science, Technology, Engineering, and Math (otherwise known as STEM), we have created a program that makes STEM activities and learning easy for teachers and mentors at community-based youth organizations to implement.

We have developed Ripken Foundation STEM Centers to facilitate STEM learning with youth partners nationwide. Each Ripken Foundation STEM Center is equipped with this STEM curriculum guidebook paired with STEM Center products and activity kits which provide a comprehensive, experiential learning environment for kids. The activities in the guidebook are designed to offer teachers and mentors many ways to teach critical thinking and problem-solving skills, all while having fun.

GUIDING PRINCIPLES OF THE CAL RIPKEN, SR. FOUNDATION

Cal Ripken, Sr. was a player, coach, and manager in the Baltimore Orioles organization for nearly four decades. He developed great players and, more importantly, great people through his style of coaching which we use as our guiding principles at the Foundation. No matter what you are teaching, you can use these four key ideas as your guide:

Keep It Simple

Lessons on the field and in life are best learned when presented in a simple manner. Teach the basics and keep standards high.

Explain Why

By helping kids understand the connections between everyday decisions and real-life outcomes, we can help them make smarter choices for brighter futures.

Celebrate The Individual

When kids are encouraged to be themselves, respected for their opinion, and are encouraged to share it, they are more likely to have a higher self-esteem and feelings of self-worth.

Make It Fun

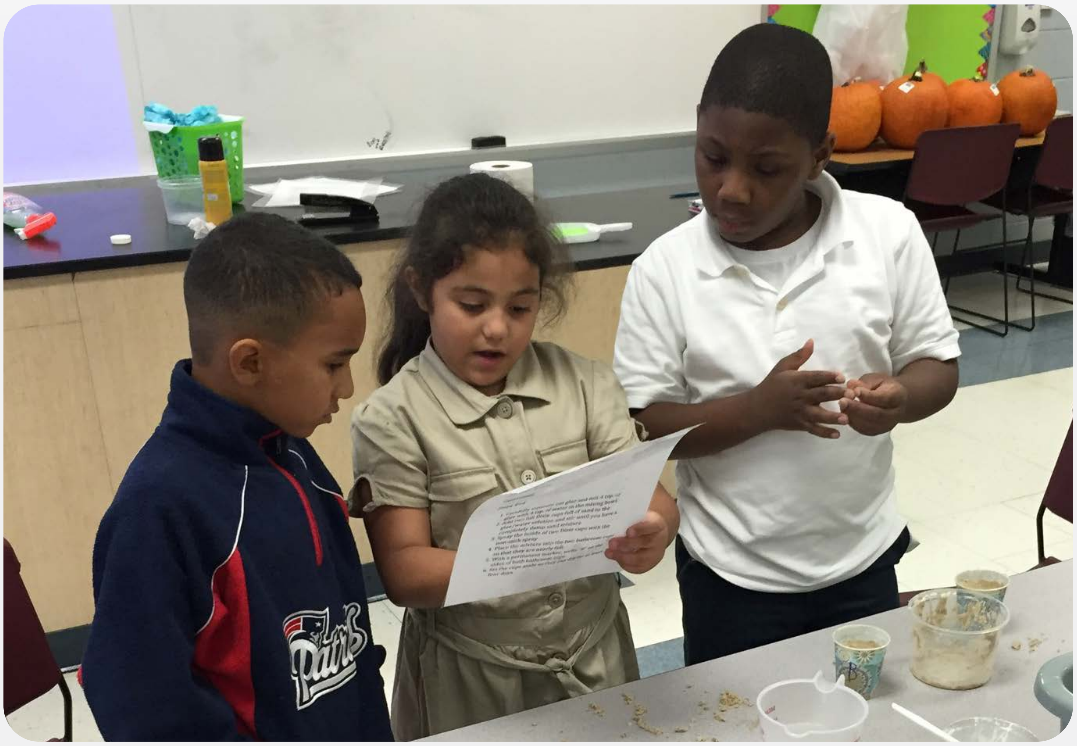
If kids aren't paying attention or participating, how much are they learning? Whether it's using a game to teach a concept or motivating kids with a little friendly competition, keeping kids engaged is essential.

Want to hear Bill Ripken explain the guiding principles of the Foundation?
Go to www.RipkenFoundation.org and sign up for a free account today!

KEEPING KIDS ENGAGED

Here are some tips to help you structure activities that keep kids engaged, excited, and coming back:

- **Have a plan**
- **Keep activities structured**
- **Provide feedback**
- **Encourage, encourage, encourage**
- **Allow kids opportunities to collaborate and learn from each other**
- **Set achievable goals**
- **Let kids be silly – they're kids!**
- **Use short time increments and reminders**
- **Rotate activities frequently**
- **Let kids have input in the activities they like best**
- **Stay consistent and create routine**
- **Affirm kids when they do well**



EDUCATIONAL PRINCIPLES BEHIND STEM EDUCATION

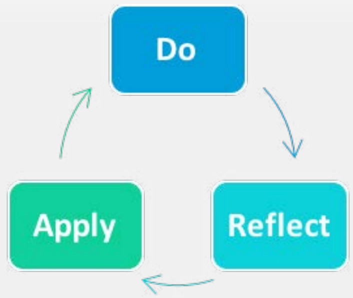
Ripken Foundation STEM Centers allow kids to learn and explore their curiosities without the confines of standardized lesson plans and testing. This curriculum guidebook is designed to give you background on the supplies we have provided, along with a set of lessons to enrich your mentoring program.

To help you curate a successful STEM program, we have provided a selection of tools that will strengthen your skills as a STEM mentor. Having these tools in your back pocket will enrich your understanding of the best practices which will enable you to teach important principles while having fun! Remember, some of these tools youth have already encountered in the classroom, so using them in afterschool mentoring programs will reinforce the skills and instill the confidence kids need to excel in STEM subjects, leading to careers in related fields.

HANDS-ON LEARNING

Hands-on learning is a key component of the Ripken Foundation STEM Centers. By having kids actively participating in a hands-on learning experience, you foster skills of inquiry, self-discovery, and problem solving, all while learning science, technology, engineering, and mathematics concepts.

The Experiential Learning Model shows how learning occurs with hands-on experiences. This model, based on the work of D.A. Kolb (1984), works on three basic principles: Do, Reflect, Apply.



Do:

Instruct the kids to conduct an activity. Kids are directly involved in the process by conducting experiments, designing solutions, and testing out ways to answer questions.

Reflect:

Ask questions to help the kids process the experience they just had. The questions offer a chance to delve deeper into the activity and understand concepts they can take away from the experience.

Apply:

Discuss other ways they can use the skills learned with other activities and experiences. The skills developed with one activity transfer to many different applications.

For example – you want your kids to build a garden. They learn how to sow seeds and care for plants, but they also learn how to plan ahead and use resources wisely. These skills developed in the garden will apply on their next project building birdhouses and beyond.

INQUIRY-BASED LEARNING

The Inquiry-based learning process allows kids to learn and grow in a supportive environment that gives them the opportunity to explore their curiosities through facilitated activities that incorporate "free play." Lessons usually begin with an introduction of concepts providing the educational background for activities. You can provide parameters and limitations such as time, budget, limited supplies, real world applications, etc. to give a context for the activities they are about to complete. After providing constructs, task kids with an open-ended challenge that allows them to explore and learn as needed within the constructs. Inquiry-based learning provides some structure for the kids on the front end, while allowing for the kids to arrive at a solution on their own or as a group.

For example – you task the kids with building the tallest tower they can in 10 minutes using only a limited number of index cards and straws. You provided the time and materials constraints, as well as gave them a goal, but left the design, use of materials, and actual construction up to the kids.

ENGINEERING DESIGN PROCESS

The Engineering Design Process (EDP) is a tool to assist with facilitation of problem solving. Children are presented with a scenario or problem, and they follow the steps of the engineering design process to imagine, create, and improve upon a solution to the issue at hand.

To help put this in context of classroom facilitation, we have created an example problem: Ellie and Henry are trying to grow three tomato plants. All three plants need to get water at the same time, but they only have one watering can. The six steps to the Engineering Design Process are as follows:

Ask:

Define the problem to address.

Scenario: We need to water three plants with one watering can.

Imagine:

Conceptualize and brainstorm ideas of possible solutions.

Scenario: How can we have the water come from one can but go three different places?

Plan:

Draw out sketches to visualize ideas including notes for assembly and constructing a model.

Scenario: Henry sketched out a picture of possible contraptions to add to the watering can. Ellie then built a working model based off Henry's drawing.

Test:

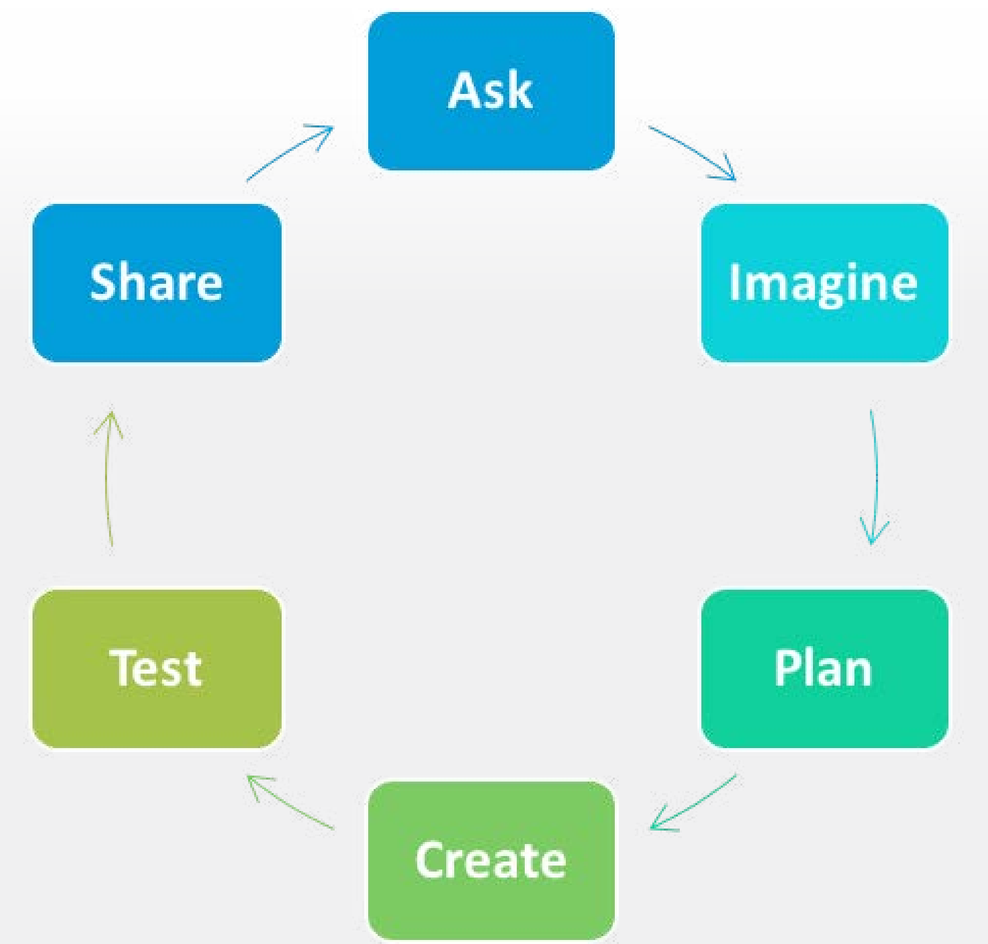
Conduct testing to determine if the plan meets the needs and solves the problem. Testing can identify improvements that need to be made and kids can go through the EDP until they are happy with a solution.

Scenario: Henry and Ellie tested their design to see if it worked. It didn't work, so they looked at the drawing and modified their model until it did what they wanted!

Share:

Engineering is a collaborative process. Kids can work in groups to create plans together, or they can offer feedback at the end.

Scenario: Ellie and Henry shared their design with their classmates, so everyone could use it and got feedback on how to make it better.



SCIENTIFIC METHOD

The Scientific Method is a process used to conduct science experiments through a logical process of problem solving and observation to help answer a question. The questions can be as simple or as complicated as you would like. Some experiments solve problems while others simply exist to satisfy a curiosity. The scientific method helps us with these questions through a step-by-step process to gather facts and arrive at an answer.

To help explain, we will follow up with Ellie and Henry's plants. They water them every day, but their plants are wilting and not growing. Ellie wants Henry's help to figure out why their plants are not growing.

Purpose

- State the problem or what you want to discover.
  - What is the question the experiment will address?
  - *The plants are wilting even though Ellie and Henry water them every day, why is this happening?*

Research

- Make observations about an issue or situation.
  - What is already known? What are you observing?
  - What potential causes of the problem can you rule out?
  - *Ellie thought, "My plants get water and sunshine, but what if I am watering them too much?"*

Hypothesis

- Predict the outcome to the problem in a testable statement.
  - Create a statement that predicts the solution - usually written as an "if...then" statement.
  - Use the research and observations to make an educated guess as to what will happen.
  - *Henry poses "If we only water our plants once a week, then they will grow?"*

Experiment

- Develop a procedure to test the hypothesis.
  - Define a step-by-step plan to follow to ensure consistency in carrying out the testing.
  - *Henry and Ellie plan to use their three tomato plants. For one month, they will water one every day, one three times a week, and one, once a week. Ellie and Henry observed their plants twice a day and measured the height of each plant.*

Analysis

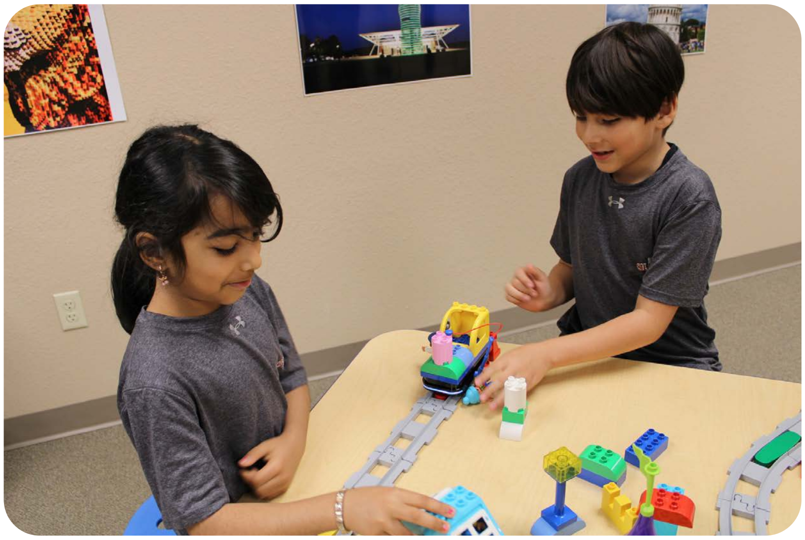
- Record the results of the experiment.
  - Keep track of the testing results and interpret them.
  - *At the end of the month, Ellie and Henry saw the plant that was watered every day did not grow, the plant watered three times a week grew one inch but was still somewhat wilted, and the plant watered once a week grew three inches and was standing tall.*

Conclusion

- Compare hypothesis to the results of the experiment.
  - Did the results of the experiment support the hypothesis? Why or why not?
  - *Ellie and Henry changed their plans and now only water their plants once per week as the experiment supported their hypothesis that watering the plants less than once per day would make their plants grow.*

WHAT IS A RIPKEN FOUNDATION ELEMENTARY SCHOOL STEM CENTER?

WHAT IS A RIPKEN FOUNDATION ELEMENTARY SCHOOL STEM CENTER?



We at the Cal Ripken, Sr. Foundation continue to help underserved kids through developing new and relevant programs. In keeping with that goal, we have created the Cal Ripken, Sr. Foundation STEM Program. According to a recent Harvard study, "there is widespread recognition of the need for literacy and proficiency in Science, Technology, Engineering, and Mathematics (STEM) to navigate the modern world. Furthermore, there is an urgent national priority to transform STEM learning and engagement in order to meet the nation's need for a STEM-skilled workforce." One of our priorities is giving underserved youth in disadvantaged neighborhoods the opportunity to participate in STEM programs.

The Ripken Foundation Elementary School STEM Center includes the following:

PRODUCTS

Organizations that implement the Ripken Foundation STEM program will receive a selection of materials to enhance STEM learning with their kids in the form of STEM Center products and STEM Kits.

RIPKEN FOUNDATION ELEMENTARY SCHOOL STEM CURRICULUM

This curriculum accompanies the Ripken Foundation STEM Center products, providing guidance on use of the products provided, as well as offering lessons to use with the kids and products.

RIPKEN FOUNDATION PORTAL

Our online portal offers digital copies of our curriculum as well as other resources for mentoring youth.

To download additional copies of the Ripken Foundation STEM curriculum, supporting files, and other educational materials, register for a FREE account at https://www.ripkenfoundation.org/resource-portal

PRODUCT GUIDE

Each Ripken Foundation Elementary School STEM Center will receive a set of STEM equipment and our Elementary School STEM Curriculum.

RIPKEN FOUNDATION STEM CENTER EQUIPMENT

The Ripken Foundation provides a variety of products to foster STEM learning in our Ripken Foundation STEM Centers. We work with our program partners to select products for their specific needs. Here is a list of some of the products available to each Center:

3D Printer:

Centers receive a 3D printer capable of bringing digital, 3-dimensional models to life! Several spools of printing filament and a replacement nozzle are also included.

Curriculum

The curriculum provided for the Center is based on the Next Generation Science Standards.

Computers:

Each Center can receive Chromebooks to meet their needs.

Furniture:

Centers can receive up to: 28 Flavors Stackable Chairs, seven Elemental Clover Tables that seat up to four students per table, and one workbench.

STEM Kits:

The Ripken Foundation STEM Kit includes fun and captivating activities that teach STEM concepts that cater to a variety of ages. The educational STEM products in the Ripken Foundation's STEM Kit could include:

- **Bee-Bot**
- **littleBits**
- **Makey Makey**
- **Ozobot**
- **Foundational Fluencies**
- **STEM Pathways**
- **Snap Circuits**
- **Squishy Circuits**
- **LEGO® Coding Express**
- **LEGO® WeDo 2.0**
- **Sphero BOLT**
- **Sphero indi**

OVERVIEW

Bee-Bot is a programmable robot designed for young children to teach counting, sequencing, coding, and problem-solving. Kids use the buttons to input commands telling Bee-Bot a sequence of actions to perform. Bee-Bot is rechargeable and comes ready to use right out of the box so with a little bit of exploration, kids can use Bee-Bot right away. Bee-Bot plays built-in sounds, but these can be muted with a switch on the bottom of the device. Kids can enter up to 40 commands, then press "go" and watch Bee-Bot in action!

PRODUCT SPECIFICS

Bee-Bot kit includes:

- **6 Bee-Bot robots**
- **1 Community mat**
- **1 Card mat**
- **1 Docking/Charging station**

TEACHER AND MENTOR NOTES

To enhance cross-curricular programming, Bee-Bot can be used in conjunction with mats with pictures of the alphabet, numbers, coins, or other objects to have kids spell words, add up coins to a target amount, or navigate a town from one store to another. Bee-Bot offers mats for sale on their website, as well as accessories and curriculum.

Bee-Bot moves in 6-inch steps and 90-degree turns and works on a variety of surfaces, so the official mats are not required for use. Groups can construct their own versions of the mats using masking tape on the floor, or other items that create a physical or visual barrier for kids to program Bee-Bot to avoid.

Command cards are another way to enhance the use of Bee-Bot. These cards have directional arrows that kids can place in a specific order to enter as a sequence for Bee-Bot. These cards help visualize the coding, and kids can easily troubleshoot if they encounter an issue.

ONLINE RESOURCES

- *https://beebot.terrapinlogo.com/*
- *https://www.terrapinlogo.com/products/books-curriculum/bee-bot-lessons/beebot-lessons-online.html*
  Bee-Bot Curriculum available for purchase (not required)

CODE HOPPER

OVERVIEW

Code Hopper from Mindware, is a game that uses interlocking foam tiles to teach decision making, and basic coding and sequencing concepts through gameplay. Blocks have words, pictures, commands, or questions on them to help kids learn input and output through logic and flow charts. Simple actions like "Kick your leg" and decisions such as "Do you see a circle?" each lead children down different paths and help build a foundation for STEM success. The kit also includes a parent guide with definitions of coding concepts.

PRODUCT SPECIFICS

Code Hopper kit includes:

- **12 two-sided mats**
- **Parent guide**

TEACHER AND MENTOR NOTES

Code Hopper is for children ages 3 and older with instructions on how to use the kit in the Parent Guide. There are activities provided in the kit that introduce preschoolers and elementary-age children to computer coding.

LITTLEBITS

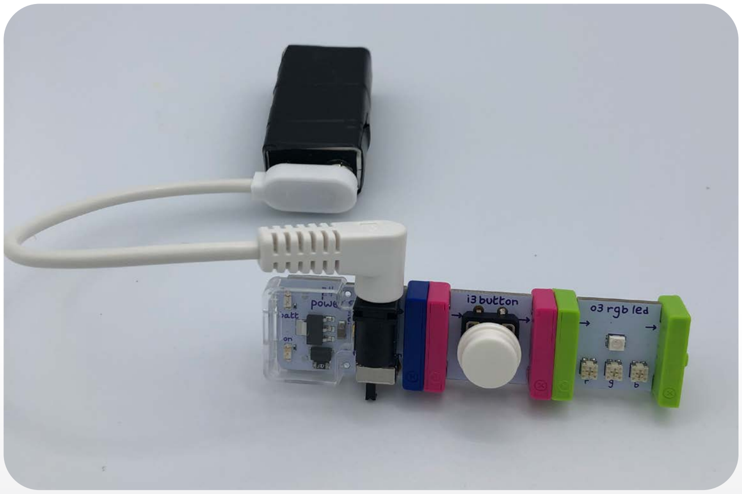
OVERVIEW

Often described as electronic building blocks, littleBits are easy to use educational tools that teach critical thinking and problem-solving through engineering and design. The kits are comprised of multiple electronic components (called bits) that each serve a specific function. The bits are color-coded and snap together using magnets making it fun and easy to use for kids and adults alike! littleBits comes with directions for assembling several projects which are easy to follow. The STEAM (Science, Technology, Engineering, Art + Design, and Math) Education Class Pack comes with lesson plans and resources to use in an educational setting.

PRODUCT SPECIFICS

littlebits kit includes:

- **8 STEAM Class Packs**
- **littleBits and accessories**
- **Introduction and littleBits Basics Guides**
- **Invention Guidebook tied to the Next Generation Science Standards (NGSS) and Common Core Standards**



TEACHER AND MENTOR NOTES

The materials are easy enough for elementary-aged children to use, but complex enough to allow high schoolers to create and explore. There are activities provided in the Teacher's and Student's Guides that come with the STEAM Class Pack, but there are many other lessons found on the littleBits educator's community website. You can sign up for a free account and gain access to many resources and ideas for using littleBits with your kids.

ONLINE RESOURCES

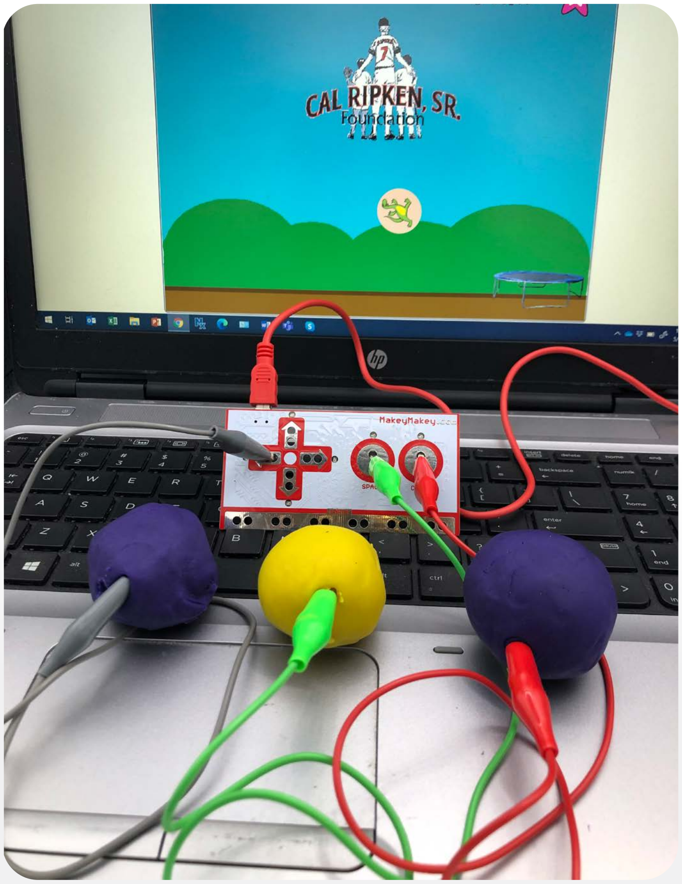
Use the camera feature on your device to scan the codes below. They will provide you with direct access or a link to the content.

- *Sphero littleBits Edu Resource Guide*
- *littleBIts STEAM Student Set Classroom Resources*

MAKEY MAKEY

OVERVIEW

Makey Makey is a computer chip that you can affix to any computer, and it will act as a keyboard, game controller, or other controlling device. Kids can play games, play a banana piano, and other neat activities, all while learning basic circuitry. Kids can also go as deep as applying it to coding and programming lessons. Makey Makey is ready to use right out of the box, so just plug it in and start the fun!



PRODUCT SPECIFICS

Makey Makey kit includes:

- **1 STEM Class Pack**
- **12 Makey Makey Chips**
- **Connecting wires**
- **USB computer connecting wires**
- **Graphite pencils optimized for use with Makey Makey**
- **Organizing carrying case**
- **Getting started guides**

TEACHER AND MENTOR NOTES

Makey Makey has a wide offering of online resources available to mentors. The Makey Makey website has instructions for some of the more popular projects such as banana bongos or play dough game controller. Makey Makey has also created an educational website where mentors from around the world can contribute and share ideas and lesson plans. There is also an online forum to ask questions and get ideas and insight on ways to use Makey Makey with your kids. Makey Makey pairs well with Scratch, a visual-based programming language. Using Scratch, kids can create colorful games and animations to use with their Makey Makey.

ONLINE RESOURCES

- *http://makeymakey.com/*
- *http://makeymakey.com/how-to/classic/*
- *http://makeymakey.com/education/*
- *https://labz.makeymakey.com/dashboard*
- *https://scratch.mit.edu/*

OZOBOT

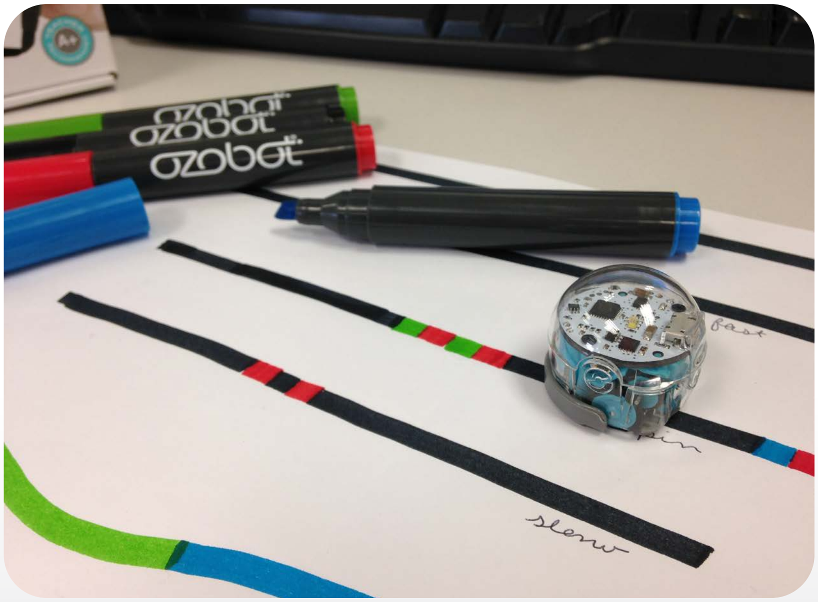
OVERVIEW

Ozobot is a programmable robot that uses simple concepts to teach coding and programming basics. Using markers, kids can simply draw a course and the robot will follow! By placing specific sets of colors along the course, the robot will read the colors and behave in a predetermined way. The robots can also be programmed on a computer using Blockly, a visual-based computer programming language.

PRODUCT SPECIFICS

Ozobot kit includes:

- **1 Ozobot Evo Class Pack**
- **12 Ozobot Evo robots**
- **Multi-port chargers**
- **Sets of markers**
- **Tip sheets**
- **Teacher's guide**
- **Storage boxes**



TEACHER AND MENTOR NOTES

Ozobot's Classroom Kit comes with some lessons and classroom resources. Ozobot has an online website that provides mentors access to additional resources such as lesson plans and activities. Mentors can also submit materials to share with others on how they use Ozobot with their kids.

ONLINE RESOURCES

- *http://ozobot.com*
- *http://ozobot.com/stem-education/*

ROK BLOCKS

OVERVIEW

ROK Blocks are a reusable set of prototyping tools that allow kids to build and create 3D models of almost anything they can imagine. This kit is a new approach to building blocks, which allows for building things in three dimensions. The variety of the pieces and their durability make this a versatile product that meets many different programmatic needs.

PRODUCT SPECIFICS

ROK Block kit includes:

- **6 ROK Blocks Mobile STEM Labs**
- **Stackable cases which hold various pieces and parts**

TEACHER AND MENTOR NOTES

Kid Spark Education has an online resource center with many different lessons available for download at no cost. These lessons cover a variety of different STEM topics, and even include 3D Printing. The lessons and resources are available for different age and grade levels.

ONLINE RESOURCES

Use the camera feature on your device to scan the codes below. They will provide you with direct access or a link to the content.

- *Kid Spark Education Main Website*
- *Kid Spark Education Online Curriculum*

FOUNDATIONAL FLUENCIES

OVERVIEW

The Foundational Fluencies STEM Lab focuses on spatial reasoning, sequence and correspondence, symbolism, patterns, and symmetry using building blocks. The materials are unintimidating and allow for collaborative learning, increasing student's confidence in STEM.

PRODUCT SPECIFICS

Foundational Fluencies kit includes:

- **4 Foundational Fluencies Labs**

TEACHER AND MENTOR NOTES

Kid Spark Education has an online resource center with many different lessons available for download at no cost. These lessons cover a variety of different STEM topics, and even include 3D Printing. The lessons and resources are available for different age and grade levels.

ONLINE RESOURCES

Use the camera feature on your device to scan the codes below. They will provide you with direct access or a link to the content.

- *Kid Spark Education Main Website*
- *Kid Spark Education Online Curriculum*

OVERVIEW

The STEM Pathways Lab focuses on structural and mechanical engineering, applied mathematics, rapid prototyping and 3D printing, and coding and robotics. The materials give students confidence in their ability to use technology to solve problems and create solutions.

PRODUCT SPECIFICS

STEM Pathways kit includes:

- **4 STEM Pathways Labs**
- **4 Spark:bit Robotic Controllers**

TEACHER AND MENTOR NOTES

Kid Spark Education has an online resource center with many different lessons available for download at no cost. These lessons cover a variety of different STEM topics, and even include 3D Printing. The lessons and resources are available for different age and grade levels.

ONLINE RESOURCES

Use the camera feature on your device to scan the codes below. They will provide you with direct access or a link to the content.

- *Kid Spark Education Main Website*
- *Kid Spark Education Online Curriculum*

SNAP CIRCUITS

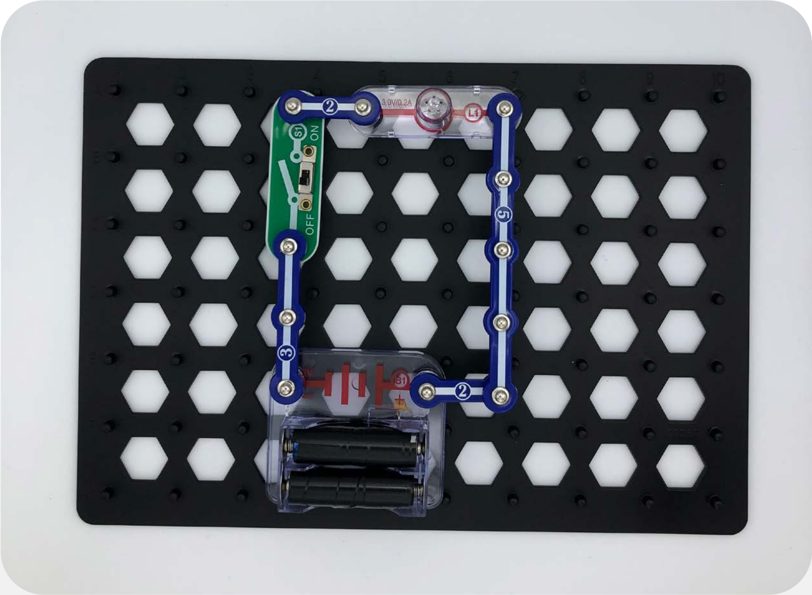
OVERVIEW

Snap Circuits from Elenco are a fun learning kit that teaches the basics of circuitry and electronics. The kit is comprised of different pieces that can be snapped together (like buttons) to create circuits which turn on lights, fans, radios, and other fun components! The kits are easy to use and assemble, and each comes with directions on how to put together different circuits. The kits can be combined to make larger circuits.

PRODUCT SPECIFICS

Snap Circuits kit includes:

- **12 Snap Circuits Jr.® Education 100 Experiments kits, including:**
  - **- Wire**
  - **- Resistor**
  - **- Speaker**
  - **- Motor**
  - **- LED**
  - **- Switch**
- **Project instruction guide**
- **Student guide**
- **Teacher guide**



TEACHER AND MENTOR NOTES

Snap Circuits allow kids to learn the concepts of electronics through easy-to-use components. The activities in the guide provided offer different projects that range in complexity from simply turning on a light to complex circuits using resistors and switches. One realistic feature of Snap Circuits is the use of actual electrical symbols on the products themselves as they would be seen in a schematic drawing or circuit diagram. Also, some of the pieces are made with clear plastic, so the internal wiring can be seen.

ONLINE RESOURCES

- *https://www.elenco.com/snap-circuits-2/*

SQUISHY CIRCUITS

OVERVIEW

Squishy Circuits teach circuitry and electronics by using conductive dough, LEDs, and other components using a fun and easy-to-grasp product. Using conductive and insulating dough, Squishy Circuits can create any shape imaginable while still teaching circuitry and electronics.

PRODUCT SPECIFICS

Squishy Circuits kit includes:

- **1 Group kit (includes enough components for a class), including:**
  - **Battery holder**
  - **LEDs (various colors)**
  - **Piezoelectric buzzer**
  - **Motor with fan blades**
  - **Switch**
- **2 Dough kits**

***Note:** *The dough is a consumable product will need replacing periodically. You can purchase more dough from the Squishy Circuits store, or make it using recipes included with the kit or found online.*

TEACHER AND MENTOR NOTES

Kids love how easy this product is to use. The dough provided works well, but there are alternatives as it is a consumable product and will need occasional replenishing. One option is to use commercial play dough as a conductive dough with modeling clay as the insulating dough. There are also recipes found online as well as in the kit to make your own doughs.

There are no official lessons provided from Squishy Circuits. You can find project ideas in the quick start guide and on the Squishy Circuits website.

ONLINE RESOURCES

- *https://squishycircuits.com/*
  Official site with store to purchase additional supplies.

LEGO® CODING EXPRESS

OVERVIEW

Taking the train set to the next level, the LEGO® Coding Express uses large, colorful bricks to teach STEM concepts such as cause and effect, and basic coding principles like sequencing and looping. Special bricks are placed along the train tracks to prompt the train to perform a specific action such as play a sound, turn on a light, or change direction. In order to introduce STEM at an early age, the LEGO® Coding Express is a kit aimed at kids two to five years old.

PRODUCT SPECIFICS

LEGO® Coding Express kit includes:

- **LEGO® DUPLO® bricks**
- **Battery-powered train**
- **Getting Started guide**

TEACHER AND MENTOR NOTES

The LEGO® Coding Express can be used on its own, or you can deepen and enhance the experience using the LEGO® Coding Express app. The app is available on Android and Apple iOS operating systems. LEGO® Education has lesson plans available to facilitate learning.

LEGO® Coding Express requires four AA batteries for each train chassis.

ONLINE RESOURCES

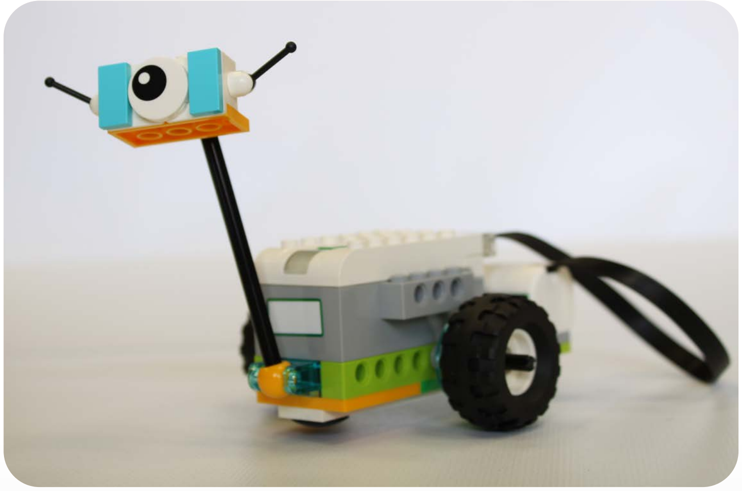
- *https://education.lego.com/en-us/support/preschool/coding%20express*
  Overview of LEGO® Coding Express resources including lesson plans, teachers guide, and building instructions
- *https://education.lego.com/en-us/lessons*
  LEGO® Education lesson plans

LEGO® WEDO 2.0

OVERVIEW

LEGO® WeDo 2.0 combines the standard LEGO® brick with motors and sensors for kids to build creations and code them to move and react to their environment. Using a visual-based coding app, kids program a sequence of events and build a structure that carries out the code. WeDo 2.0 comes with several sensors that react to movement as well as a motor and power hub.

PRODUCT SPECIFICS



LEGO® WeDo 2.0 kit includes:

- **LEGO® bricks**
- **Organizing tray**
- **Motors and sensors**

TEACHER AND MENTOR NOTES

LEGO® WeDo 2.0 requires the use of an app to program and use the motors and sensors. This app is available for multiple devices and operating systems. The LEGO® Education website has links to download the app for each platform.

LEGO® WeDo 2.0 requires two AA batteries per kit.

ONLINE RESOURCES

- *https://education.lego.com/en-us/support/wedo-2*
  Overview of LEGO® WeDo 2.0 resources including lesson plans, teachers guide, and building instructions
- *https://education.lego.com/en-us/lessons*
  LEGO® Education lesson plans
- *https://education.lego.com/en-us/downloads/wedo-2/software*
  LEGO® WeDo 2.0 App Downloads – available for multiple devices including tablets and computers
- *https://education.lego.com/en-us/support/3rd-party-support*
  Third-Party Software that is compatible with LEGO® WeDo 2.0

SPHERO BOLT

OVERVIEW

The Sphero BOLT is a programmable robot that transforms the way kids learn and create through coding, science, music, and the arts. The Sphero ecosystem of tools and content gives kids, teachers, and parents of all learning and coding abilities a blank canvas to solve challenges at home, in school, and beyond.

PRODUCT SPECIFICS

Sphero BOLT kit includes:

- **Sphero BOLT**
- **1 Inductive charging cradle**
- **1 Micro USB to USB charging cable**

TEACHER AND MENTOR NOTES

The Sphero Edu app contains 100+ guided STEAM and Computer Science lessons, activities, and programs, consisting of varying skill levels and content areas. We've curated a selection of 30 activities that will help guide you as you get started.

ONLINE RESOURCES

Use the camera feature on your device to scan the codes below. They will provide you with direct access or a link to the content.

- *Sphero Edu Browser*
- *Sphero Educator Resource Guide*
- *Sphero Edu App*

SPHERO INDI

OVERVIEW

The Sphero indi is an approachable entry-level learning robot for ages 4 and up. indi inspires imaginative, play-based learning by empowering kids to design and build their own mazes while creating opportunities for students to learn the basics of coding, solve problems, and nurture computational thinking skills.

PRODUCT SPECIFICS

Sphero indi kit includes:

- **8 indi robots**
- **Color tiles**
- **Storage case**
- **Charging case**
- **indi Educator Guide Book**

TEACHER AND MENTOR NOTES

The indi Educator Guide Book includes standard-aligned lesson plans for instruction. indi offers an unplugged programming experience with an onboard color sensor, or kids can kick their skills into high gear with more block coding options in the free Sphero Edu. Jr. app, designed just for indi.

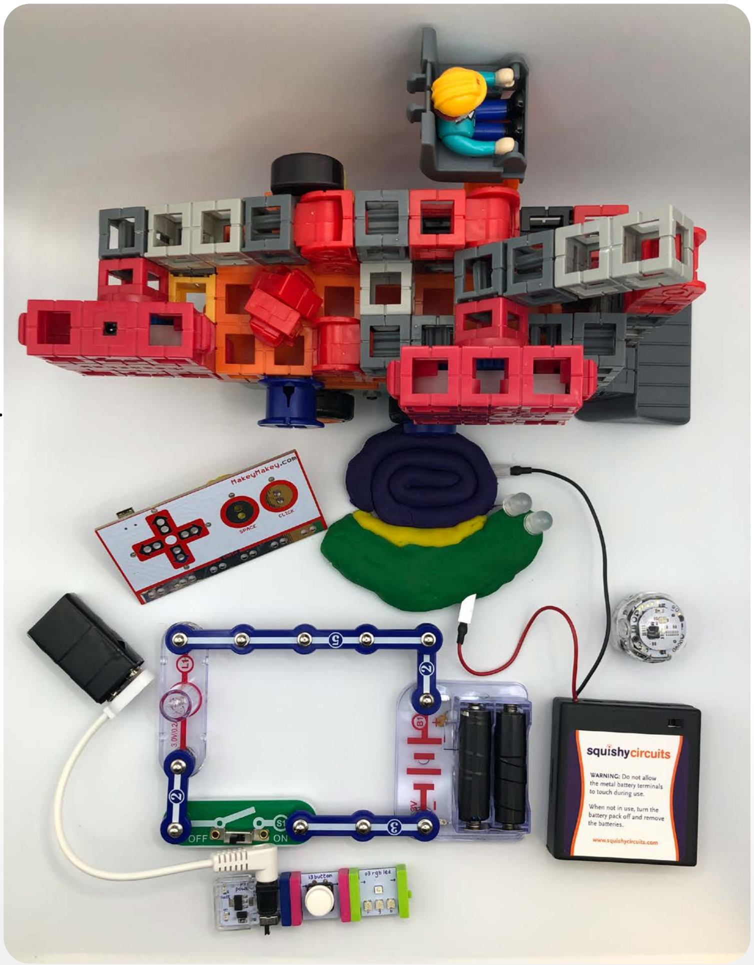
ONLINE RESOURCES

Use the camera feature on your device to scan the codes below. They will provide you with direct access or a link to the content.

- *Literacy and Math Support*
- *Special Education Guide*
- *Educator Guide Book*
- *Beginner's Guide to Programming Cards*
- *DIY Challenge Cards for indi*

LESSONS

LESSONS



We put together several lessons that utilize the Ripken Foundation STEM Kit. The lessons will rely heavily on the equipment provided, but may call for some additional resources. These lessons are designed for primary or intermediate elementary and middle school range students.

All of our lessons were developed to align with the Next Generation Science Standards. The Next Generation Science Standards is a national set of educational standards for STEM fields. These standards are used with in-school plans of study creating a cohesive learning experience for kids during mentoring programs. The Next Generation Science Standards were developed to establish skills and concepts crucial to STEM learning. By basing our curriculum on these standards, we are making sure that the activities and lessons create a meaningful experience for all children that attend Ripken Foundation STEM Center programs. This also places your organization ahead of others who do not align their programs to national standards, showing your dedication to education and youth development. For more information, visit *https://www.nextgenscience.org/*

OVERALL TIME *60-minute lesson*

GROUPS *Three to four kids per Bee-Bot*

Next Generation Science Standards:

K-2-ESS3-3
Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

OBJECTIVE

Kids will work together to program a Bee-Bot to meet different challenges.

OVERVIEW

Bee-Bots can be used to teach early programming skills, such as directionality, planning, sequencing, and counting while aligning to the engineering design process of working together. The Bee-Bot can travel forward, backward, as well as turn left and right.

MATERIALS

- **Bee-Bots (one per group)**
- **Mats (alphabet, coins, city)**

PREPARATION

Clear a space for groups to be able to spread out and use a Bee-Bot. In this activity, kids will be provided with enough programming basics to get them started while allowing time for them to engage in free exploration.

LAUNCH *10 to 15 minutes*

Bring everyone together in a large circle. Make sure there is enough space for kids to move around. Tell the group that you will be giving a direction, and they need to move like a robot in that direction. For example, if the path is forward three steps, kids will move forward three steps like a robot. Have kids move forward, backward, turn left, turn right, and complete a circle. Be sure to include the number of steps for each move, e.g. "move forward one step, turn right, or move forward three steps."

EXPLORATION *45 to 50 minutes*

Inform the group that they have just followed a sequence of code just like robots! Code is a set of instructions that tells a robot what to do. Now, they are going to use what they learned about coding in this next activity. Choose one of the following mats to use for the lesson:

- Community Map
- US Coins
- Alphabet

Show the mat to the group highlighting the layout and the different items in the spaces on the mat. Depending on the mat, the groups will program their Bee-Bot to travel to/from a pre-selected starting and ending point. For example, if you are using the community mat, pick one of the stores that the Bee-Bot will leave from and pick a second store as the destination. The groups need to develop a sequence of instructions for the Bee-Bot to follow to get from the start to the end destination.

Tell the groups to write down what they think they need to input into the Bee-Bot. Have the groups come up with their sequence, input it into the Bee-Bot, and test it on the mat. After testing, encourage groups to go back and look at their instructions and see what needs to be modified. Allow groups to test and modify as time allows.

If all groups accomplish this route, select two different points with a slightly more complicated path. Other options for extending the lesson:

- If using the US Coins mat, select a monetary value (that is attainable by combining two or three of the coins on the mat). Have the groups find the coins that add together to that value, and program the Bee-Bot to start at one corner of the mat, and travel to pick up the coins.
- If using the Alphabet mat, select a two or three letter word. Have the groups program the Bee-Bot to spell the word starting from one corner of the mat and traveling to each letter in the word.

CLOSING *5 to 10 minutes*

With 5 to 10 minutes left in the session, bring everyone back together to discuss the activity. Ask the group the following questions, and have the kids respond:

- *Can you think of other things that might follow code like Bee-Bot?*
- *Did anything happen that you didn't expect?*
- *What did your group do well?*
- *What would you do differently next time?*

ENRICHMENT AND NEXT STEPS

Here are some ways to use Bee-Bot in future activities:

- Program a Bee-Bot to stop at all the vowels, silver coins, or letters that are the same color.
- Have the Bee-Bot travel the community pausing at each stop.
- Program the Bee-Bot to travel backward around the perimeter of the carpet or mat.
- Design a maze for the Bee-Bot using rulers, markers, books, or any additional materials.

BEE-BOTS DIORAMA STORYBOARD

OVERALL TIME *60-minute lesson*

GROUPS *One to two kids per Bee-Bot*

Next Generation Science Standards:

K-2-ETS1-2

Develop a simple model based on evidence to represent a proposed object or tool.

OBJECTIVE

Kids will work together using a grid to create a pathway for a Bee-Bot to travel.
Kids will sketch and communicate the programming code using directional vocabulary.

MATERIALS

- **Bee-Bots**
- **Bee-Bot Journal Page (one per group)**
- **Bee-Bot cutout (one per group)**
- **Scissors**
- **Pencil**
- **Colored pencils (optional)**

PREPARATION

Kids will use previous programming basics to create a code sequence. Prepare an example of a coding sequence on large paper mirroring the Bee-Bot Coding Journal to use in the launch. One example: forward, turn right, forward, forward. Decide if you want to assign partners ahead of time, or allow kids to pick their partner. Set up an area where groups can complete a test run using a Bee-Bot and grid mat.

KEY TERMS

Program: the action of writing code for computers

LAUNCH *10 to 15 minutes*

Bring everyone together in a large circle. Remind the group that they have been learning about coding using directions such as forward, backward, turn left, and turn right to program the Bee-Bots. Hold up and show off the example grid, then place it in the middle of the circle. Next, hold up the Bee-Bot. Tell the group that they are going to read the code on the Bee-Bot grid. Start by asking what the first move the Bee-Bot needs to make to follow the path. Choose someone to answer. Then, have them check their answer by using the example grid and program the Bee-Bot to go forward one move. Ask the kids if the move was correct. Ask them what move the Bee-Bot needs to make next. Continue until the example coding sequence is complete.

ACTIVITY *15 to 45 minutes*

Give each pair a Bee-Bot Coding Journal page and a Bee-Bot cutout. Tell everyone they will create a path for a paper bot to travel by coloring in a path of squares on their Bee-Bot Coding Journal page. The path should have the Bee-Bot make five or more moves, and include one start square and one stop square. Once the pairs are done with their path, have them switch worksheets with another group.

Once they have switched worksheets, have pairs use the Bee-Bot cutout to figure out the directions needed to navigate the path. Instruct the group to write their code on the bottom of the Bee-Bot Coding Journal page.

After testing on paper, have kids move to the grid mat and test their code with a Bee-Bot.

CLOSING *5 to 10 minutes*

Bring the group back together.

Ask the group the following questions and choose a few kids to respond.

- *How did you work together?*
- *How did you decide on the pattern the Bee-Bot would travel?*
- *Was it hard to identify the directions the Bee-Bot needed to take? Is so, what did you do?*
- *Did you use directional vocabulary while working with your partner?*

ENRICHMENT AND NEXT STEPS

Challenge kids to complete a Bee-Bot Coding Journal independently, and
find the total distance in inches a Bee-Bot would travel, remembering the bot travels in six inch steps.

BEE-BOT CODING JOURNAL

NAME ______________________________

Write the code.

______________ ______________ ______________ ______________ ______________

______________ ______________ ______________ ______________ ______________
















CODE HOPPER

OVERALL TIME *60- to 70-minute lesson*

GROUPS *Three to four kids*

OBJECTIVE

Kids will work together to design a code sequence using two-sided mats.

OVERVIEW

Code Hopper is a fun way to introduce kids to computer programming through repeated body movements and actions, simulating how a computer follows commands.

VARIATION

This lesson could be completed over two days, demonstrating the launch on day one, followed by the activity on day two.

MATERIALS

- **Code Hopper (one per group)**
- **Color cards (optional)**

KEY TERMS

Code: a list of instructions that a particular program operates by.

PREPARATION

Set up a large area for kids to be able to move around.

LAUNCH *10 to 15 minutes*

Moving Mats

Have kids form a circle. Ask the group to raise their hand if they have played hopscotch. Tell kids that today they are going to be playing a coding hopscotch game.

Next, show the group the "start" mat and place it in the center of the circle. Then, choose a different piece. Look at the visual and read the action with the group. Together, complete the move, for example: stomp your feet. Attach this mat to the start mat. Continue this process until each of the pieces are used to complete the hopscotch. Then, finish by connecting the "stop" mat.

Have each kid take a turn playing hopscotch. Tell the group that in the next activity, they will be creating a Code Hopper hopscotch.

PREPARATION

Prepare a list of teams or give each kid a color card. The color represents the team they are on. Make space for each group to assemble the Code Hopper and number each station. Have a Code Hopper set ready for each team at each station. Decide on a signal to be used during rotations, for example: ring a bell or clap a pattern.

ACTIVITY *30 to 45 minutes*

Hopscotch

In the launch, kids learned that each visual on a mat represents a movement. Have groups go to their assigned station. Review the signal and rotation pattern.

Have each participant take one of the mat pieces. Tell kids to decide which side of the mat they want to have as part of the coding sequence.

Each kid will attach a mat piece. After all of the pieces have been connected, kids can get in line and play hopscotch.

After 8 to 10 minutes, use the signal and have teams switch to a different hopscotch mat. Continue the rotation until every group has interacted with each hopscotch.

CLOSING *5 to 10 minutes*

Bring the group back together. Have each group collect the Code Hopper and replace the pieces in the container. Then, ask the following questions:

- *How did your team work together?*
- *Were there some similarities and differences between the different hopscotches?*
- *What is something that you want to try next time?*
- *Raise your hand if you had FUN!*

ENRICHMENT

Use sidewalk chalk and create a hopscotch game outside.

OVERALL TIME *60- to 90-minute lesson*

GROUPS *Three kids per kit*

Next Generation Science Standards:

4PS3

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. An example of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound.

OBJECTIVE

Kids will apply the Engineering Design Process to build a moving object.

OVERVIEW

Kids should have had prior opportunities to explore with circuits using the introductory lessons included in the littleBits Educator's Guide. The group will engage in the engineering process to guide them as they brainstorm ideas, plan, test, modify, and retest their design to meet the challenge.

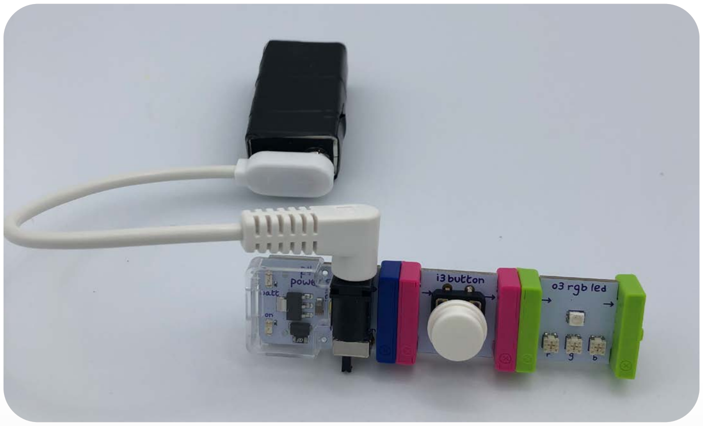
MATERIALS

- **littleBits kit**
- **Timer**
- **Paper**
- **Markers**
- **Tape**

PREPARATION

Each group will need an Engineering Design Process Sheet. Set up an area where kids can test and demonstrate their design. Provide each team with a piece of tape labeled with the group name or number. Post the different job roles, located in the launch on chart paper, or have it printed on index cards so each person in the group can take one.

*Kids will only be able to use the materials from the littleBits kit for the challenge.



LAUNCH *10 to 15 minutes*

Have kids form groups of three. Give each group a different colored marker and a sheet of paper. Tell the groups that they will be given five minutes to come up with a list of different types of items they use or have seen that include a switch, buzzer, or button circuit. Time the kids for five minutes. Set the timer and once the time is completed, have teams share their responses. Ask kids the following question:

How many of these items do you use or see daily? Have kids raise hands and share answers with the group.

Some possible answers:
Switch - lights, power windows, door locks on a car, radio, computer
Button - emergency stop buttons, phones, doorbells
Buzzer - horn, intercom, emergency doors

Tell kids that they will be creating electrical circuits. Review the Engineering Design Process with the group and answer questions as needed. Each kid will have a job in the challenge. Share the list of job roles and tasks assigned to each one. Provide teams with two minutes to decide on the different job roles.

Organizer: holds all kids accountable while supporting the work of the Programmer and Reporter, and keeps track of time.

Programmer: completes the working demonstration and is in charge of making modifications.

Reporter: sketches design, takes notes on experiments, and reports conclusions.

Share the challenge with mentees. The **challenge** is to create a design that moves and includes one of the following: switch, button, or buzzer.

EXPLORATION *50 to 60 minutes*

Teams will be given 25 minutes to design and build. Walk around to each group.

Possible questions to ask the **Organizer**:

- *What are your ideas for the design?*
- *What bits are you going to include?*
- *How did you decide?*
- *Did everyone contribute?*

After 25 minutes have gone by, give teams a 5-minute warning, marking 30 minutes. Check in with teams to see how much more time they will need. Feel free to allow more time if it is possible.

MODIFY *10 to 15 minutes*

Teams can take this opportunity to make modifications to their design, and then test again.

CLOSING: FINAL DEMONSTRATION

10 to 15 minutes

Choose a team to go first. Have the **Programmer** from the team come up and share their design and the different Bits used.

Next, call on the **Reporter** from each team to answer the following questions. If they need help, they can call on someone from their team to respond. *A variation could be to have each kid answer the following questions on an exit slip.*

- *Did your team have difficulty including any of the Bits?*
- *What modifications did your team make along the way?*
- *What could your design be used to do?*
- *If you could go back, what would you do differently now?*

Continue until all teams have had the opportunity to share.

* Encourage groups to cheer for each other, and take time for teams to thank each other for being a part of their learning community.

CLEAN-UP *5 minutes*

Have kids break apart the structures and use the littleBits Educator's Guide to put all the materials back in the box.

MAKEY MAKEY MUSIC AND FUN!

OVERALL TIME *60- to 75-minute lesson*

GROUPS *Three to four kids per kit and computer*

Next Generation Science Standards:

3-5-ETS1-3

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.

OBJECTIVE

Design a musical device or game controller using Makey Makey.

OVERVIEW

Makey Makey is a computer chip that connects objects to a computer, changing those objects into a musical device or a game controller. Kids will use their knowledge of basic circuitry as they create their own design.

MATERIALS

- **Electronic device – connected to the internet**
- **Makey Makey kit & How To Use It sheet**
- **Music and Fun Challenge Sheet**
- **Additional Materials: bananas, oranges, celery, lemons, cardboard, paper, aluminum foil, Playdoh**

PREPARATION

Gather as many of the additional materials ahead of time.

LAUNCH *5 to 10 minutes*

Have kids form a circle. As a group, ask the kids to raise their hand and name different musical instruments. As the instruments are named, have the kids make the sound that instrument makes. You can also record the responses on a whiteboard.

If the group is having difficulty coming up with instruments, suggest a few and ask the group if they know what sound the instrument makes. Once you cover a few different types of instruments, shift the discussion and ask if they can name any video games or consoles that use a controller. Some examples are Xbox, PlayStation, Wii, Nintendo, Mario Kart, Minecraft, etc.

EXPLORATION *35 to 40 minutes*

During the previous activity, kids had the chance to share different musical instruments and gaming systems, now they can transfer those ideas into a Makey Makey design challenge. Task the teams to design a musical device or game controller.

Challenge: Try to include one or more of the additional materials as part of the design.

Review the materials that come in the kit: Makey Makey board, alligator cables, white wires, and USB cord, How-to Use It guide, and additional resources.

CLOSING *10 to 15 minutes*

Invite two teams to partner up and share their designs with each other.
Here are some possible questions they can address while sharing:

- *What is your Makey Makey design?*
- *What worked well with this activity?*
- *Were there any challenges your team faced with this activity?*
- *How did your team address these challenges?*
- *What would you change, modify, or add to the design?*

Take time for teams to thank each other for being a part of their learning community.

ENRICHMENT AND NEXT STEPS

Have the kids create their own game or instrument simulator using scratch, then create the controller or instrument using Makey Makey.

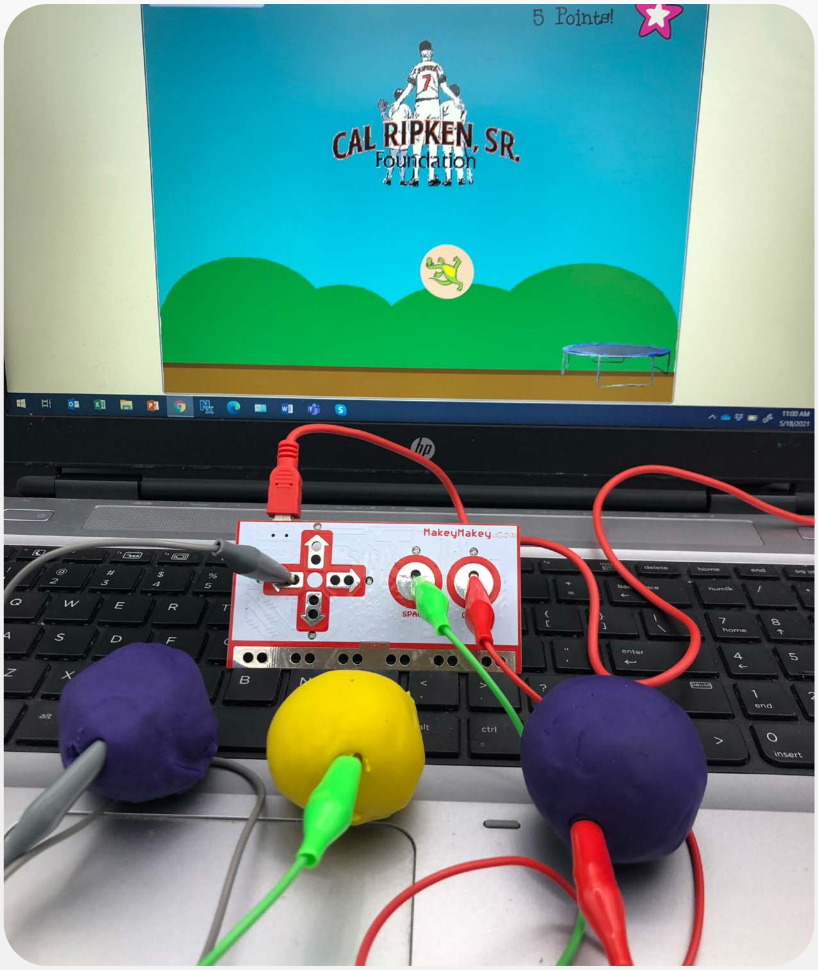
Your team needs to create a musical instrument or game controller using the Makey Makey! Use the "How-to Guide" included with your Makey Makey to learn how the chip works, then let your imagination run wild! You will find some games and online instruments to play using the links below, but you must design and create a controller or instrument to make the online programs work!

As a bonus: use at least one of the additional materials available to make your game controller or instrument.

When time is up, share your design with another team and learn how to use their design!

ONLINE GAMES AND WEBSITES THAT WORK WITH MAKEY MAKEY:

- *https://scratch.mit.edu/users/CRSFSTEM/*
- *http://makeymakey.com/how-to/classic/*
- *http://makeymakey.com/apps/*
- *https://www.coolmath-games.com/0-jumpingarrows*
- *http://www.Guitarflash.com*
  - *On the game, you will have to change the "settings keys."*
  - *You can use the arrows and space, or use the back of the Makey Makey and use the "asdfg" keys.*



FOR AN EXTRA CHALLENGE

Use Scratch to create a program – either an instrument simulator or a game of your own – then create a controller with Makey Makey.

MAKEY MAKEY INTRODUCTION LESSON K-2
BASIC CIRCUITRY

OVERALL TIME *50- to 60-minute lesson*

GROUPS *Three to five kids per computer*

Next Generation Science Standards:

K-2 ETS1-1

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

OBJECTIVE

Kids will explore and interact with basic circuitry using Makey Makey.

MATERIALS

- **Electronic device**
- **Makey Makey kit**
- **Games/activities from the Makey Makey or Scratch websites**

PREPARATION

Set up two demo games or activities for six to eight stations from the Makey Makey or Scratch websites. Select two activities that integrate with your grade level standards in science, literacy, or math or one that you think would be engaging for the kids. For example, the bongo drums or banana keyboard for reinforcing different types of patterns, ABB, AABB, etc.

LAUNCH *10 to 15 minutes*

Explain to the group that they will explore and interact with basic circuitry using Makey Makey. Say which activities you selected. Then, choose two or three volunteers to come up in front of the class and demonstrate the activity.

EXPLORATION *35 to 40 minutes*

Have kids partner up in groups of four to five. Depending on the grade-level and time available, consider having the groups already formed and pre-select the order the kids will rotate.

Assign half of the group to one game station and the other half to the other station. Set a timer for 20 to 25 minutes to mark the time for kids to switch stations.

CLOSING *10 to 15 minutes*

Invite groups to gather around in a circle to answer the following questions:

- *What did you learn about Makey Makey?*
- *Which activity was your favorite? Why?*
- *Did you have fun?*
- *Are you interested in finding out more about Makey Makey?*

MAKEY-MAKEY K-2 BLOCK CODING

OVERALL TIME *One or two 50- to 60-minute lesson(s)*

GROUPS *Three to five kids per computer. Depending on the grade level and time available, consider having the groups already formed.*

Next Generation Science Standards

K-2 ETS1-1

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

OBJECTIVE

Kids will explore programming using block coding.

MATERIALS

- **Electronic device**
- **Coding Journal**
- **Scratch website tutorials** *https://scratch.mit.edu/educators*

Optional:

- **Scratch Coding Cards (downloadable from website)**
- **Scratch Jr. and iPads (if available)**

KEY TERMS

Algorithm: a list of steps to complete a task

Program: an algorithm that contains a series of coded instructions to be followed by a computer or other machine

Programming: designing and creating a program

PREPARATION

Take some time to view the tutorials on the website. Then, choose a tutorial for the kids to view. Connect a computer to a projector to display during the launch. Show the introduction video for the selected tutorial. Prior to the lesson, print a coding journal for each kid. Prepare the following T-Chart to utilize during the launch.

What do you know or think you know about coding?	What do you want to learn about coding?

LAUNCH *5 to 10 minutes*

Ask kids what they know or think they know about coding. Record responses on the left side of the T-Chart. Then, ask what they would like to learn about coding. Record responses on the right side.

EXPLORATION *35 to 40 minutes*

Review the school's technology expectations with the group. Explain they will be learning more about how to code using Scratch.

Display the preselected coding tutorial. Once done, have groups practice what they have learned on their computers. Have kids sketch or write what they learned in the Coding Journal.

Then, review another tutorial as a large group or have everyone choose one individually. Once done, have them record what they learned in the journal.

CLOSING *10 to 15 minutes*

Have the group clean up and form a large circle. Here are some possible discussion starters:

- *Share one thing learned about coding.*
- *Were there any parts of coding that were challenging*?
- *What would you like to try next*?

ENRICHMENT AND NEXT STEPS

Kids can continue with the Scratch tutorials or use other programming apps such as Hour of Code and Kodable.

Print out extra sets of Scratch task cards for students to take home.

OVERALL TIME *50- to 60-minute lesson*

GROUPS *Three to five kids per computer*

Next Generation Science Standards

K-2 ETS1-1

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

OBJECTIVE

Kids will explore and interact with basic circuitry using Makey Makey.

MATERIALS

- **Electronic device**
- **Makey Makey kit**
- **Games/activities from Makey Makey or Scratch websites**
  - *https://scratch.mit.edu*
  - *https://makeymakey.com*

PREPARATION

Set up two demo games or activities for six to eight stations from the Makey Makey or Scratch websites. Select two activities that integrate with your grade level standards in science, literacy, or math or one that you think would be engaging for your group. For example, the bongo drums or banana keyboard for reinforcing different types of patterns, ABB, AABB, etc.

LAUNCH *10 to 15 minutes*

Explain to the group that they will explore and interact with basic circuitry using Makey Makey.

Show the group the materials that come in the kit:

- Makey Makey board
- Alligator cables
- White wires
- USB cord
- How To Use It guide

Explain how these materials are used in the selected activities.

Next, share the activities you selected. Then, choose two or three volunteers to come up in front of the class to demonstrate each activity.

EXPLORATION *40 to 50 minutes*

Have kids form groups of four to five. Depending on the grade level and time available, consider having the groups already formed.

Explain to the group that they will have time to explore the Makey Makey and Scratch websites. Each group will choose an activity or game to try out. The challenge is for groups to find an activity that uses up to four arrows on the keyboard or the Makey Makey board.

**Remind kids of the center's technology expectations.*

CLOSING *10 to 15 minutes*

Invite teams to gather around in a circle to answer the following questions:

- *What activity did your group try?*
- *Did you use the keyboard arrows or the Makey Makey board?*
- *What did you learn about Makey Makey?*
- *Are you interested in finding out more about Makey Makey?*
- *What would you like to try next using Makey Makey?*

NOTE

If more time is needed, consider having an additional exploration day.

OVERALL TIME *One or two 50- to 60-minute lesson(s)*

GROUPS *Four to five kids per computer. Depending on the grade level and time available, consider having the groups already formed.*

Next Generation Science Standards

3-5 ETS1-1

Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

OBJECTIVE

Kids will explore programming using block coding to solve a problem or complete an action.

MATERIALS

- **Electronic device**
- **Coding Journal**
- **Scratch website:** *https://scratch.mit.edu/*

Optional:

- **Scratch Coding Cards (downloadable from website)**

KEY TERMS

Algorithm: a list of steps to complete a task

Program: an algorithm that contains a series of coded instructions to be followed by a computer or other machine

Programming: designing and creating a program

PREPARATION

Take some time to view the tutorials on the website. Then, choose a tutorial for the kids to view. Connect a computer to a projector during the launch. Show the introduction video for the selected tutorial. Prior to the lesson, print a coding journal for each person.

LAUNCH *5 to 10 minutes*

Provide each kid with a coding journal. Give them five minutes to respond to the following questions in their journal:

- *What is your experience with coding?*
- *What would you like to learn about coding?*

Next, have them partner up and share their responses with three other people. Have each person write down one thing their partners shared in the journal. Have music, a timer, or a bell to signal a partner change.

EXPLORATION *35 to 40 minutes*

Review the school's technology expectations with the group. Explain that they will be learning how to code using Scratch.

Introduce the group to the coding tutorials on the Scratch website using the one you have preselected. Provide each kid with a coding journal. Each person then chooses one tutorial to explore from each of the Scratch categories: animation, art, music, games, or stories.

Kids will not have time to view all tutorials during this lesson. In the journal, kids should write down what they learned from the tutorials they viewed. Additionally, they may note any categories they may want to revisit.

CLOSING *10 to 15 minutes*

Have everyone clean up and form a large circle for a coding debrief. Here are some possible discussion starters:

- *Share one thing you learned about coding.*
- *Were there any parts of coding you found challenging?*
- *What is one thing you would like to try?*

ENRICHMENT AND NEXT STEPS

Have kids continue with learning to code using the Scratch tutorials or other programming apps such as Hour of Code or Hopscotch.

Print out extra sets of Scratch task cards to take home.

MY CODING JOURNAL K-2

Sketch or write about what you learned.

Rate how you feel about programming using an emoji.

MY CODING JOURNAL 3-5

Name ___________________ Date ____________________

CODING JOURNAL

What is your experience with coding?

What would you like to learn about coding?

Partner 1 ____

Partner 2 ____

Partner 3 ____

Name ___________________ Date ____________________

CODING JOURNAL

What is your experience with coding?

What would you like to learn about coding?

Partner 1 ____

Partner 2 ____

Partner 3 ____

Circle the category: animation music games stories

Sketch an example from the lesson.

When would you use this learning in a project?

Circle One

1. **I could use help with this.**
2. **I am starting to understand, but I could use more time and/or help.**
3. **I understand! I can do this on my own.**
4. **I am confident! I can help a friend.**

Circle the category: animation music games stories

Sketch an example from the lesson.

When would you use this learning in a project?

Circle One

1. **I could use help with this.**
2. **I am starting to understand, but I could use more time and/or help.**
3. **I understand! I can do this on my own.**
4. **I am confident! I can help a friend.**

OZOBOT BOWL-O-RAMA

OVERALL TIME *60-minute lesson*

GROUPS - *Activity 1: Partners*
- *Activity 2: Three to four kids*

Next Generation Science Standards

3-5-ETS1

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.

OBJECTIVE

Demonstrate an understanding of programming basics using color-coding.

OVERVIEW

Kids will use programming basics to program a small robot to act as a bowling ball to push down pins.

MATERIALS

- Ozobots
- Markers
- Ruler
- Paper (plain)
- Bowling set
- Ozobot Bowling sheet (copies for every kid)
- OzoCodes sheet

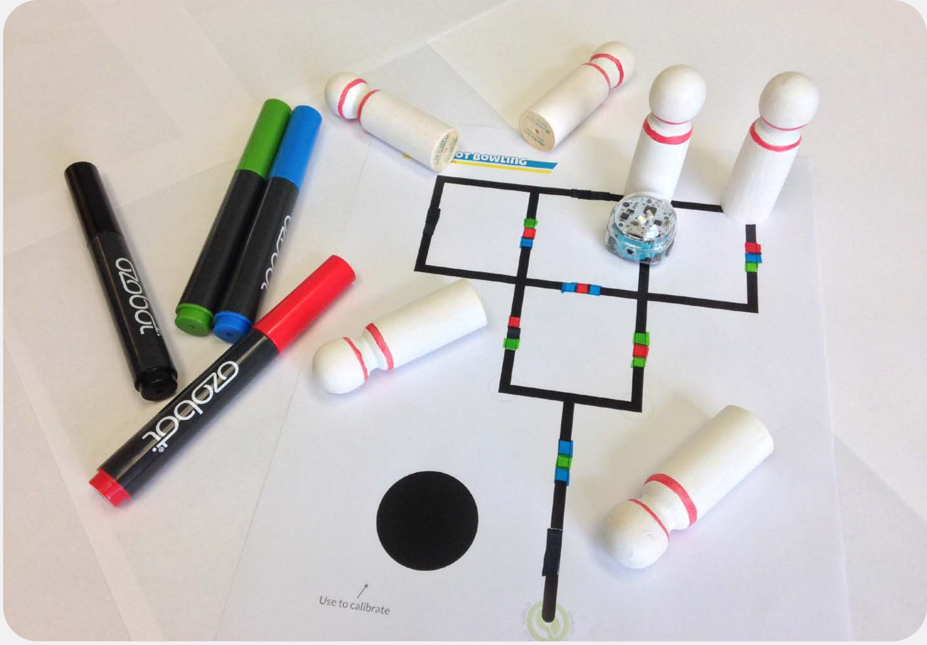
KEY TERMS

Ozobot: A programmable robot that follows commands from color-coded paths on paper, as well as computer coding.

Coding: A set of signals called code are sent to a device to provide specific instructions on how to perform an action. With Ozobot, the robot reads the code via colored dots on a piece of paper.

PREPARATION

- Prepare a couple examples of solid lines using the Ozobot colored markers along with an example of a rectangle or other shapes.
- Complete a color-coded Ozobot bowling sheet ahead of time to use for the activity demonstration.
- Make copies of Ozobot bowling sheet (1 per child) and Ozobot Score sheet (1 per group of 3 to 4 kids)



LAUNCH *10 to 15 minutes*

Have kids gather around in a circle. Model programming techniques for the Ozobot using the sheets prepared ahead of time (line and shapes). Make sure to reference how the width of a line and line spacing helps the Ozobot to read the program.

Activity 1 - Color Coding

Have kids partner up to explore creating color-coded programming for the bot with lines and shapes. Kids will need a blank piece of paper and markers for this activity.

Bring the group back together and collect Ozobots. Choose a few kids to share their observations.

> *The Ozobot bowling sheet is in the resources included with the classroom kit. The OzoCodes sheets are also in the classroom kit. Both can also be downloaded online from: http://ozobot.com/stem-education/stem-classroom-kit*

EXPLORATION *40 to 45 minutes*

Activity 2 - Ozobot 10 Pin Bowling

Kids are going to take their learning from the color coding activity and apply it to a bowling challenge. They will use color-coding to program the Ozobot to act as a bowling ball to push down pins.

Display an example of a color-coded Ozobot Bowling sheet. Show kids the OzoCode sheet and how it is used to create patterns for speed and turns of the Ozobot. Set up the 10 bowling pins on the bowling sheet. Turn on the Ozobot and let it read the programming. Count how many pins are pushed over, for example, if seven pins are pushed or knocked over, your score would be seven for that round. Write down the score on the score sheet and any additional observations (i.e. if the 2, 3, and 5 pin are left standing up, write it down).

Each child will design an individual Bowling Sheet using the Ozobot Coding Sheet. Provide kids with adequate time to complete an individual color-coded bowling sheet.

When kids finish color-coding, they can make groups of 3 to 4 to start bowling using the Ozobot. Each child will use their individual programming sheet to bowl. Have teams play as many rounds as time permits. The player with the most points at the end is the winner. Teams can keep score on the bowling sheet and make notes under observations of what pins remained standing. The notes can be used later to make changes and programming adjustments.

Clean up materials. Take time for teams to thank each other for being a part of their learning community.

CLOSING *5 minutes*

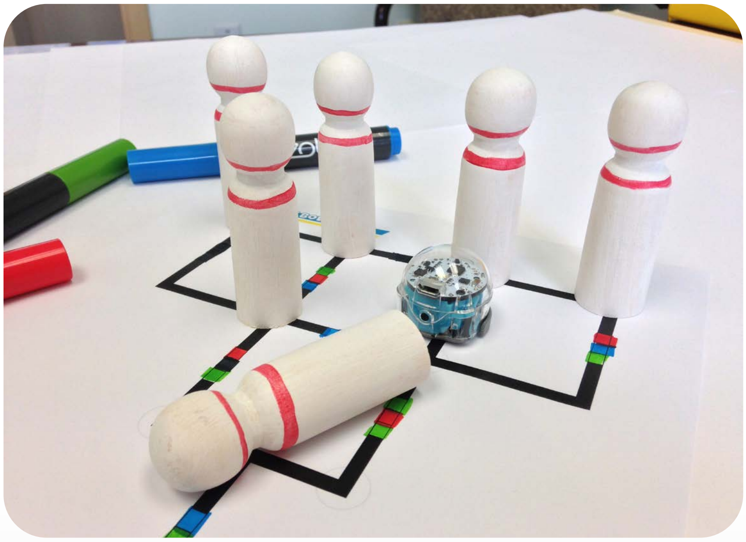
Have each team respond to the following questions:

- *What did you learn about programming the Ozobot from this activity?*
- *Was there a color-coding pattern that worked better? Why?*
- *If you had an opportunity to make changes, what would you make, why?*

Choose a couple of teams to share their responses with the larger group.

ENRICHMENT AND NEXT STEPS

Have the kids design a maze that their peers will have to fill in with OzoCode to get to the end.



OVERALL TIME *60- to 75-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

3-5-ETS1-3

(4th grade and up)

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.

OBJECTIVE

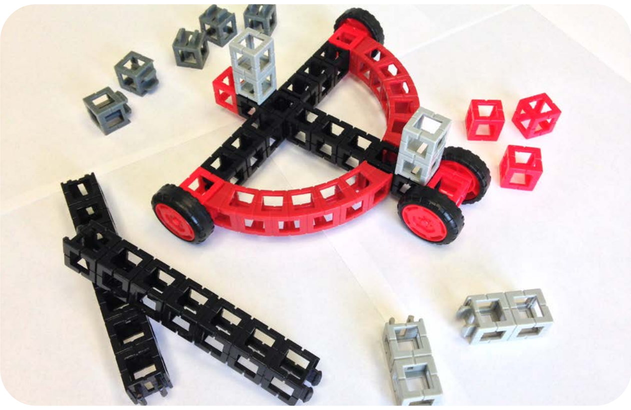
Kids will apply the Engineering Design Process to solve a problem.

OVERVIEW

Kids will have the opportunity to work together as a team to solve a problem using the Engineering Design Process. The team will use the engineering design process to guide them as they brainstorm ideas, plan, test, modify, and retest their design. Add collected measurement data to the class chart to see which team's vehicle traveled the farthest.

MATERIALS

- **ROK Blocks or Foundational Fluencies kit**
- **Tape measure**
- **Paper**
- **Pencils**
- **Masking tape**
- **Chart paper**
- **Ramp (optional)**



PREPARATION

- Create a class team chart with a row for each team, and a column to record the distance their vehicle traveled
- Set up an area where kids can complete a test run
- One piece of tape per team labeled with the team's name or number

LAUNCH *5 to 10 minutes*

Introduce the Engineering Design Process with the group. Each child will have a job in the challenge. Share the list of job roles and tasks assigned to each child. Provide teams with two minutes to decide on the different job roles.

Organizer: helps decide roles, holds all kids accountable, and keeps track of time.

Technician: measures, sketches, and makes sure data is recorded.

Programmer: completes tests and the final run; and is in charge of making modifications.

Reporter: takes notes on experiments and reports conclusions.

CHALLENGE

Introduce the challenge to the teams:
The objective of this challenge is to have a vehicle that can travel the farthest distance going down a ramp carrying a load of 12 balls (6 red and 6 blue) from the kit. All balls must remain inside of the vehicle while traveling down the ramp. The vehicle that goes the farthest will win the challenge.

EXPLORATION *45 to 50 minutes*

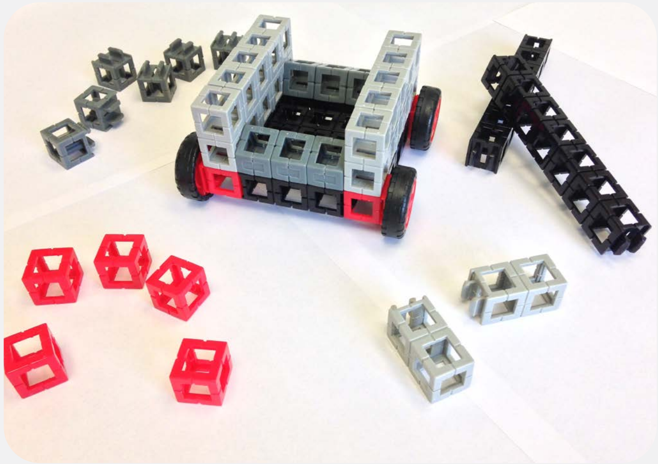
Give teams 30 minutes to design and build a vehicle. Walk around to each group as they are designing and talk with the youth.

Possible questions to ask:

- *What are your ideas for the design?*
- *How did you decide?*
- *Did everyone contribute?*

Give time warnings along the way to keep teams on track. Suggested times: halfway, 10 minutes left, five minutes left, one minute left

Encourage groups to test and modify their design as they go and allow them to use the ramp to practice.



OFFICIAL RUNS *10 minutes*

The ramp should be viewable by all kids. Choose a team to go first and have the Programmer from each team come up to complete the official run for the vehicle. As each vehicle goes down the ramp, have a piece of masking tape ready with the team number and place it where the vehicle stopped. Then, have the Technician measure the distance the vehicle traveled and record data on the class chart. Continue until all teams have had the opportunity to test their vehicle.

**Encourage teams to cheer each other on.*

CLOSING *5 to 10 minutes*

Call on the Reporter from each team to answer the following questions. If they need help, they can call on someone from their team to answer. A variation could be to have each child answer the following questions on an exit slip.

- *How did your design work?*
- *Did your team test the design before the official run?*
- *What changes did you make after the test run?*
- *If you could go back, what would you do differently now?*
- *How did each of your teammates work together?*

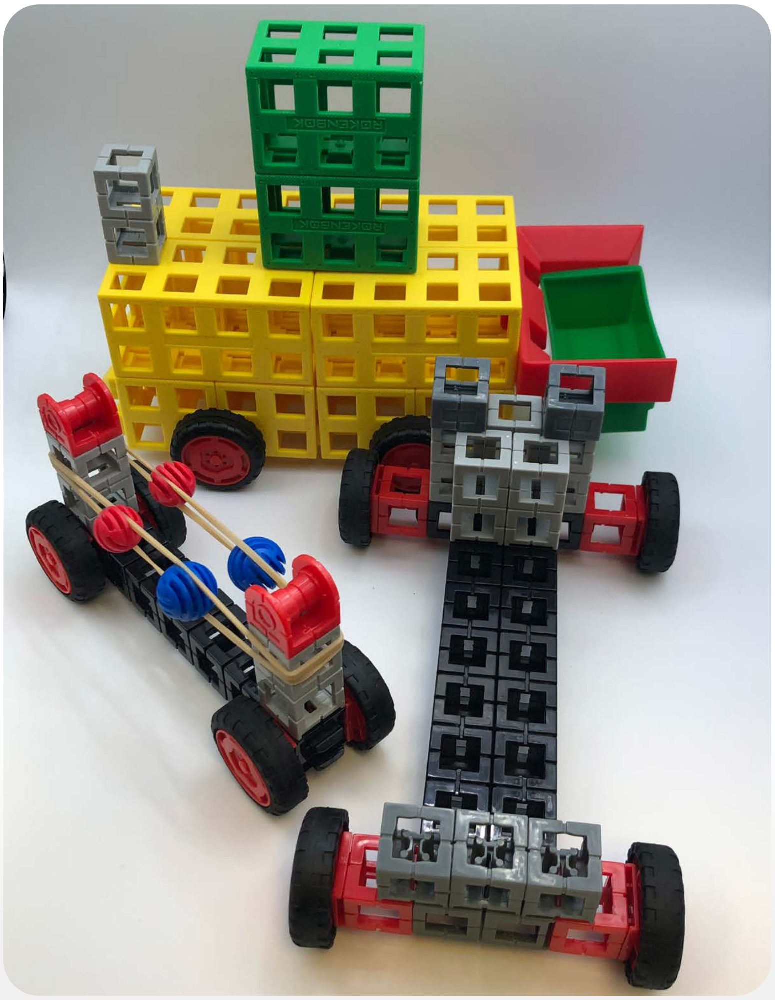
Take time for teams to thank each other for being a part of their learning community.

CLEAN UP *5 minutes*

Have children break apart vehicles and use the ROK Blocks or Foundational Fluencies guide to put all the materials back in the box.

ENRICHMENT AND NEXT STEPS

Change the challenge and have teams design vehicles to meet a new standard – which can travel the furthest, carry the heaviest load the furthest, or a vehicle only using two wheels – the possibilities are endless!



OVERALL TIME *60- to 90-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

3-5-ETS1-3

(4th grade and up)

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.

OBJECTIVE

Kids will apply the Engineering Design Process to solve a problem.

OVERVIEW

Kids will have the opportunity to work together as a team to solve a problem using the Engineering Design process. The team will engage in the engineering process to guide them as they brainstorm ideas, plan, test, modify, and retest their design. Teams will record data to see which team's structure can hold twelve thin books.

MATERIALS

- **ROK Blocks, Foundational Fluencies, or STEM Pathways kit**
- **Timer**
- **Chart paper**
- **Markers**
- **Tape**
- **Rulers**
- **12 thin books**

Variation: use a different amount of books or other objects as weights

PREPARATION

Set up an area where mentees can complete the weight test. Create a Class Data Chart with the headings, "Team," "Height," and "Books." Write down the job roles with task assignments and the challenge on chart paper. Have one Engineering Design Process sheet and a piece of tape per team labeled with the team's name or number.

*Kids will only be able to use the materials from the ROK Blocks, Foundational Fluencies, or STEM Pathways kit for the challenge.

LAUNCH *10 to 15 minutes*

Review the Engineering Design Process and the challenge with the group. Each kid will have a job in the challenge. Share the list of job roles and tasks assigned to each one. Provide teams with two minutes to decide on the different job roles.

Organizer: helps decide roles, holds all kids accountable, and keeps track of time.

Technician: measures, sketches, and records data.

Programmer: completes the test, final demonstration, and is in charge of making modifications.

Reporter: takes notes on Engineering Design Process sheet and reports conclusions.

ACTIVITY

A new office building needs to be constructed. The company is requesting the tallest structure possible to allow for maximum office space. However, with the harsh winters in this region, the design needs to support the extra weight of snow and ice during the winter months.

Design the tallest standing structure using the materials in the ROK Blocks, Foundational Fluencies, or STEM Pathways kit that can support the weight of twelve thin books representing snow and ice.

EXPLORATION *45 to 60 minutes*

Teams will be given 25 minutes to design and build the tallest structure. Walk around to each group.

Possible questions to ask:

- *What are your ideas for the design?*
- *How did you decide?*
- *Did everyone contribute?*

After 20 minutes have gone by, give teams a five-minute warning.

Test *5 to 10 minutes*
Have teams test their structures as they are ready.

Modify *10 to 15 minutes*
Kids can take this opportunity to make modifications to their structure.

Final demonstration *10 to 15 minutes*
Choose a team to go first. The **Organizer** will keep track of time. Each team will have two to three minutes to perform the demonstration. Have the **Programmer** from the team come up to complete the test. Then, have the **Technician** record the team number, and the number of books the structure can hold on the class chart. Continue until all teams have had the opportunity to complete the weight test.
**Encourage teams to cheer each other on.*

CLOSING *10 to 15 minutes*

Call on the **Reporter** from each team to answer the following questions. If they need help, they can call on someone from their team to respond. *A variation could be to have each kid answer the following questions on an exit slip.*

- *What changes did you make after the practice test?*
- *Why do you think your design met or didn't meet the challenge?*
- *If you could go back, what would you do differently now?*
- *How did each of your teammates work together?*

Take time for teams to thank each other for being a part of their learning community.

CLEAN-UP *5 minutes*

Have groups break apart the structures and use the materials in the ROK Blocks, Foundational Fluencies, or STEM Pathways guide to put all the materials back in the box.

NEXT STEPS OR TAKE HOME CHALLENGE

Allow kids to complete a similar challenge by exploring other materials, such as blocks, paper, or cards, to build a tall structure. Weights could be dice or pencils. Be creative!

THE SPARK:BIT
(MOTOR OVERRIDE MODE)

OVERALL TIME *120-minute lesson (can be split over two class periods)*

GROUPS *Up to four kids*

OBJECTIVE

- Identify the features on the Spark:bit robotics controller.
- Assemble and test a simple mechanism using the Motor Override Mode on the Spark:bit. Build a custom design that is controlled using the Spark:bit.

OVERVIEW

In this lesson, kids will learn how to use the Motor Override Mode on the Spark:bit to control Motor Modules and Light Modules. This lesson does not require any computers or programming.

MATERIALS

- **STEM Pathways kit**
  - **Need different kinds of blocks**
- **Spark:bit**
- **Motor Module**
- **Light Module**
- **Motor cable**

PREPARATION

Prepare enough lesson materials for each team.

Become familiar with how to use the Spark:bit and Motor/Light Modules.

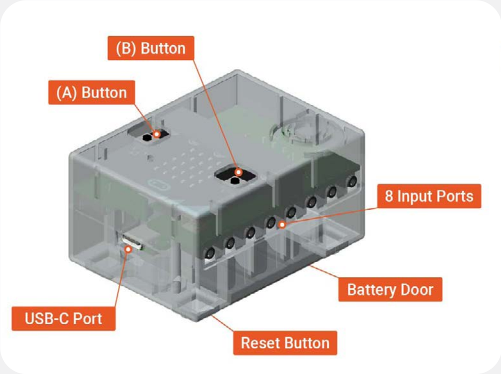
Prepare an example solution for the Design and Engineering Challenge.

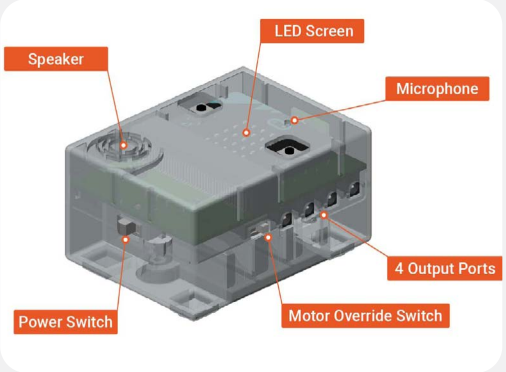
CONVERGENT LEARNING ACTIVITY

1. Work with kids as they locate and observe the features of the Spark:bit.
   Note: Kids will only be using the Motor Override Mode on the Spark:bit throughout this unit. In later units, kids will learn how to incorporate sensors with the Spark:bit and create custom programs that can be uploaded to it.
2. Work with kids as they assemble and test a mechanism using the Spark:bit.

The Spark:bit is a programmable robotics controller that can be combined with sensors, motors, and other Kid Spark engineering materials to create robots, machines, and much more. The Spark:bit also includes a Motor Override Mode which allows users to control Motor Modules and Light Modules with no programming required.

Instructions: Locate the Spark:bit robotics controller and observe all of the features on it.

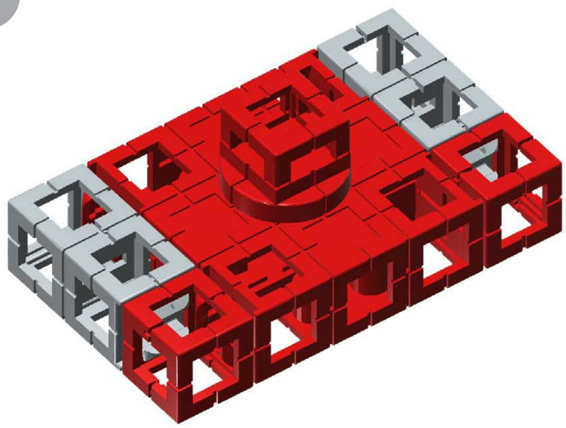




Instructions

Follow the step-by-step instructions to assemble a mechanism. Then, connect the Spark:bit to the mechanism

1

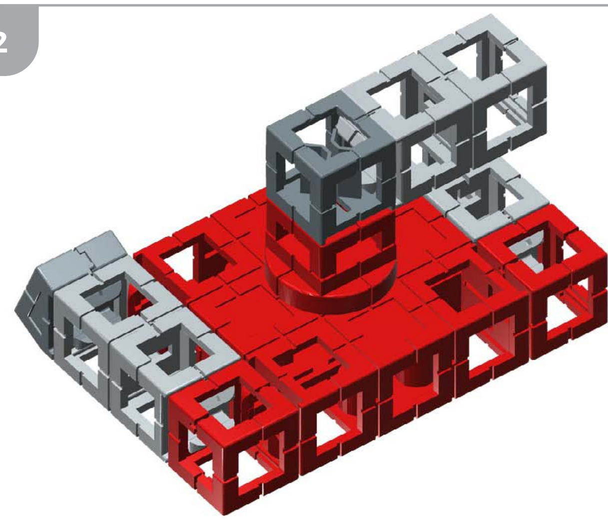


2x
Block

2x
Riser

1x
Motor Module

2

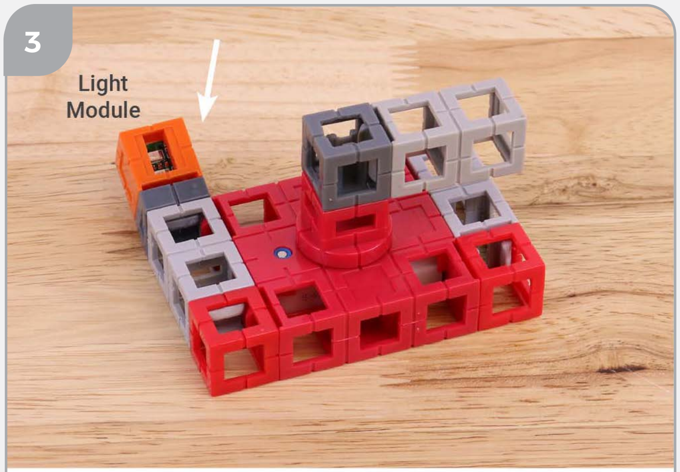


1x
Single Snap Block

1x
Riser

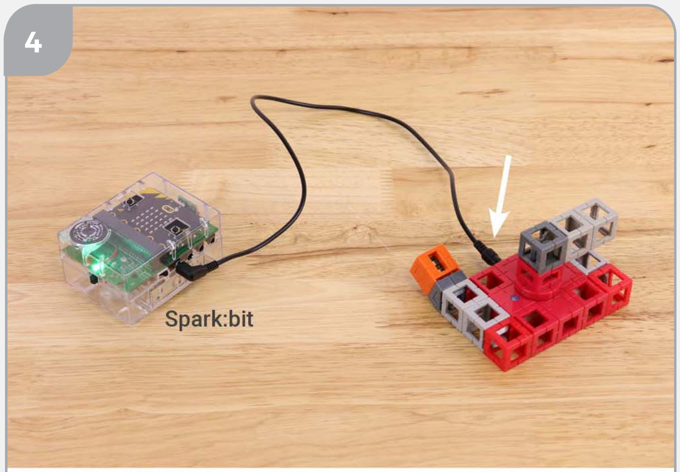
1x
30° Block

3



Attach a Light Module to the mechanism as shown.

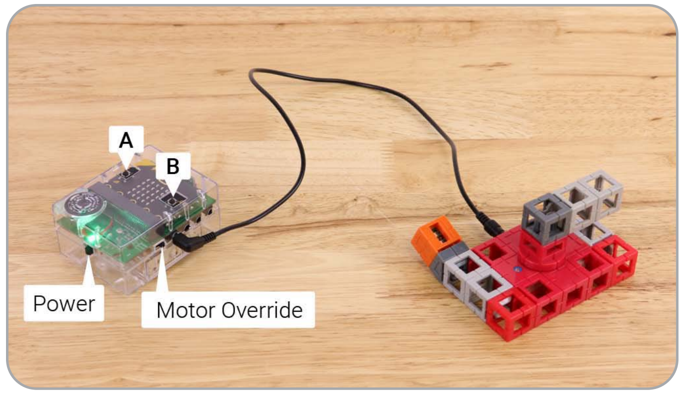
4



Using a Motor Cable, connect the Motor Module to output 1 on the Spark:bit.

Instructions

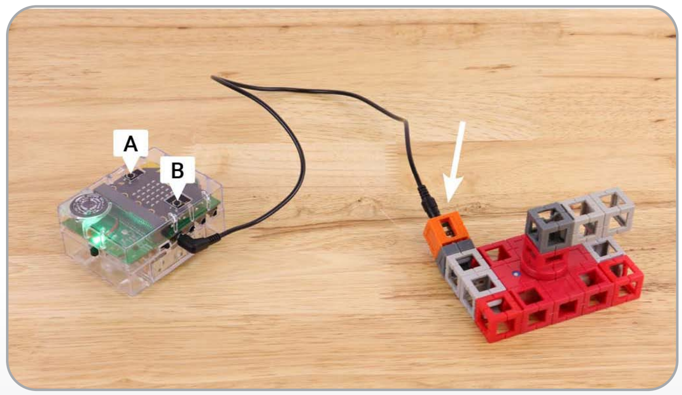
Follow the step-by-step instructions to control the Motor Module and Light Module using the Spark:bit.



Step 1: Power on the Spark:bit.

Step 2: Activate Motor Override Mode on the Spark:bit using the switch located next to output 1.

Step 3: Press the A/B buttons on the top of the Spark:bit and observe how the Motor Module rotates clockwise and counterclockwise.



Step 4: Disconnect the cable from the Motor Module and connect it to the Light Module.

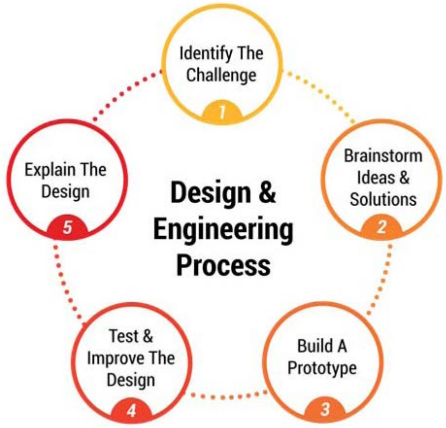
Step 5: Press the A/B buttons on the top of the park:bit and observe how the Light Module illuminates red and green.

DIVERGENT LEARNING ACTIVITY

1. Review the Design & Engineering Challenge with teams.
2. Instruct teams to use the Kid Spark Design & Engineering Process to develop a solution to the challenge.
3. Instruct teams to fill out the design specification after they have completed their project.
4. Review the challenge rubric with teams so they understand how they will be evaluated for the project.
5. Consider setting strict time boundaries for the divergent learning activity (see example below). Keep in mind that teams won't always complete a design that works or looks as intended. That's alright! Kids can learn a lot by reflecting on their experience and considering what they might have done differently if they had more time or could start the project over.
   a. Review the challenge with teams. *(2 minutes)*
   b. Teams work through the Design and Engineering Process to create a design. *(30 minutes)*
   c. Teams complete design specification. *(10 minutes)*
   d. Teams present designs to class. Each team has 2 to 3 minutes max to present. *(10 minutes)*
   e. Lab cleanup. (*8 minutes)*

Scenario:

Kid Spark Engineering is currently accepting proposals for new and creative product inventions or innovations.



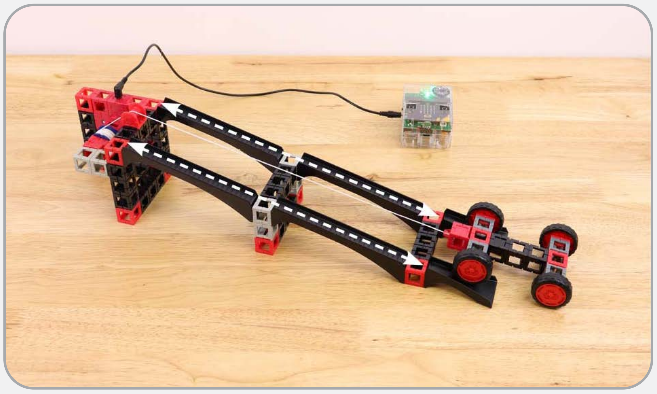
Design & Engineering Challenge:

Create a custom design that includes motor and/or light modules and is controlled using the Motor Override Mode on the Spark:bit. See example below.

Specifications/Criteria:

1. Kids will work in teams of up to 4 to design and engineer a new product that serves a specific purpose. Teams can invent something completely new or improve an already existing product.
2. Teams must work through each step of the Design & Engineering Process to design, prototype, and refine their design. Teams will demonstrate and present their designs to the class when they are finished.
3. The design must be powered by the Spark:bit and use either a Motor Module or a Light Module.
4. Teams must determine the overall dimensions (length, depth, and height) of the design, as well as any detailed specifications that are relevant to the design.
5. With each building component costing $2, determine the total cost of the design.

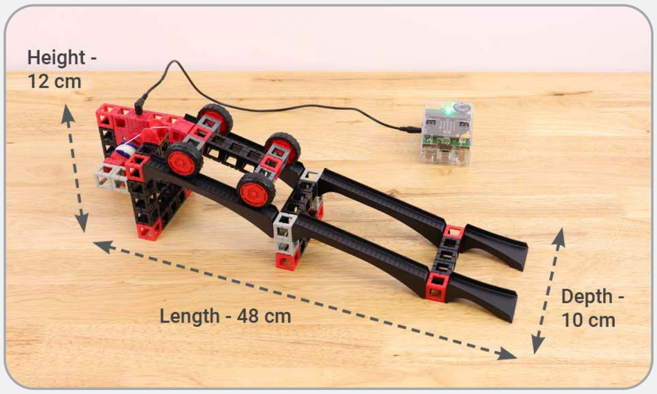
EXAMPLE IDEA



Product Innovation/Invention: Winch

Purpose: To help pull vehicles up a ramp so routine maintenance can be done.

Design Notes: The winch is powered by a single Motor Module that is connected to a spool. Operators can raise and lower vehicles by pressing the A/B buttons on the Spark:bit.



Dimensions: 48 cm x 10 cm x 12 cm (L x D x H)

Material Cost: 47 components x $2 = $94

CHALLENGE

When teams have completed the Design & Engineering Challenge, it should be presented to the teacher and classmates for evaluation. Teams will be graded on the following criteria:

Design and Engineering Process: Did the team complete each step of the Design and Engineering Process?

Design Specification: Did the team complete a design specification?

Team Collaboration: How well did the team work together? Can each kid describe how they contributed?

Design Quality/Aesthetics: Is the design of high quality? Is it structurally strong, attractive, and well-proportioned?

Presentation: How well did the team communicate/explain all aspects of the design to others?

Grading Rubric	Advanced 5 Points	Proficient 4 Points	Partially Proficient 3 Points	Not Proficient 0 Points
Design & Engineering Process	☐ Completed all 5 steps of the process	☐ Completed 4 steps of the process	☐ Completed 3 steps of the process	☐ Completed 2 steps of the process
Design Specification	☐ Complete/well-detailed and of high quality	☐ Complete/ opportunities for improvement	☐ Incomplete/ opportunities for improvement	☐ Incomplete
Team Collaboration	☐ Every member of the team contributed	☐ Most members of the team contributed	☐ Few members of the team contributed	☐ Team did not work together
Design Quality/ Aesthetics	☐ Great design/ great aesthetics	☐ Good design/ good aesthetics	☐ Average design/average aesthetics	☐ Poor design/ poor aesthetics
Presentation	☐ Great presentation/ very well-explained	☐ Good presentation/ very well-explained	☐ Poor presentation/ poor explanation	☐ No presentation/ no explanation
Points	....	....	....	....
Total Points				................/25

CLOSING

1. Project presentations - Instruct each team to share the design they created with the rest of the class.
2. Lab cleanup - After teams have finished their presentations, instruct them to disassemble

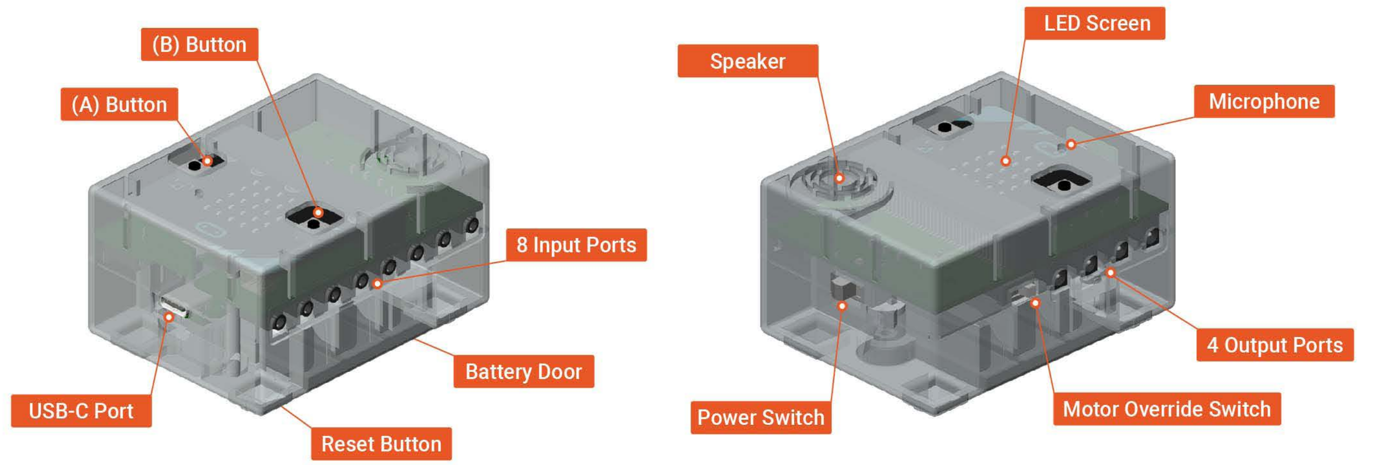
their designs and pack all engineering materials back into the labs correctly.

3. Lesson reflection - If time permits, do a quick recap/review of the lesson.

SPARK:BIT ROBOTICS CONTROLLER

The Spark:bit can be programmed to read information from sensors connected to input ports, process that information into relevant commands, and send those commands to modules connected to the output ports. Users can create custom programs using Microsoft's MakeCode programming environment. The Spark:bit is powered by three AA batteries and can be connected to a computer using the provided USB-C cable.

Program Reset



To reset the Spark:bit, press and hold the Reset button. This will reload the last program that was downloaded to it.

Motor Override Mode

Users can control Motor Modules and Light Modules without having to program the Spark:bit using Motor Override Mode. Once Motor Override Mode has been activated, connect a Motor Module or Light Module to output 1, then press the A & B buttons on the top of the Spark:bit to control the connected device.

Note: The Spark:bit must be powered on in order for Motor Override Mode to work. A flashing blue light indicates that Motor Override Mode is activated. Make sure to deactivate Motor Override Mode when using the Spark:bit in programming situations.

Input Sensors & Cables

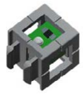

Angle Sensor

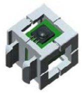

Bump Sensor


Light Sensor


Sensor Cable


High Power IR Transmitter


Low Power IR Transmitter


IR Sensing Receiver


Sponsor Cable Extender

Tip: Make sure cables are pressed firmly into connecting ports to ensure a good connection.

Output Modules & Cables


Motor Module


Motor/Output Cable


Light Module


Motor/Output Cable Extender

TEAM MEMBERS

1. ______________________ **3.** ______________________

2. ______________________ **4.** ______________________

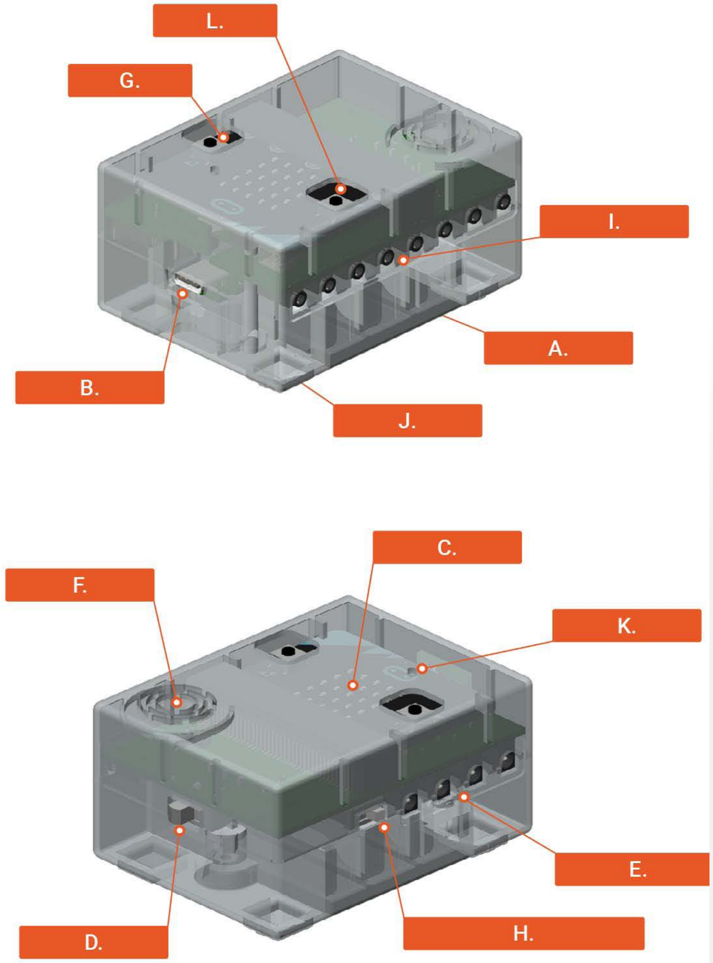
Total Points

Workbook: ..../13 pts

Challenge: ..../25 pts

THE SPARK:BIT

Instructions: Write the letter of the corresponding Spark:bit feature in the spaces provided below.



1. ....LED Screen
2. ....Battery Door
3. ....Motor Override Switch
4. ....(B) Button
5. ....USB-C Port
6. ....Microphone
7. ....Reset Button
8. ....4 Output Ports
9. ....(A) Button
10. ....Speaker
11. ....Power Switch
12. ....8 Input Ports

Instructions: Place a check in each box as each step is completed.

13. ▢ Follow the step-by-step instructions on pages 2 - 3 in the Curriculum Packet to assemble and test a mechanism using Motor Override Mode on the Spark:bit. Design & Engineering Challenge

DESIGN & ENGINEERING CHALLENGE

Follow each step in the Design & Engineering Process to develop a solution to the challenge. Place a check in each box as each step is completed. Fill in the blanks when necessary.

1. Identify The Challenge

   ▢ Challenge: ____

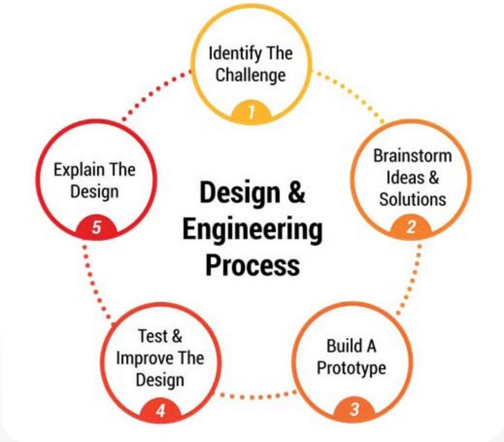
2. Brainstorm Ideas & Solutions

   ▢ Discuss design ideas.

   ▢ Consider building components.

   ▢ Sketch out design ideas on paper.

   ▢ Choose the best design.



3. Build A Prototype

   ▢ Discuss design ideas.

4. Test & Improve The Design

   ▢ Look for opportunities to improve the design. (Is it practical, proportional, etc..)

   ▢ Review challenge specifications/criteria and grading rubric.

5. Explain The Design

   ▢ Determine the specifications of the design that was created. Kid Engineering ....

   ▢ Discuss the following items with your team and be prepared to share with the rest of the class.

   a. How did the team arrive at the final design solution? Discuss how each step in the Design & Engineering Process was used to develop the design.

   b. Is the design realistic and well-proportioned?

   c. How did each team member contribute towards the overall design? Do you feel like everyone had an equal opportunity to contribute in the creative process?

   d. Is the team prepared to share detailed specifications of the design to others?

DESIGN SPECIFICATION

Determine the specifications of the completed design/project. Teams can use these specifications as they prepare to present their design to others.

Product Innovation/Invention: ____

Purpose: ____

Engineering Notes:

(How does the design work? Are there any key engineering materials that make the design function well?)

____

____

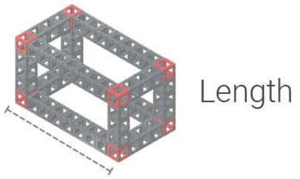
____

____

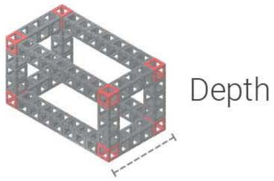
____

____

Project Dimensions



______ cm



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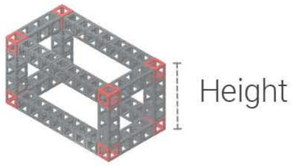


______ cm

Cost Analysis

Engineering materials used:________ x 2 = Total Cost $ ________

THE SPARK:BIT - ANSWER KEY
(MOTOR OVERRIDE MODE)

TEAM MEMBERS

1. ______________________ 3. ______________________

2. ______________________ 4. ______________________

Total Points

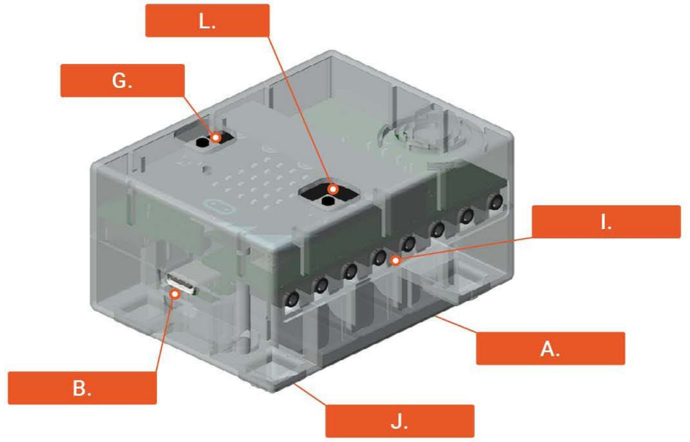
Workbook: ..../13 pts

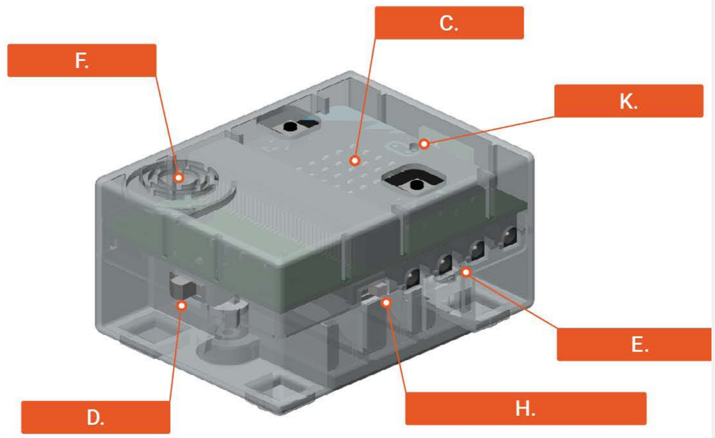
Challenge: ..../25 pts

THE SPARK:BIT

Instructions: Write the letter of the corresponding Spark:bit feature in the spaces provided below.

1. **C.** LED Screen
2. **A.** Battery Door
3. **H.** Motor Override Switch
4. **L.** (B) Button
5. **B.** USB-C Port
6. **K.** Microphone
7. **J.** Reset Button
8. **E.** 4 Output Ports
9. **G.** (A) Button
10. **F.** Speaker
11. **D.** Power Switch
12. **I.** 8 Input Ports





SNAP CIRCUITS ELECTRIC BINGO

OVERALL TIME *60-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

4PS3-4

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound.)

OBJECTIVE

- **Identify and construct different types of circuits.**
- **Make connections to energy sources in real life.**

OVERVIEW

Kids will engage in the basics of circuitry by building and drawing working electronic circuits.

MATERIALS

- **Snap Circuit Kit & Resource book**
- **STEM Circuit BINGO board**
- **Pencils/Writing utensils**
- **Batteries (AA)**

KEY TERMS

Circuit: a complete and closed path around which electricity can flow.

Closed Circuit: an endless path for electricity to flow.

Conductor: an object or material that allows the flow of electrical current in one or more directions.

Insulator: an object or material that allows little or no electricity to go through.

Negative: the negative pole of a storage battery.

Open Circuit: an electrical circuit that is not complete.

Parallel Circuit: a circuit which has two or more paths for electricity to flow.

Polarity: attraction toward a particular object or in a specific direction.

Positive: the positive pole of a storage battery.

Series Circuit: an electrical circuit in which electricity passes through components following one path.

Short Circuit: the failure of electricity to flow properly.

LAUNCH *5 to 10 minutes*

Have kids stand in a circle. Ask the following question and give kids a moment to think.

What items do you see every day that use energy from electrical current?

Go around the circle and have each child share an example, trying not to repeat one that was already said. This activity represents how much we rely on electricity throughout a given day.

EXPLORATION *40 to 50 minutes*

Provide each team with a STEM bingo board (see page 26). Using Snap Circuits, the team will need to work together to build various types of circuits working towards a blackout bingo board (all boxes filled in). Each box of the bingo board has a different type of circuit or Snap Circuits component the team must build or incorporate in the build. Once they have built the circuit, the group must write down an example of where they might see this in real-life. For example, the flying saucer is an example of a ceiling fan, whereas a light switch is an example of a circuit with a switch.

As kids are working, walk around to each of the groups.

Possible questions to ask:

- *What circuit are you building?*
- *What order are you connecting the parts?*
- *Can you trace the path the current flows through the circuit?*

CLOSING *5 to 10 minutes*

Allow kids time to clean up and organize the Snap Circuits.

Bring the group back together. Ask kids to find a partner and answer the following questions:

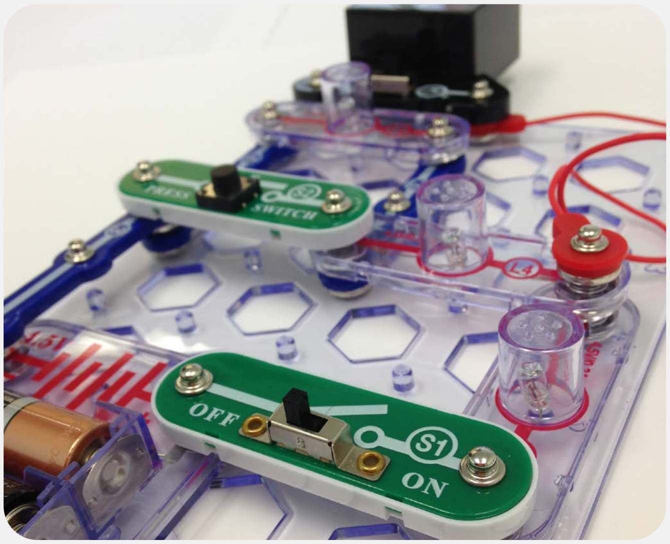
- *What new learnings did you have?*
- *What circuits were challenging to make?*
- *Why?*
- *Was your team able to make real life circuit connections?*

Choose a few partners to share aloud with the large group.

***Note:** *Have teams give each other a high five to celebrate their new learning.*

ENRICHMENT AND NEXT STEPS

Allow kids to explore the Snap Circuits guidebooks and build as many circuits as they want. Challenge them to design their own and explain how it works.



SNAP CIRCUITS BINGO

NAME ______________________________

Using Snap Circuits, build an example of each of the circuits listed below. Then in the box, write down a short description, sketch of the activity, and where have you seen an example of this in real life?

COMPLETE CIRCUIT	FLYING SAUCER	MOTOR CIRCUIT
FAN	**FREE (YOUR CHOICE)**	**PARALLEL CIRCUIT**
SWITCH CIRCUIT	**SERIES CIRCUIT**	**SOUND**

OVERALL TIME *60- to 120-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

4PS3-4

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound.)

OBJECTIVE

- **Identify and construct different types of circuits.**
- **Make connections to energy sources in real life.**

MATERIALS

- **Snap Circuit kit (one per group)**
- **Snap Journal (one per person)**
- **Chart paper**

PREPARATION

Copy Snap Journals for the class.
On chart paper, write the challenge and requirements.

LAUNCH *5 to 10 minutes*

Have kids form a circle. Ask them to think about what their life would be like without electricity. Are there things they would miss? Go around in a circle and have each kid name one thing.

EXPLORATION *40 to 90 minutes*

Have kids form groups of three to four. Once kids are in groups, explain that they will be exploring and interacting with basic circuitry using Snap Circuits to perform a challenge. Introduce the challenge, requirements, and Snap Journal.

CHALLENGE

Create a circuit that includes the following: light, movement, and sound.

Requirements:

- Groups will present their design.
- All kids will complete a Snap Journal.
- Each group member will be responsible for answering one or more of the following questions during the presentation:
  - *What is your Snap Circuit design?*
  - *Does your design include light, movement and sound?*
  - *Explain and demonstrate how the circuit works.*
  - *How did your team decide on this design?*
  - *Were there any challenges your team faced during this activity?*
  - *How did your team address these challenges?*

CLOSING *15 to 25 minutes*

Allow each team 3 to 5 minutes to present.

OVERALL TIME *60- to 120-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

4PS3-4

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound.)

OBJECTIVE

- **Identify and construct different types of circuits.**
- **Make connections to energy sources in real life.**

MATERIALS

- **Snap Circuit kit (one per group)**
- **Snap Journal (one per person)**
- **Chart paper**
- **Vocabulary cards (one set for each group)**
- **Timer**

KEY TERMS

Circuit: a complete and closed path around which electricity can flow.

Closed Circuit: an endless path for electricity to flow.

Conductor: an object or material that allows the flow of electrical current in one or more directions.

Insulator: an object or material that allows little or no electricity to go through.

Negative: the negative pole of a storage battery.

Open Circuit: an electric circuit that is not complete.

Parallel Circuit: a circuit which has two or more paths for electricity to flow.

Polarity: attraction toward a particular object or in a specific direction.

Positive: the positive pole of a storage battery

Series Circuit: an electrical circuit in which electricity passes through components following one path.

Short Circuit: the failure of electricity to flow properly.

PREPARATION

Copy Snap Journals for the class. On chart paper, write the challenge and requirements. Have a copy of the vocabulary cards cut out for each group.

LAUNCH *10 to 15 minutes*

Have children form groups of 3 to 4. Explain to kids that they will be working together to complete an electricity vocabulary match. Pass out a set of cards to each group. Then, set a timer for five minutes. After kids have discussed and completed the match, ask if they have any questions about the vocabulary words.

EXPLORATION *45 to 90 minutes*

Have kids form groups of three to four. Once kids are in groups, explain that they will be exploring and interacting with basic circuitry using Snap Circuits. Introduce the challenge, requirements, and Snap Journal.

CHALLENGE

As a team, think of an improvement to the classroom that could be made with electricity. For example, adding a doorbell to the classroom. Kids will make a model of their circuit using Snap Circuits. Teams will be allowed to use the Electronic Snap Circuits Instruction Manual. However, if the team uses the diagram from the manual to create the circuit, an additional change or modification must be made.

Requirements:

- Groups will present their design.
- All kids will complete a Snap Journal.
- Each group member will be responsible for answering one or more of the following questions during the presentation:
  - *What is your new Snap Circuit design that improved your classroom?*
  - *Explain and demonstrate how the circuit works.*
  - *How did your team decide on this design?*
  - *If you used the manual diagram, what modification did your team make?*
  - *Were there any challenges your team faced with this activity?*
  - *How did your team address these challenges?*

CLOSING *15 to 25 minutes*

Allow each team 3 to 5 minutes to present.

ELECTRICAL VOCABULARY

Circuit	a complete and closed path around which electricity can flow	**Closed Circuit**	an endless path for electricity to flow
Short Circuit	the failure of electricity to flow properly	**Series Circuit**	an electrical circuit in which electricity passes through components following one path
Positive	the positive pole of a storage battery	**Conductor**	An object or material that allows the flow of electrical current in one or more directions
Insulator	an object or material that allows little or no electricity to go through	**Negative**	the negative pole of a storage battery
Open Circuit	an electric circuit that is not complete	**Parallel Circuit**	a circuit which has two or more paths for electricity to flow
Polarity	Attraction toward a particular object or in a specific direction		

OVERALL TIME *60- to 120-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

4PS3-4

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound.)

OBJECTIVE

- **Identify and construct different types of circuits.**
- **Make connections to energy sources in real life.**

MATERIALS

- **Snap Circuit kit (one per group)**
- **Snap Journal (one per person)**
- **Chart paper**
- **Markers**
- **Masking tape**

PREPARATION

Copy Snap Journals for the class. On chart paper, write the challenge and requirements.

LAUNCH *5 to 15 minutes*

Have kids form groups of three to four. Provide each group with a piece of chart paper and markers. Explain to kids that they will have ten minutes to create a list of as many electricity words as possible. When the ten minutes are up, have kids display their posters on the wall.

Then, have groups participate in a Gallery Walk to view all posters.

Choose a few kids to respond to the following questions:

- *Did you notice any words that appeared on every list?*
- *Is there a word that stuck out for you during the Gallery Walk? What word? Why?*

EXPLORATION *45 to 90 minutes*

Explain to kids that they will be exploring and interacting with basic circuitry to create a new circuit using Snap Circuits. Groups will remain the same for the challenge. Introduce the challenge, requirements, and Snap Journal.

CHALLENGE

Design your own Snap Circuit.

Requirements:

- Groups will present their design.
- All kids will complete a Snap Journal.
- Each group member will be responsible for answering one or more of the following questions during the presentation:
  - *What is your new Snap Circuit design that improved your classroom?*
  - *Explain and demonstrate how the circuit works.*
  - *How did your team decide on this design?*
  - *Were there any challenges your team faced with this activity?*
  - *How did your team address these challenges?*

CLOSING *15 to 30 minutes*

Allow each team 3 to 5 minutes to present.

SNAP JOURNAL

NAME ____

SNAP CIRCUIT TITLE OR NUMBER ______________________________

Sketch Your Circuit. Refer to page 43 for Schematic Symbols in the Student Guide.

	1	2	3	4	5	6	7	8	9	10
A										
B										
C										
D										
E										
F										
G										

What did you learn about circuits from doing this activity? ______________________

____

____

____

OVERALL TIME *60-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

4PS3-4

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

OBJECTIVE

Kids will identify materials as conductors or insulators for electricity to travel.

OVERVIEW

Children will have the opportunity to build upon previous circuit learning while creating circuits using electrical and motion energy with conductor (Playdoh) and insulator (modeling clay) materials.

MATERIALS

- Squishy Circuits
- Circuit Sketch sheet
- Pencils (optional-colored pencils)
- Insulator and conductor examples
- Batteries (AA)

KEY TERMS

Circuit: a complete and closed path around which electricity can flow.

Closed Circuit: an endless path for electricity to flow.

Conductor: an object or material that allows the flow of electrical current in one or more directions.

Insulator: an object or material that allows little or no electricity to go through.

Negative: the negative pole of a storage battery.

Open Circuit: an electrical circuit that is not complete.

Parallel Circuit: a circuit which has two or more paths for electricity to flow.

Polarity: attraction toward a particular object or in a specific direction.

Positive: the positive pole of a storage battery.

Series Circuit: an electrical circuit in which electricity passes through components following one path.

Short Circuit: the failure of electricity to flow properly.

PREPARATION

Gather some common everyday materials ahead of time:

Sample conductors: penny, aluminum foil, paperclip, water, (Playdoh will be the conductor in the experiment)

Sample insulators: rubber band or rubber ball, something plastic, glass, wood (baseball bat) (modeling clay will be the insulator in the experiment)

LAUNCH *15 to 20 minutes*

Activity 1-Circuit Model
Have kids form a circle by holding hands. This activity will model how electricity flows through a circuit. The leader starts by squeezing the hand of the person next to them. Kids will squeeze the hand of the person next to them and this pattern continues until it comes back to the leader. The leader can then ring a bell or raise their hand to represent a closed complete path. Next, have one kid step out of the circle to represent an open, not complete circuit. *Ask kids, what just happened? What might the break in the chain represent?*

Activity 2-Conductor or Insulator
The previous activity modeled how a complete circuit is made. Now, we are going to learn about different types of materials that allow electricity to flow in one or more directions called conductors. Other materials that allow little or no electricity to go through are called insulators.

Hold up the common everyday items (i.e. paperclip) one at a time. Ask the group: Does this paperclip act as a "conductor" or as an "insulator" for electricity? A follow up question could be, what makes you think that?

EXPLORATION *35 to 40 minutes*

Task the children to use Squishy Circuits and challenge them to do the following:

1. Make a complete circuit with a light bulb.
2. Make a circuit with a motor and switch.
3. Choose a circuit to create.

Review the materials that come in the kit (battery holder, wires, motor, switch, Playdoh, modeling clay, LED lights). Hold up the LED light and show kids the longer terminal. This terminal will need to go in the dough with the positive (red) wire. Have kids sketch and label each of the circuits created using the Circuit Sketch sheet.

CLOSING *5 minutes*

Have kids partner up with someone from a different group to share new learning from their choice circuit.

ENRICHMENT AND NEXT STEPS

Have extra colored Playdoh out for children to design a creature or organism light up sculpture.

CIRCUIT SKETCHES

NAME ____

Design, sketch, and label the following circuits:

COMPLETE CIRCUIT

MOTOR AND SWITCH

CHOOSE YOUR OWN

OVERALL TIME *60- to 90-minute lesson*

GROUPS *Three to four kids per kit*

Next Generation Science Standards

K-2-ETS1-1

Ask questions based on observations to find more information about the natural and/or designed world(s). Define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2

Develop a simple model based on evidence to represent a proposed object or tool. Asking questions, making observations, and gathering information are helpful in thinking about problems. Before beginning to design a solution, it is important to clearly understand the problem.

OBJECTIVE

Kids will work together to create a city that includes all action bricks from the LEGO® Coding Express kit.

OVERVIEW

The LEGO® Coding Express kit includes cards and videos for introducing the materials. Kids then build upon those lessons while creating a city that offers a variety of goods and services.

MATERIALS

- LEGO® Coding Express kits
- Chart paper
- Markers

PREPARATION

Clear a large space for groups to spread out and use the LEGO® Coding Express materials. Make a large circle map on chart paper with the word "city" in the middle.

LAUNCH *10 to 15 minutes*

Bring everyone together in a large circle. Tell kids that they are going to share what they know about cities. Cities can vary in size, but all cities usually include special attractions or businesses while providing many goods and services.

Have kids partner up and ask them to discuss what they might see in a city. Then, ask them to share their responses out loud. Record the responses on a piece of chart paper.

EXPLORATION *45 to 60 minutes*

Have kids get into groups of three or four. Instruct each group to build a city using LEGO® bricks that includes a variety of goods and services. The train tracks will be the form of transportation that connects the city. All coding action bricks must be used in the design. Each group needs to work together to decide the transportation design (circle, Y, or straight line), and where to place different elements of the city.

CLOSING *10 to 15 minutes*

Bring everyone back together. Have each group share their city design.

Ask each group the following questions:

- *What are some of the goods and services your city provides?*
- *Does your city include all the action bricks?*
- *How did your team work together?*
- *Did your team encounter any problem(s)?*
- *If so, how did you solve the problem(s)?*

ENRICHMENT AND NEXT STEPS

Here are some options to consider for additional activities:

- Challenge kids to create a mat to go under the track highlighting the physical features (i.e. water for the port, the gas station). This could be done with paper or material. Encourage kids to be creative.
- Have the group write a story highlighting the attractions found in their city.

LEGO® WEDO 2.0

OVERALL TIME *60-minute lesson*

GROUPS *Two kids per kit*

Next Generation Science Standards

K-2-ETS1-1

Ask questions based on observations to find more information about the natural and/or designed world(s). Define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2

Develop a simple model based on evidence to represent a proposed object or tool. Asking questions, making observations, and gathering information are helpful in thinking about problems. Before beginning to design a solution, it is important to clearly understand the problem.

OBJECTIVE

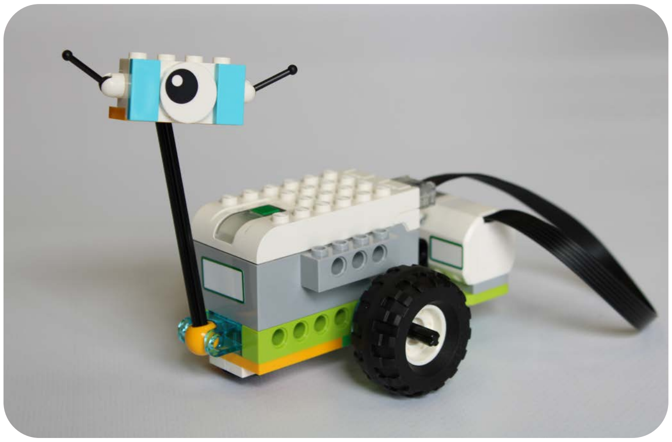
Kids will work together to design, build, and code a bot that includes movement.

OVERVIEW

Kids will have the opportunity to work together building on previous LEGO® WeDo 2.0 coding experience to design a bot that moves.

MATERIALS

- **LEGO® WeDo 2.0 sets**
- **Electronic device with the WeDo 2.0 app (to download, visit:** *https://education.lego.com/en-us/support/wedo-2***)**
- **Chart paper**
- **Markers**



PREPARATION

Have a blank piece of chart paper located where everyone can view for the launch. Clear an area where groups will test their robot after coding.

LAUNCH *10 to 15 minutes*

To start, have the whole group form a large circle. Ask the group to think of something that moves. Have kids volunteer to share answers. Ask them to describe how the object moves (if time allows, have them demonstrate the movement). Record the list of moving objects on a piece of chart paper.

EXPLORATION *30 to 40 minutes*

Have kids partner up. Tell the group they will be working in pairs to complete a challenge to design, build, and code something that moves. The design can be a form of transportation, an animal, or a robot. Teams will need to come up with an idea or choose one from the list created during the launch.

Allow kids to run bot tests for coding in the area you have available. Share with kids that it is encouraged for teams to watch each other's bots much like engineers collaborate and learn from each other.

Give teams time to design and build their bot. Walk around to each group as they are designing. Possible questions to ask:

- *What are your ideas for the design*?
- *How will your team work together to decide*?
- *Did everyone contribute*?

CLOSING *10 to 15 minutes*

Bring everyone back together. Have each team demonstrate the movement of their WeDo 2.0 robot.

Select a different kid from the group to respond to the following questions:

- *Did your team encounter any problem(s)*?
- *If so, how did you solve the problem(s)*?

ENRICHMENT AND NEXT STEPS

Have the bot move clockwise and counter-clockwise, use motion sensor, or include different power levels.

INTRODUCTION TO 3D PRINTING CONCEPTS

***Note:** *This is an introductory lesson to 3D printing where kids will be observing the 3D printer in action, while their team is creating an object using the Design Process that could later be designed and printed.*

OVERALL TIME *60-minute lesson*

GROUPS *Three to four kids*

Next Generation Science Standards

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.

3-5-ETS1-1

Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

OBJECTIVE

- **Gain a better understanding of how 3D printing works.**
- **Design and sketch an object that solves a problem.**

OVERVIEW

Kids will learn how a 3D printer works, and what a 3D printer is capable of printing. Kids will design and sketch an object that would be useful to solve a problem in their school using 3D printing to create. Kids will also observe a 3D object being printed.

MATERIALS

- **3D printer**
- **Downloaded .stl file to print**
- **Playdoh**
- **Paper**

PREPARATION

- Be sure to prepare files for printing using a slicing software such as Cura or Matter Control. The slicing process is an essential part of the printing process to establish the settings for the printer. When you are ready to print, download an object file compatible with your 3D printer.
- Warm up the printer prior to starting the printing process. Be sure the printer is calibrated and the filament is properly fed to the print nozzle.

LAUNCH *10 to 15 minutes*

Bring kids together in a large group. Have them choose a partner and share what they know about 3D printing. After a minute of discussion, have a few pairs share aloud in a large group. Then have the kids choose a different partner and *ask where do we see 3D printing in real life*? Give a minute for discussion, and then ask a few pairs to share with the group. Some examples might be: prosthetic limbs, toys, vases, replacement parts, prototypes, etc.

Have the kids pair up with a third partner. To begin exploration into 3D printing, have kids take 5 to 10 minutes using the STEM Lab computers to research what can be printed using a 3D printer.

We have several .stl files located on the materials page of the portal.
To download, visit:
http://www.ripkenfoundation.org

EXPLORATION *35 to 40 minutes*

Kids will partner up in groups of 3 to 4, to brainstorm and create a useful object that would be helpful in school such as a door stop, sign holder, or picture frame. Then kids will sketch the design on paper noting different angles of the object (top, bottom, side, etc.). After making the sketches, kids will use Playdoh to create the 3D object.

While kids are working on their design, print an object using the 3D printer. Many of the .stl files found on RipkenFoundation.org only take about 15 minutes, depending on the printer settings.

Have groups come up one at a time to observe the 3D printer in action.

CLOSING *5 to 10 minutes*

Bring everyone back together. Have groups share their 3D design and how it would be helpful in school.

Pass around the object that was printed. Have kids share any interesting observations. Take time for teams to thank each other for being a part of their learning community.

ENRICHMENT AND NEXT STEPS

For kids interested in creating their own 3D designs, TinkerCAD is a great website for beginners. TinkerCAD is a free website that allows anyone to learn how to design and print simple or intricate 3D objects. TinkerCAD offers lessons on how to use the controls for the website, as well as how to create designs and objects! Visit *http://www.tinkercad.com* for more information and to access the lessons and design tools.

For additional training and resources, visit *http://www.mystemkits.com*. Your Robo 3D printer comes with a free, two-hour online training session.

POSSIBLE YOUTUBE VIDEOS

What is 3D printing and how does it work?

- ▶ *https://www.youtube.com/watch?v=Llgko_GpXbI*

3D Printing in the Elementary School

- ▶ *https://www.youtube.com/watch?v=QTW4r4qfHys*

3D Printing in the Middle School Science Classroom

- ▶ *https://www.youtube.com/watch?v=1jp-RemY-_4*

Kids Learn 3D Design and Printing

- ▶ *https://www.youtube.com/watch?v=nHgY947uCbU*

SPHERO BOLT LONG JUMP

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Science*

OVERVIEW

Kids will use block coding to get the Sphero BOLT to jump the farthest.

A variety of 3 ramps will be used to see which one results in the longest jump.

Kids will record their data in the EDP journal documenting mean, median, mode, and range.

MATERIALS

- **Box of sand**
- **3 ramps**
- **Maze Tape or ruler**
- **Sphero BOLT**
- **Electronic device**

INSTRUCTIONS

Create a simple block code that will send the Sphero BOLT on its way to the ramp.

Make a prediction in your EDP journal as to how the Sphero BOLT will fly for Ramp 1, 2, and 3.

Document your results for Ramp 1, 2, and 3. Include heading, speed, duration, and distance traveled (cm).

SPHERO BOLT LONG JUMP

NAME ____________________

Ramp Height	Speed	Distance (cm)	Heading

When you've tested all your ideas look back at your recording sheet and ask yourself:

- *Why did those ideas cause the Sphero BOLT to jump a shorter distance?*
- *Which ideas helped the Sphero BOLT jump farther?*
- *Why did those ideas make the Sphero BOLT jump farther?*
- *Which idea or combination of ideas helped the Sphero BOLT jump the farthest?*
- *Why did that idea or combination of ideas help the Sphero BOLT jump the farthest?*
- *Are there any other ideas or combinations of ideas that you want to go back and test?*

Mean	*Median*	*Mode*	*Range*

BRIDGE CHALLENGE

OVERALL TIME *2- to 4-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Beginning Block: Roll, Delay, Sound, Speak, and Main LED*

CONTENT THEME *Science*

OBJECTIVE

- **I will identify how the Sphero BOLT can cross a bridge constructed with inexpensive materials.**
- **I will illustrate the process of determining which code elements would be best suited to accomplish an objective.**
- **I will drive and create a program that moves the Sphero BOLT over a bridge of my own design.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

OVERVIEW

Build a bridge using classroom materials and then program the Sphero BOLT to drive across it. This challenge can also include researching different types of bridges and incorporating those concepts into the designs.

MATERIALS

- **Sphero Bolt**
- **Tape**
- **String**
- **Glue**
- **Popsicle sticks, toothpicks, uncooked pasta, balsa wood, cardboard or other building material**
- **Measuring tape or rulers**
- **2 tables or other objects to span the bridge across**

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION: BRIDGE CHALLENGE INTRODUCTION

There are a lot of different types of bridges. Which types have you seen before? Research different types of bridges and think of how you might build one for the Sphero BOLT to cross it.

As you learn about different types of bridges, think about the following:

- *What kind of bridges exist and how are they designed?*
- *How are they built?*
- *How might you construct your bridge?*
- *How large of a bridge can you build in your classroom with the materials provided?*

Watch the video of the Tacoma Narrows Bridge collapse. What are some important things you can learn from watching this video when designing your bridge?

▶ *https://youtu.be/j-zczJXSxnw*

EXPLORATION: ENGINEERING FRAMEWORK

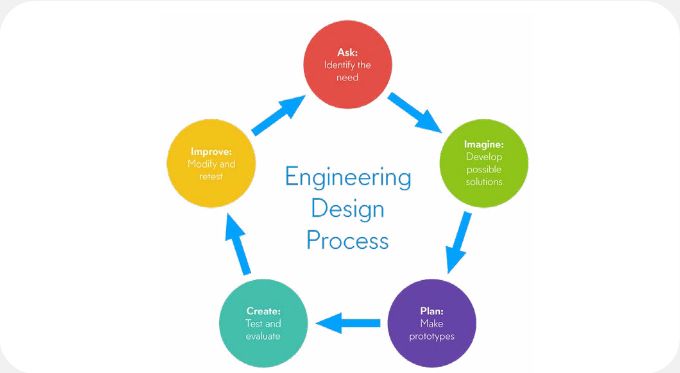
On a piece of paper, list at least five features that your bridge will need in order to support the Sphero BOLT as it crosses.

Think about the Engineering Design Process and how it can help guide your building of a bridge.

As you brainstorm ideas, constraints, and possibilities, consider the following:

- *What are the Sphero BOLT's dimensions?*
- *How wide is the gap that the bridge needs to span?*
- *What are the materials and how can they be used?*
- *What surfaces does the Sphero BOLT drive best on?*

▶ *https://youtu.be/nesX_q-wYl8*



EXPLORATION: BRIDGE DESIGNS

Take a piece of paper, fold it in half, then in half again the other way. Each one of the boxes created is a space for an idea. Come up with some ideas of your own, and then share with the rest of your team. Collaborate on a single idea.

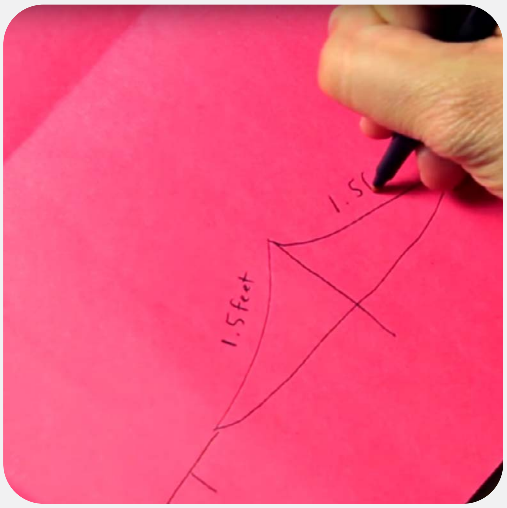
When working with your team, try to:

- Have one conversation at a time.
- Share as many ideas as possible.
- Be short and sweet.
- Build on the ideas of others.
- Be visual.
- Be encouraging; especially the "This might sound crazy..." ideas.
- Stay on topic.
- Defer judgement.

SKILLS BUILDING: THE SPHERO BOLT PROGRAM

Open a new Blocks canvas and begin to experiment with some code. *Which blocks are best suited to help the Sphero BOLT cross safely?*

While evaluating different materials, think about which will best support the Sphero BOLT's weight and which make it easier for the Sphero BOLT to cross the bridge. All of this will influence the type of program you create.



SKILLS BUILDING: BUILD A BRIDGE

Build that bridge!

Take your time and make smart material decisions during the building process. Always measure before cutting, and make sure to test for strength and rigidity. Don't hesitate to place or to roll the Sphero BOLT up onto your incomplete bridge from time to time to make sure things are going as planned.

▶ *https://youtu.be/-j8C3HgVTMM*

SKILLS BUILDING: CROSSING THE BRIDGE

Open back up the program you began in Step 4. Now that your bridge is done, you need to practice having the Sphero BOLT cross the bridge. This may take several tries. Experiment with speed and duration. Also, it is super important that you place the Sphero BOLT in the same starting spot each time before aiming.

▶ *https://youtu.be/Qj92sXEvsqo*

CHALLENGE: FINAL PRESENTATION

Come together as a class and test the bridges. Set up your bridge and run the program for the Sphero BOLT to cross it.

Each team should make a short presentation (4-5 minutes) about your bridge plan. Your presentation should include the following:

- *Why do you believe your team's bridge was successful (or not)?*
- *Which materials did you use, and why?*
- *What part of the building process was difficult?*

If there is time, try programming the Sphero BOLT to cross other bridges created by your classmates.

REFLECTION

Write your reflections on this activity and discuss with the class.

- Record whether or not your bridge was successful. If it failed, note where the failure occurred.
- *How would you do things differently in the future?*
- *What materials worked best?*
- *What bridge type worked best?*
- *What was the hardest or most fun part of the challenge?*

LIGHT PAINTING

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Science*

OBJECTIVE

- **I will create a long exposure photograph.**
- **I will create and execute a program, either using the Draw or Blocks canvas.**
- **I will create an original work of art using the Sphero BOLT and long exposure photography.**

OVERVIEW

Learn how to use long exposure photography to take pictures that capture an image over time. Create a light-filled program using the Sphero BOLT to create your own artwork to share with others.

MATERIALS

- **Sphero BOLT**
- **Two smartphones or tablets**
- **Long exposure photography app (ie. LongExpo)**
- **Tripod that will hold a phone or tablet**
- **Painters tape**

EXPLORATION: DRAWING LIGHT WITH THE SPHERO BOLT

Use the Sphero BOLT to paint with light!

Watch the video below to find out how.

▶ *https://youtu.be/hek4uEJ7WLw*

Sphero BOLT + Long Exposure Photography = Light Painting!

The Sphero Edu app allows you to create programs for the Sphero BOLT. These programs tell the Sphero BOLT what to do. To get started quickly, take a look at the Light Write program (*https://edu.sphero.com/remixes/1100273*) or Shape Shifter (*https://edu.sphero.com/remixes/963849*). Light Write uses premade functions that program the Sphero BOLT to draw different letters with light. Shape shifter is a simple Blocks program that allows you to draw all the polygons.

Another place to start is the Draw canvas. If you are unfamiliar with Draw, check out this simple getting-started activity (*https://edu.sphero.com/cwists/preview/6872x*).

And for you more advanced programmers, give the Blocks or Text canvas a shot.

Remember that your program needs to have the Main LED lights on, and preferably, changing colors throughout the program.

EXPLORATION: CAMERA SETUP

The video below will help you get your camera set up. If you want to follow along, use the Shape Shifter program (*https://edu.sphero.com/remixes/963849*) and set the number of sides to three.

▶ *https://youtu.be/8DU1n2oafP4*

There are numerous long exposure photography apps available for smartphones. Continue to Step 3 to learn how which settings will be most important.

EXPLORATION: FINDING THE RIGHT SETTINGS

Change the settings in your camera app so that it is in "light trail" mode with the highest sensitivity and longest shutter speed possible.

- Sensitivity relates to how much light is necessary to capture an image. A higher sensitivity is typically used when there is less light available for taking the image. For example, a low sensitivity might be used in bright sunlight, but a high sensitivity might be used indoors.
- Shutter speed is the length of time light is exposed to a camera's sensor. A fast shutter speed helps freeze action. A slow shutter speed can make moving objects blurry, often creating a sense of movement.

SKILLS BUILDING: TESTING YOUR PROGRAM

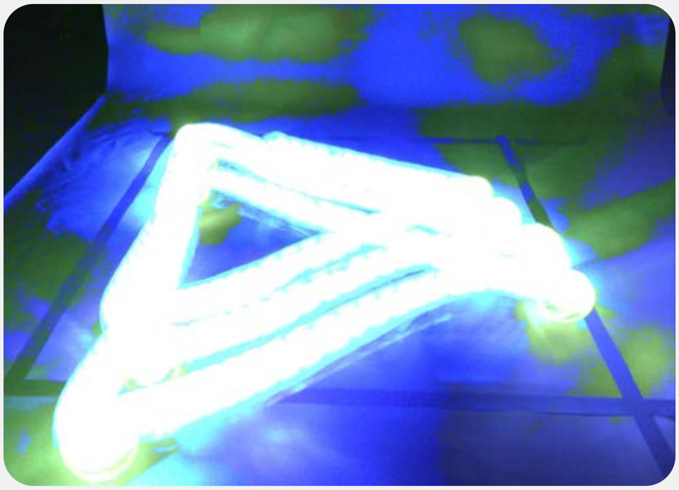
Put the Sphero BOLT in the left corner of your shot and take a long exposure photo as you run one of your programs from the Sphero Edu app.

Did the Sphero BOLT stay in the frame of the camera the entire time? Make any adjustments needed to the camera's position to ensure that the Sphero BOLT stays in the shot the entire time.

If you are struggling with a new program, go back to Step 1 for a couple sample programs you can use.

SKILLS BUILDING: PERFECT PICTURE

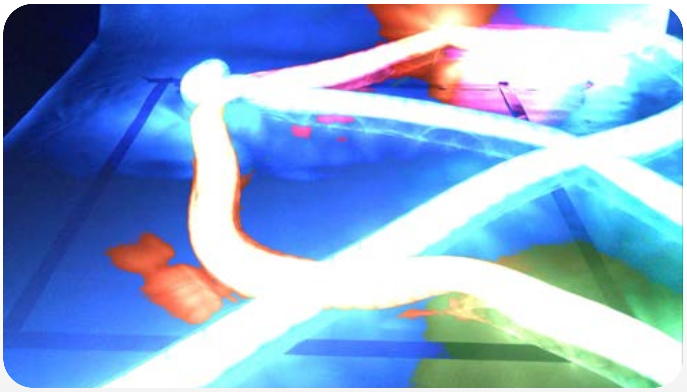
What does your picture look like? Did it capture the Sphero BOLT's light trail?
If you were unable to capture a picture similar to the one below, explore the long exposure app's settings. Encourage kids to ask for help!



CHALLENGE: CREATE YOUR OWN ARTWORK

You have had time to prepare the camera and test your programs, and now it's time to create some artwork.

Pick the program (or create a new one) that you want to be your final product. If you want something more spontaneous, don't hesitate to create a new Draw canvas and have at it!



Be sure that the camera is picking up all of the Sphero BOLT's movements. What have you noticed if the program is too busy or the Sphero BOLT's movements are too close to one another?

CHALLENGE: COLLABORATIVE ART (OPTIONAL)

Get together with some classmates and create a collaborative piece of art. You can simply run your programs simultaneously and snap a long exposure picture, or do something new and more coordinated. Again, feel free to use the Draw or Blocks canvas.

Share a picture of your collaborative artwork at the end.

Watch the video below to see how students just like you used their Sphero BOLT to create their own artwork.

▶ *https://youtu.be/1NbLRiL1Mbw*

REFLECTION

Take some time to reflect on this experience. Use these questions to guide a discussion with a partner:

- *Did your photo turn out the way you thought it would?*
- *What could you do to make your light drawing even better?*
- *How do you think changing the sensitivity or shutter speed might affect your photo?*

If time allows, modify your program until you are happy with your design.

TRACTOR PULL

OVERALL TIME *2- to 4-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Science*

OBJECTIVE

- **I will identify how the Sphero BOLT can power a land-based vehicle constructed with inexpensive materials.**
- **I will illustrate the process of determining which code elements would be best suited to accomplish an objective.**
- **I will program the Sphero BOLT to pull a tractor carrying objects with increasing amounts of weight.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

OVERVIEW

Explore Newton's Laws of Force and Motion. Build a Sphero BOLT powered tractor and see what happens when speed and mass are changed.

MATERIALS

- **Sphero BOLT**
- **Building Supplies: cups, straws, pipe cleaners, string, masking tape, or a building systems like LEGO® or K'nex**
- **Measuring Supplies: masking tape, yard stick or measuring tape, Maze Tape**
- **Possible Weights: Maze Tape, marbles, pennies, etc.**

EXPLORATION: UNDERSTANDING NEWTON'S LAWS

As part of this activity, you will need to describe the various forces acting upon the Sphero BOLT. Take a few minutes to watch Joshua Manley's TED-Ed video on Newton's 3 Laws. It's worth the watch.

▸ *https://youtu.be/JGO_zDWmkvk*

While watching, keep these questions in mind:

- *How would YOU explain* ***inertia*** *to someone else?*
- *What is the relationship between* ***force*** *and* ***acceleration****?* ***Force*** *and* ***mass****?*
- *How would YOU explain the* ***action/ reaction*** *pair of the Sphero BOLT's and the ground?*

EXPLORATION: BASELINE DATA

This acivity is all about observing and understanding how forces affect the motion of objects. To help you better understand this relationship, let's collect some baseline data to compare later in this activity.

You will need to set up a straight 5m track that your soon-to-be-built tractor will travel down. Find an open space and measure 5m. You can either use masking tape to mark the start and stop of track or stretch a piece of masking tape/Maze full length of the track.

Now use **Part 1** of the attached Tractor Pull Activity Pack to run an initial test, collect the baseline data, and make some early observations.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/72/36/Tractor%20Pull%20Activity%20Pack.pdf

SKILLS BUILDING: TRACTOR BUILD & DESIGN

Now you know how fast the Sphero BOLT travels 5m at a speed of 150. How will that data change when you add a tractor to the Sphero BOLT? How will that change when you add a tractor AND an added weight to pull? We can't find out unless we try.

So, LET'S BUILD SOME TRACTORS!

Be sure to check with your teacher to understand any additional rules or restrictions that may apply to the materials you are allowed to use and not use to build your tractor. Keep in mind that your tractor should not only be Sphero BOLT-driven, but it needs to be able to pull/carry any assigned added weight.

Before you build, brainstorm some ideas with your team. Use the top portion of Part 2 of the Activity Pack to guide your thinking.

Share a picture of your tractor when you are done with this step.

SKILLS BUILDING: TRACTOR TEST #1

Your tractor is done and ready to test. Before you take it to the track, make a couple predictions based on the baseline data and your understanding of the relationship between **force**, **mass**, and **acceleration** (Newton's Second Law).

- Predict the time it will take the Sphero BOLT-driven tractor to travel 5m:
  - ________ sec (at speed 150 without any added weight)
  - ________ sec (at speed 150 with the assigned added weight)

Be sure to record your predictions in Part 2 of the Activity Pack.

Now let's test your tractor. Head over to the track. Place the Sphero BOLT and your tractor down at the start. Aim the Sphero BOLT and run the same program you ran for the baseline data. Record the results in Part 2 of the Activity Pack.

Discuss the results as a team, using the end of Part 2 and all of Part 3 in the Activity Packet to guide your discussion.

What are two things your team can do to make your tractor go faster?

SKILLS BUILDING: TRACTOR TEST #2

What are some ways that you can make the Sphero BOLT and the tractor go faster? Why will that make a difference?

Take a look at Part 4 in the Acivity Pack. Make your predictions:

1. What would happen if you just increased the Sphero BOLT's speed in the program?
2. What would happen if you just decreased the mass of the tractor?

Before you make ANY changes to your tractor, you need to run the speed tests in Part 4. You will use the same tractor you used before but increase the speed in the program. Do this twice with the two new speeds mentioned in the Activity Pack.

Run the tests and record your results. Be sure to run the additional tests at each new speed with and without the added weight.

CHALLENGE: TRACTOR V2

Now it's time to shed some weight. The second part of Part 4 asks you what would happen if you decreased the mass of the tractor.

Brainstorm quickly with your team how you can shed enough weight to make a difference, but keep the structural integrity of the tractor AND still be able to pull/carry the added weight.

Make the necessary changes. When you are done, share a picture of Tractor v2.

CHALLENGE: TRACTOR TEST #3

Head on over to the track with the Sphero BOLT and Tractor v2. You will be using the original speed of 150 but now with a lighter tractor. Run the test with and without the added weight.

Record your results at the end of Part 4 and be sure to discuss your observations with your team.

Hopefully your tractor doesn't end up like the one in the video!

▸ *https://youtu.be/-adGzlXOLDQ*

HYDRO-HYPOTHESIS

OVERALL TIME *2- to 4-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Science*

OBJECTIVE

- **I will identify how the Sphero BOLT can power a water-based vehicle constructed with inexpensive materials.**
- **I will drive the Sphero BOLT across a water course in a straight line with a payload attached.**
- **I will learn to improve the Sphero BOLT's performance as the power source for a water-based vehicle.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

OVERVIEW

Design and test a contraption for the Sphero BOLT to carry a load of pennies across a small body of water. You will need to consider buoyancy, density, surface area, and what types of materials float in water. Drive the Sphero BOLT to move the load across a designated distance and/or around floating obstacles.

MATERIALS

- **Sphero BOLT**
- **Foam**
- **String**
- **Cardboard**
- **Scissors**
- **Rubber bands**
- **Tape, pennies**
- **Small swimming pool or large tub of water**

EXPLORATION: CAN THE SPHERO BOLT MOVE THROUGH WATER?

The Sphero BOLT can move through the water, *but how can the Sphero BOLT transport a load of pennies while moving through water?*

Using the materials supplied in your classroom, build a watercraft powered by the Sphero BOLT to carry a load of 10-20 pennies.

If given the chance, try driving the Sphero BOLT in water.

- *Does it float? How does it move across the water?*
- *Is it easy to control? Why or why not?*
- *What could you do to improve how the Sphero BOLT performs in water?*

Watch the video below to see how the Sphero BOLT reacts to carrying pennies under water.

▶ *https://youtu.be/1lUz0cTSdR4*

EXPLORATION: DESIGN IDEAS

Take a blank piece of paper and fold it in half. Fold it in half again the other way so you have four sections. Based on what you know and have learned about how the Sphero BOLT operates in water, think of four unique ideas for a penny-carrying contraption and draw each one in a separate section.

Crazy and weird ideas are encouraged! Pick your favorite to share with your team. Take a look at the video below to give you some inspiration for your ideas!

- *https://youtu.be/EQa7YStVfWQ*

EXPLORATION: FLOATING OBSTACLES

Think of some fun and silly floating obstacles that can mark a spot in the water course that the Sphero BOLT must navigate around. The obstacles should remain in place even if impacted by the Sphero BOLT as it passes by.

SKILLS BUILDING: DESIGN ENGINEERING

Experiment with materials and designs to determine which performs best. *Which elements should you include in your design?*

With your team, review each member's ideas and see if you can come up with any new designs. Select the best design to create and determine the materials needed.

Present a picture of your team's idea to the class and describe why you think it will be successful.

- *What will be the most challenging part of the construction?*

SKILLS BUILDING: BUILD AND TEST

Below is a video and an image to help you with some ideas. Your watercraft **does not** have to look like either of those. Remember, crazy and wacky are just fine.

- *https://youtu.be/2L-i3z6dRrU*

Start building your watercraft with your team. Remember to think about buoyancy, the density of the materials you use, and their surface area. If you are unsure of why those things are important, do a quick search on each one and how they relate to floating objects.

Don't get discouraged if your design isn't working as planned. Keep at it and test your design along the way.

CHALLENGE: SINK OR SWIM

Time to find out which creations will sink and which will swim! Test your contraption with different numbers of pennies. It can be tricky to build a Sphero BOLT-powered watercraft because the Sphero BOLT is partially underwater when it swims.

Provide directions and specifics of the challenge to kids. May the best boat float!

REFLECTIONS

Write your reflections on this activity and discuss with the class.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What happened the first time you tested your watercraft?*
- *How did your watercraft change from the initial design?*
- *What materials worked best?*
- *What happened when more weight (pennies) were added?*
- *What was the hardest or most fun part of the challenge?*

ATOM TRACKS

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OBJECTIVE

- **I will simulate how atoms move in solid, liquid, and gas states.**
- **I will understand atomic movement and compare different movements based on the state of the atom.**
- **Advanced: I will illustrate a chemical reaction, Boyle's Law, Charles's Law, or Newton's 3rd law.**

OVERVIEW

Use the Sphero BOLT and a pan of paint to see how atoms move in solid, liquid, and gas states. By programming the Sphero BOLT to move about in different sized spaces while tracing its path with paint, you can "see" atomic movement in action in order to compare solid, liquids, and gases as well as comparing atomic movement based on atoms with different mass.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **18in x 18in box**
- **14in x 14in box**
- **9.5in x 6in box**
- **Water-based paint**
- **Paint tray**
- **Gloves**

EXPLORATION: PAINTING WITH THE SPHERO BOLT

The Sphero BOLT loves to paint! Watch the video below to see how it does. To get started, set up a large box like you see below.

▸ *https://youtu.be/2bGOxv-UMXY*

EXPLORATION: ATOMS IN MOVEMENT

Atoms are in constant motion. As they move, they are continuously bouncing off of other atoms and anything else they collide with.

Work with your teammates to write a Blocks program that causes the Sphero BOLT to roll and change directions randomly every second- similar to how atoms move.

Watch the video below if you're unsure what to do!

▸ *https://youtu.be/gLWTwThLsq8*

EXPLORATION: ATOM TRACK PAINTING

When you're satisfied with your program:

1. Cover the Sphero BOLT with paint.
2. Drop it in the box.
3. Aim the Sphero BOLT and run the program.

For additonal observations, try doing the same thing with two or more Sphero BOLTs in one box. (You will need to have another device controlling the additional Sphero BOLT and running the program.)

When the Sphero BOLT runs out of paint, stop the program and take him out of the box. *What does the painting look like? Can you follow the tracks?*

Explore for an added challenge:

- Open the sensor data to preview the different results of your Sphero BOLT's movement. (Note: You can export these results to a spreadsheet if needed.)

SKILLS BUILDING: SMALLER BOX

Pretend the big box in the last experiment was a container of gas. Particles in liquid have a force of attraction drawing them closer together than they would be in a gaseous state, but they maintain the ability to move.

- *What do you think the painting would look like if you used a smaller box to simulate a container of liquid?*

Test it out by repeating the experiment with a smaller box and/or with two Sphero BOLTs in one box. (You will need to have another device controlling the additional Sphero BOLT and running a program.)

SKILLS BUILDING: AN EVEN SMALLER BOX

In a solid state, the force of attraction between atoms is very strong and movement of atoms is limited. This is why a solid takes up less space (or volume) than a gas.

What do you think would happen if you used an even smaller box to simulate a solid?

Test it out by repeating the experiment with an even smaller box.

SKILLS BUILDING: COMPARE & CONTRAST

Compare all three paintings by asking yourself these questions:

- *What is similar about the paintings?*
- *What is different about the paintings?*
- *How was the Sphero BOLT's path affected by the size of the box?*
- *What does this tell you about how atoms move in a solid, a liquid, and a gas?*

CHALLENGE: SIMULATE DIFFERENT GASES

Watch the video below.

▶ *https://youtu.be/EsvXhIZbFVY*

Consider doing the experiment again with multiple Sphero BOLTs and adjusting the movement of atoms to simulate different gases based on their masses such as helium and krypton, or neon and argon.

BONUS: Record your experiment by pressing the three dots in the top right corner and tap on "Camera."

Explain what is happening in your experiment while you are recording.

CHALLENGE - OTHER SIMULATIONS

Using Block Coding, create a program to model or illustrate one of the following (Research more about these laws, if needed):

- Chemical reactions
- Boyle's Law
- Charles's Law
- Newton's 3rd law.

Test your program and simulation, analyze the data, and make changes as necessary.

HELMETS FOR THE WIN

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OBJECTIVE

- **I will learn about the scientific method.**
- **I will make educated predictions, experiment, analyze data, draw conclusions, and share their findings.**
- **I will be able to identify and complete the six parts of the scientific method based on the provided question and experiment.**
- **I will learn what g-forces are and learn how they are measured by an accelerometer.**

OVERVIEW

In this activity you will learn about g-forces, how they are measured by an accelerometer, and identify and complete the six parts of the scientific method based on the provided question and experiment. This short activity explores the scientific method through a discussion around concussions and g-forces. Which helmet configuration will best protect the Sphero BOLT?

MATERIALS

- **Sphero BOLT**
- **Boxes or containers**
- **Small helmets**
- **Rubber bands**
- **Foam insert**
- **Shop towels**

**The experiments in this activity are not meant to provide exact data but to provide a visual representation of possible outcomes. Sensor streaming may provide inconsistent results. We recommend multiple tests be done.*

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION: G-FORCES

What is a g-force?

The **g-force** (with **g** from gravitational) is a form of acceleration that causes the accelerating object to experience a force acting in the opposite direction to the acceleration, thus causing a perception of weight. The term g-force is technically incorrect as it is a measure of acceleration, not force.

Imagine a running back getting the handoff from the quarterback and running up field. He's the object accelerating in a given direction. Now picture a linebacker. He wants to stop the running back from making it up field. He's the force acting (accelerating) in the opposite direction.

Both players experience g-forces when they finally collide. Sometimes one experiences more than the other.

EXPLORATION: MEASURING G-FORCES

An accelerometer is a device that measures acceleration. Acceleration is the rate of change of the velocity of an object. The accelerometer in the Sphero BOLT reads g-forces (g). A single g-force from a human being is equivalent to about 9.8 m/s2 depending on the eleveation of where you live. Accelerometers are useful for sensing the smallest vibration to the bigger bumps, drops, and crashes that your SPRK+ will inevitably experience.

Accelerometers are electromechanical devices that sense either static or dynamic forces of acceleration. Static forces include gravity, while dynamic forces can include vibrations, movement, and orientation. Accelerometers can measure acceleration on one, two, or three axes.

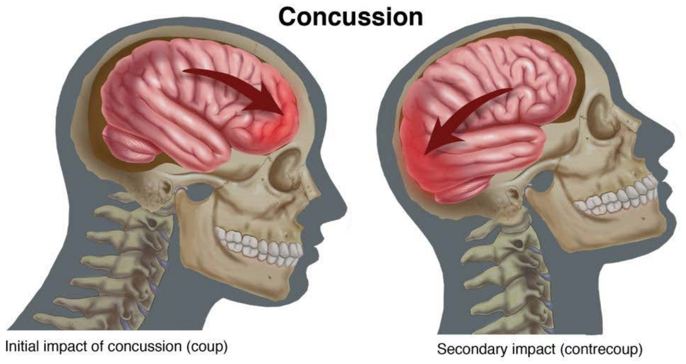
EXPLORATION: REAL LIFE G-FORCES

Have you ever stubbed your toe or bumped your head? If so, you've experienced g-forces in your life.

There is a lot of research and discussions right now around g-forces in professional and youth sports. Conucussions are a common injury in many contact sports. They are caused by acceleration forces (like whiplash or a blow to the head) that shakes the brain inside the skull.

Most helmets are designed to absorb the g-forces caused by falls, bumps, and crashes. Modern research explains that a concussion can deliver 95 g on the human body. The average football player experiences 103 g when hit hard during a game, where as the average fighter pilot only experiences 9 g. Quick question: *What's the difference between the g-forces felt by a football player and the g-forces felt by a fighter pilot*? When you have time take a few minutes to do some searching to find out.

Resources: concussion, from Science Daily



EXPLORATION: WHAT IS THE SCIENTIFIC METHOD?

Take a few minutes to watch "The Scientific Method" by Sprouts on Youtube.

▶ *https://www.youtube.com/watch?v=yi0hwFDQTSQ&t=359s*

Pay close attention to the six steps of the Scientific Method. What are they (in order)? What do you do during each step?

Download or print the chart below ("Scientific Method.pdf) to use for the rest of the activity.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/f7/2a/Scientific%20Method.pdf

SKILLS BUILDING: WHICH WORKS BETTER?

So here is where ALL this comes together.

Your Sphero BOLT has an accelerometer. It measures g-forces on three different planes. We're going to use the sensor to measure the amount of g-force the Sphero BOLT experiences after a fall from about three feet.

As you briefly learned above, most helmets are designed to protect your head from g-forces acting on your brain. In this experiment we will test three different modified mini helmets to see which one will protect the Sphero BOLT from experiencing too many g-forces.

The three helmets include:

1. Maroon: The Sphero BOLT sits in the helmet and is only held in place by two paper towels.
2. Gold: The Sphero BOLT is suspended in a hammock of sorts made out of women's nylons.
3. Green: The Sphero BOLT is surrounded by one-inch thick packing foam.

Using the Scientific Method chart from above, do the following:

1. Write down the question for this experiment --> *Which modified helmet will best protect the* Sphero BOLT *from experiening too many g-forces?*
2. Record your hypothesis. Remember your hypothesis is an educated guess of what is going to happen during the experiment based on the little information you've been given thus far. It can start with something like, "I think..."

SKILLS BUILDING: THE EXPERIMENT

The Control

Experiments usually have a control group to give base data. In this case, you'll drop the Sphero BOLT without a helmet from about three feet off the ground. Here are the steps:

1. Open the program titled Helmet Test (*https://edu.sphero.com/remixes/821341*).
2. Be sure that the Sphero BOLT is paired to your device.
3. Start the program.
4. Hold the Sphero BOLT about three feet above the ground and let it go.

The program is designed to register three ranges of g-forces. As mentioned previously, a concussion can deliver 95 g. The accellerometer in the Sphero BOLT will register about 14 g, so we will use a multiplier of 7 to give us a rough idea of whether or not the Sphero BOLT gets a concussion.

- **Green** -- It's just a bump. It'll be ok. (less than an estimated 50 g)
- **Yellow** -- That really hurt. Put some ice on it. (between an estimated 51 and 90 g)
- **Red** -- We probably should take it to the doctor. It's eyes don't look right. (more than an estimated 90 g)

If all goes as it should, the Sphero BOLT will turn red and you should hear an ambulance siren.

The Variables

Experiments also have experimental variables. These are the different things that are being tested, usually one at a time. In this case we are testing three different modified helmets. Here are the steps for the remainder of the experiment.

1. Place your Sphero BOLT into the first helmet to be tested.
2. Be sure the Sphero Edu app is open and that the robot is paired with your device.
3. Open the attached program titled Helmet Test.
4. Start the program.
5. Hold the helmet about three feet off of the ground. Be sure to hold it so that the actual top of the helmet is what will hit the ground when dropped.
6. Let go of the helmet.

Repeat steps 4 and 5 for each helmet. You can start and stop the program for each drop to record individual readings if you'd like.

What were the results? Which was the better helmet based on this experiment? Record what happend (colors the Sphero BOLT changed) in box for of your Scientific Method chart.

CHALLENGE - WHICH HELMET WORKS BEST?

So which was it? Which modified mini helmet kept the Sphero BOLT *from going to the emergency room?*

The last two steps in the Scientific Method are Draw a Conlcusion and Communicate the Results. Here's what you need to do to wrap this all up:

1. Take a look at the results you recorded in box 4 of your chart. Was there a clear "winner" or was the experiment inconclusive (that means the results experiment didn't give you enough to answer the original question)?
2. Write down your conclusion in box 5. In other words, answer the original question. If you can't answer the question, say that and tell why.
3. Last, communicate your findings. Get creative here. You'll need to attach an image to this step that communicates the results of the experiment and the answer to the original question. Maybe hold up the best helmet or take a picture of your chart. It's up to you. Have fun with it!

ORGAN QUIZ

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OBJECTIVE

- **I will name the nine vital organs and where they are located in the human body.**
- **I will create my own game by editing the provided code.**

OVERVIEW

Identify the organs in the human body and then create your own quiz!

MATERIALS

- **Organs PDF**
- **Butcher paper**
- **Markers or crayons**
- **Scissors**

EXPLORATION: THE ORGANS

Grab your stack of organs and begin to color each one. As you color them, take a moment to read the captions. You might learn something about an organ that you didn't know before.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/c9/75/Organ%20Quiz_Organs.pdf

When you are done coloring, carefully cut out each organ.

EXPLORATION: THE BODY

Where do all these parts go? They need a body, of course!

Work with a friend or a partner for this step. Grab some butcher paper and make sure it's a little taller than you. Lay the butcher paper down on the floor and lay down on top of it. Ask your partner to trace an outline of your body. You will use this outline to place the different organs as they are called out during the Organ Quiz.

Place your organs where they should go on the body outline you and your partner made.

EXPLORATION: TAKE THE QUIZ

Have you studied up? Do you know where all nine organs go in your body? I hope so because it's time to play the Organ Quiz!

Watch the video to learn how to play the game: Organ Quiz.

▸ *https://youtu.be/3LFTehM1alU*

Be sure to lay down the body outline and gather all the organs before you play. When you're done, use your camera to take a snapshot of your organs located on the body outline.

SKILLS BUILDING: ADD PARTS TO THE BODY

Attached to this activity is a program titled "Organ Quiz." Open the program - we're going to edit it to add an additional organ: the Pancreas!

- Go to the Function (green) tab, then select "edit", then, "evaluate."
- Find the Speak blocks that contain the 9 organs. Tap the first If/Then block and then copy. Scroll to the bottom of the program and tap the last If/Then block. Tap the paste button.
- Tap the Variables tab at the bottom (red), then Add New, then Number (check), then name the variable Pancreas (done), then 1 (check).

SKILLS BUILDING: VARIABLES

1. Now you can replace the If/Then Heart variable you copied earlier with the Pancreas variable. Do this for both variables in the block grouping.
2. Change the Organ = 9 block to Organ = 10 (because we added one more organ) and check. Now, edit the Speak block text by tapping on it and type in the new label "Pancreas" to be spoken and save. Select Done.
3. There are a few last things to change on you main canvas. Go to the Set Number block with organ = Random Int 1 to 9 located at the top of the program. Change from 9 to 10, indicating 10 organs to label.
4. Select the Operators tab, then add an "add (+)" to the If/Then block with other organ variable listed. Select Variables and move the Pancreas variable you made to 0 next to the + you just added.
5. Go to the bottom of your program, before the Main LED block and add a Set block from the Operators tab. Choose Number (check), change the 0 to 1 (check). Now add the Pancreas variable to the open blue circle in that block.
6. Run your program!

CHALLENGE: BUILD YOUR OWN QUIZ

Build your own quiz! Brainstorm ideas of other complex objects that could be labeled. Examples may include the parts of cell or parts of a flower.

By editing the Organs Quiz or beginning a blank program canvas, work with your partner or small group to:

1. Change the number of variables (parts you need to label)
2. The words spoken in the function.
3. Finally, include content materials for others to study as well as cut out they can use for your quiz.
4. Switch programs with another group and attempt their test. Good luck!

PLANETS QUIZ

OVERALL TIME *2- to 4-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OBJECTIVE

- **I will learn about the eight planets in our Solar System.**
- **I will execute a Blocks program.**
- **I will deconstruct the attached program.**
- **I will edit the attached Blocks program to make your own quiz.**

OVERVIEW

Create your own quiz by editing this block program.

MATERIALS

- **The Sphero BOLT**
- **Planet packet**

EXPLORATION: LEARN ABOUT THE PLANETS

Review the attached Planet Quiz Research Guide to learn all about the 8 planets in our solar system. As you are reviewing the guide, highlight key facts that you believe to be important. Once you are done reviewing, work with a partner to share the most important attributes of each planet.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/dc/70/Planets%20Quiz%20-%20Research.pdf

EXPLORATION: PLANET CARDS

Cut out each planet in the below Planet Pack PDF.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/74/ee/Planets%20Quiz.pdf

On the back of each planet are three facts. These are the facts that you will learn about in this activity and that the Sphero BOLT will quiz you on.

SKILLS BUILDING - TAKE THE QUIZ

Have you cut out the planets? Have you studied up on each one? Are you ready for the quiz? Watch this video to see an introduction to the game.

▶ *https://youtu.be/yID6KH_hFnc*

This game works best in a group of 2-3 players. The goal of the game is to name the planet to match the spoken fact. Here's how to play:

- Connect the Sphero BOLT to the app and start the linked "Planets Quiz" program to hear the first fact. There are 3 possible facts for each planet.
- Pick up the planet you think matches the fact and check the back to see if you're right.
- Shake the Sphero BOLT to hear the next fact, and continue to see how many the group can answer.

- Restart the program and keep playing until you can get all 8 correct.

SKILLS BUILDING: DECONSTRUCTING A PROGRAM

We will now deconstruct the Planets Quiz program.

- Go to the Function (green) tab, then select "edit", then planetPicker.
- Remove If/Then blocks (purple) for planets 5-8. Look for the planet number to help you locate them. Select Done.
- On you main canvas, go to the Set Number block with planet = Random Int 1 to 8 located at the top of the program. Change from 8 to 4, indicating only four planets to pick.
- Remove the last four planets variables (red, labeled with the planet name) from the If/Then block.
- Now when you run your program, you should only have 4 planets to choose from and only four facts per round.

CHALLENGE: WRITE YOUR OWN QUIZ

You will now create your own quiz about a different topic of your choosing (Animals, computers, video games, sports, etc.)

- Work with a partner to create 3 facts about 4 different related topics (*ex: Write 3 facts about each of the following: baseball, football, basketball and golf*).
- Open your edited Planets Quiz program. Find the Speak blocks by editing the planetPicker Function that contains the 12 facts.
- Edit each block of Speak block text to include facts you have created. Run the program again with your facts.

CHALLENGE - CREATE YOUR OWN QUIZ EXPERIENCE

Create your own quiz-style program by:

- Changing the number of facts.
- Changing how many facts are given each round.
- Adding your own variables and function.
- Changing what action is done to hear the next fact.

Add any idea you think would enhance the quiz, and be sure to include content materials for others to study prior to your quiz.

BLOCKS 1: INTRO & LOOPS

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Beginning Block: Roll, Delay, Sound, Speak, and Main LED*

CONTENT THEME *Technology & Engineering*

OBJECTIVE

- **I can practice refactoring code.**
- **I can define and use loops.**
- **I can create and execute a Blocks program.**

OVERVIEW

Welcome to your first Blocks activity! This lesson introduces you to the Blocks canvas. Learners will be challenged to create a program using block coding and gain an understanding of loops and operators.

MATERIALS

- **Sphero BOLT**

EXPLORATION: BLOCKS CATEGORIES

The Blocks programming canvas is designed to teach principals of programming. At the bottom of the Blocks canvas you will find 11 block categories. To view the blocks within a category, simply select the category tab.

Movements	Control the robot motors and control system.
Lights	Control the LEDs on your robot.
Sounds	Play sounds or text-to-speech on device.
Controls	Allow conditional or branching logic.
Operators	Math statements to modify or create values.
Comparators	Can compare two values and create conditional logic.
Sensors	Add read-only values streamed from robot's sensors.
Communications	Control a BOLT or RVR's ability to send and receive IR.
Events	Can embed conditional logic in predefined functions.
Variables	Value that limits redundant logic.
Functions	Help organize complex logic.

SKILLS BUILDING: PROGRAM A SQUARE

Follow along with the video below to create a Blocks program. You will program your Sphero BOLT to move in a square with roll and delay blocks.

▶ *https://youtu.be/ZfpPvnEsbto*

SKILLS BUILDING: REFACTORING WITH LOOPS

Now let's refactor your code so that it draws a square using a loop.

- **Refactor** is a common term used by developers that means to improve the way your code is written while still making sure it performs that same action.

You will use a loop to repeat any repeated actions in your original code. A loop repeats a series of blocks as many times as you want.

- *Why would this be useful?*
- *How do loops make it easier to create a shape with five sides, ten sides, or even 100 sides?*

Watch the video below for guided instructions.

▶ *https://youtu.be/6zoXyh5Qoz0*

CHALLENGE: LIGHTS & SOUNDS

Add an extra layer of fun to your program by including lights and sounds as your Sphero BOLT moves in a square. Use the video below if you are unsure how to do this.

▶ *https://youtu.be/x0ly6eYu6Lg*

CHALLENGE: OTHER SHAPES

How would you change your code to make a different shape?

1. Draw a triangle on a piece of paper. How is it different from a square?
2. Create a new program that has your Sphero BOLT robot move in a triangle. Challenge yourself and see what other shapes you can code.

REFLECTION

Think about the following questions on your own or with a partner:

- *What is a loop?*
- *What are the benefits of refactoring your code to use a loop?*
- *Are there actions you repeat every day? If you could program these actions, how would you write a loop to repeat them for you?*

MAZE MAYHEM

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Technology & Engineering*

OBJECTIVE

- **I will evaluate a maze for the quickest and most efficient solution.**
- **I will create a program to navigate the Sphero BOLT through a maze using Blocks and the Blocks Canvas.**

OVERVIEW

Program the Sphero BOLT to navigate your own original maze. To complete this challenge, you must gather data about the best route through the maze and figure out how to build a program so the Sphero BOLT can successfully navigate through the mayhem.

MATERIALS

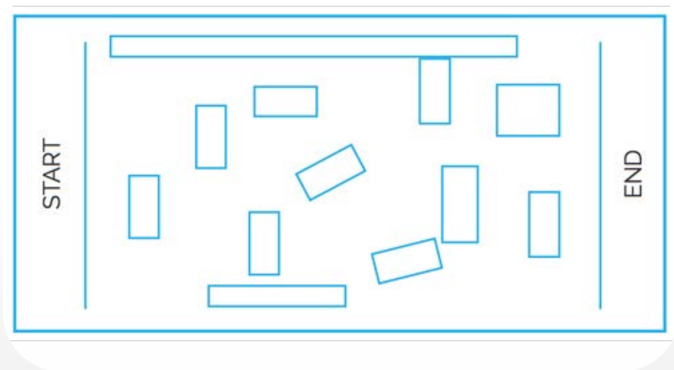
- **Sphero BOLT**
- **Sphero BOLT Maze Tape (or masking tape)**
- **Stopwatch or timer**
- **Measuring tape or rulers**
- **Protractors**
- **Large space on the floor**
- **Books and other everyday objects to build the maze**

EXPLORATION: MAZE INSPIRATION

What does it take for the Sphero BOLT to navigate a maze? It's definitely more than just driving it around. In this activity you will gather data and program the most efficient path through a maze.

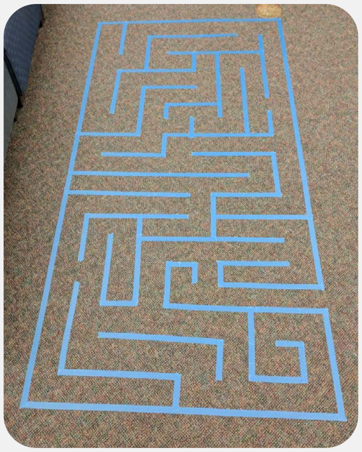
Below is a video and an image with examples of possible mazes.

▶ *https://youtu.be/X9rElBhT9nE*



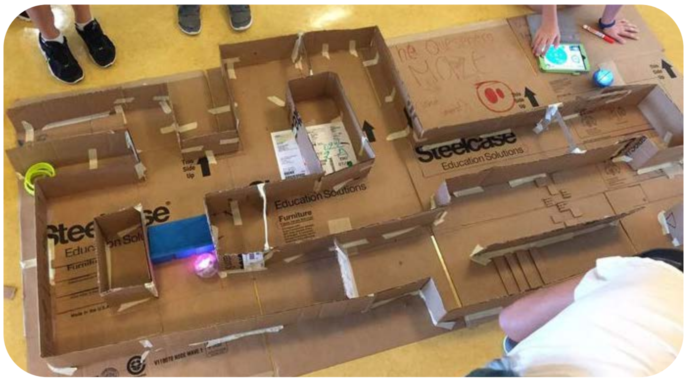
EXPLORATION: MAZE BUILDING

Your maze can be as simple as blue tape on the floor. It doesn't take much to create a path for the Sphero BOLT to navigate. If you have the space, grab some object from around the room to create walls and a path for the Sphero BOLT. Things like books, LEGO® bricks, boxes, shoes, or even waste baskets will work.



As you create this maze, add some obstacles to make the path more difficult. Narrow passages can be tricky too.

SKILLS BUILDING: HOW FAR DOES THE SPHERO BOLT TRAVEL?



To navigate the maze quickly and effeciently you'll want to determine how far the Sphero BOLT travels. You will need to know how far the Sphero BOLT travels in a set period of time (for example, in 1 second). Watch the video below to get started.

▸ *https://youtu.be/_RDZQvh3Qlc*

Create a program that will help you take this measurement. (**HINT:** Start with a simple roll block, set the speed and set the duration to one second.)

SKILLS BUILDING - NAVIGATING THE MAZE

Using the data you gathered in Step 3, write down instructions for what you want the Sphero BOLT to do. Draw the maze on a piece of paper, determine the Sphero BOLT's path and take measurements of distances and angles. Something like this:

- Go straight for 40 cm
- Stop
- Turn left 90 degrees
- Go straight for 20 cm

Next to each instruction, write which block you would need to complete that instruction. When you are done, you will have step-by-step instructions for the Sphero BOLT to move through the maze.

CHALLENGE: MAZE MAYHEM!

Time to put all of the planning to work and start programming!

Test your program as you go. Modify the program as needed. Remember you are programming for quickness and efficiency.

HINT: If you find that the Sphero BOLT isn't turning consistently or as sharp as you'd like, explore the Delay block unter "Controls."

REFLECTION

Write your reflections on this activity.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What route worked best?*
- *What was the trickiest part of the maze?*
- *What was the most challenging part of the activity?*

BLOCKS 2: IF/THEN/ELSE

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Technology & Engineering*

OBJECTIVE

- **I can define and use conditionals, including if/then/else statements.**
- **I can create and execute a Blocks program.**

OVERVIEW

In this activity, you will learn your first conditional by building a fun animal sound game with your Sphero BOLT. This is a great follow-up activity to Blocks 1.

MATERIALS

- **Sphero BOLT**
- **Download and print Toss Game.pdf** *https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/dd/06/Toss%20Game.pdf*

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION: CONDITIONALS

Most software programs include conditionals. A conditional is an action that takes place when certain conditions are met. An example is an if/then/else statement.

EXPLORATION: TOSS GAME OVERVIEW

In this activity, you will design your own "Toss Game" to show your understanding of conditionals. Watch the video below for an overview.

▶ *https://youtu.be/GOUmz02io94*

Animal sounds?

Yup. Animal sounds.

Which animal sound is the most difficult for you to imitate?

SKILLS BUILDING: INITIAL LOGIC

In this video you will learn how to write the initial logic for the toss game.

▶ *https://youtu.be/hh2SMKLb1aM*

SKILLS BUILDING: IF/THEN/ELSE

Show your understanding of conditionals by using an if/then/else statement to develop the main structure of the game. Follow along with the video below.

▶ *https://youtu.be/kiIZqp5M1xw*

- *Why is it important to select TOTAL on the Accelerometer sensor?*
- *What does g measure?*
- *What do you think the g-force of an astronaut leaving the atmosphere is?*

SKILLS BUILDING: ANIMALS ROAR

Finally, add the logic for a random animal sound to play when the Sphero BOLT is tossed, and for the Sphero BOLT to stay quiet when it's not being tossed.

- *Why is it unnecessary to place an additional Accelerometer sensor measuring force under 3g under the ELSE condition?*

Watch the video below to see how you can make animals roar!

▶ *https://youtu.be/pQaHEobtfj0*

CHALLENGE: PLAY THE TOSS GAME

Now you get to play the game!

Did the game playout like it was meant to? If not, go back into your code and see what is causing the issue. This is called **debugging**. Replay the game after each change you make to the code.

Watch the video below to see how to play the game.

▶ *https://youtu.be/NZe3N3tOCtk*

CHALLENGE: RECORD THE GAME

When you have conquered your challenge, run your program and record your Sphero BOLT at the same time to share with your mentor.

Take a look below to see how to record your Sphero BOLT!

▶ *https://youtu.be/u7zvS2-Rvn0*

CHALLENGE: ADD A TIMER

Instead of having the toss game loop forever, add a custom timer that will end the game automatically after a set amount of time.

See how you can set a timer in this video.

▶ *https://youtu.be/dQGseEkLbmw*

REFLECTION

Write or reflect with a partner about what you learned in this activity:

- *What is a conditional?*
- *What was the conditional used in the toss game?*
  - Draw a diagram that shows the logic for this game.
- *What is an example of a conditional in your daily life?*
  - Write it as an if/then/else statement.

BLOCKS 3: LIGHTS

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Technology & Engineering*

OBJECTIVE

- **I can use a gyroscope to calculate rotational velocity.**
- **I can learn what absolute value is.**
- **I can create and execute a Block program.**

OVERVIEW

In this activity, you will build a spinning top program where the gyroscopic spin rate will control the main LEDs, and you will use the concepts of normalization and absolute value. This is a great activity after you complete Blocks 2.

MATERIALS

- **Sphero BOLT**

EXPLORATION: SPINNING TOP

In this activity you will learn a new way to control the Sphero BOLT's lights and use them to build a creative program that replicates a spinning top toy.

- *How do you think the Sphero BOLT can recognize when it's spinning or rolling? Do you know of a sensor that might do this?*
- *What other devices can recognize rotation?*

EXPLORATION: LED

- *What does LED stand for?*
- *Can you think of other devices (besides the Sphero BOLT) that use LEDs?*
- *Why does the Sphero BOLT only need three different color channels?*

To learn more about LEDs, take a look at the video below.

▶ *https://youtu.be/AgSSSOKIJZA*

EXPLORATION: GYROSCOPE

Change the Sphero BOLT's red and green color channels to visualize the gyroscope's sensor values.

- *What is the vertical axis also known as and how is it measured?*
- *What is the horizontal and forward axis known as?*
- *How do you designate whether the Sphero BOLT spins clockwise or counterclockwise? What is your value range?*

SKILLS BUILDING: PROGRAM FRAMEWORK

Setup the framework for the spinning top program.

- *Why should the stabilization feature be turned off to complete this assignment?*

Take a look at the video below to see how to setup the framework for the spinning top program.

▶ *https://youtu.be/MNo6hEfJr2Y*

SKILLS BUILDING: GREEN FOR "IF" (POSITIVE VALUES)

Use the gyroscope sensor data to modulate the green channel on the LEDs, and introduce normalization.

- *Why are we normalizing the gyroscope spin rate with these two numbers?*
- *What happens if you spin the Sphero BOLT clockwise? Why does this happen?*

Learn how to modulate the green channel on the LEDs below.

▶ *https://youtu.be/GNng3GLfaqA*

SKILLS BUILDING: RED FOR "ELSE" (NEGATIVE VALUES)

Use the gyroscope sensor data to modulate the red channel on the LEDs, and introduce "absolute value."

- *What is absolute value?*
- *Why is the absolute value necessary when determining the LED channel scale?*

Learn how to modulate the red channel on the LEDs below.

▶ *https://youtu.be/JB2ecAVRRnE*

CHALLENGE: SENSOR STREAM

Now that you've completed building this program, investigate the gyroscope sensor stream data.

- *What did you notice about the sensor data?*
    - *Pay special attention to the gyroscope pitch and roll.*

Take a look at the video below to check out the Challenge!

▶ *https://youtu.be/TUgb4exCDn8*

REFLECTION

Write or reflect in a group what you learned with the Sphero BOLT:

- *What is a gyroscope?*
- *How does the the Sphero BOLT's acceleration and direction affect the velocity?*

BLOCKS 4: VARIABLES

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Technology & Engineering*

OBJECTIVE

- **I can create code from pseudocode.**
- **I can define and use variables, conditionals, loops, random within bounds, and data types.**
- **I can create and execute a Blocks program.**

OVERVIEW

In this activity, you will use variables to build a hot potato game powered by the Sphero BOLT. You will also learn about loop until statements, and randomness within bounds to bring this classic game to life. This is a great activity after you complete Blocks 3.

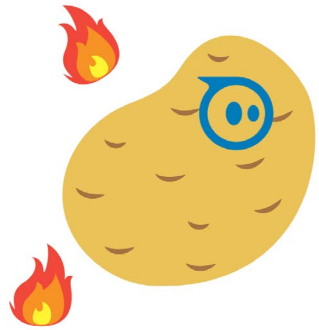
MATERIALS

- **Sphero BOLT**
- **Paper**
- **Pencil**

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION

In this activity, you will create a Hot Potato game with your the Sphero BOLT.



EXPLORATION

Learn the concepts you will use to create this game: loop until and random within bounds.

- *What is a variable?*
- *What is an operator?*
- *What is a loop until statement?*
- *What does random within bounds mean?*

Watch this video to learn how to create the game.

▶ *https://youtu.be/Va-jHqk62-w*

EXPLORATION

Now, write down very detailed instructions for how you might build this game. These instructions are called **pseudocode**.

- **Pseudocode** is a term for the instructions that software developers write BEFORE they write code. By writing pseudocode first, a software developer can make sure the logic for the program makes sense before translating the steps into a language the browser can understand, like JavaScript.
- Be very specific with the pseudocode you write. Imagine you have to give this piece of paper to a software developer. *Do you think they could build this game with your instructions?*

SKILLS BUILDING: VARIABLES

Create your first variables and learn how they will interact with each other to power the game.

Watch the video below to learn about variables.

▶ *https://youtu.be/707A2Yks-40*

SKILLS BUILDING: RANDOMNESS & LOOP UNTIL

Use randomness to make the game unpredictable, and loop until to repeat the game logic until the toss variable is greater than the expire variable.

- *What is the difference between an integer and a float?*
- *What are the bounds you have set for your random integer?*
- *What is the condition that causes the loop to stop?*

▶ *https://youtu.be/3zjWpE-XeBA*

SKILLS BUILDING: IF TOSSED

Create an if/then statement to indicate a toss occurred.

Learn how to create an if/then statement to indicate a toss below.

▶ *https://youtu.be/sl0H_5RUmcA*

SKILLS BUILDING: CONDITION REACHED

When the toss variable is greater than the expire variable, you need to communicate that the player holding the Sphero BOLT is OUT.

Learn how with the video below.

▶ *https://youtu.be/qRU_INLtUeA*

CHALLENGE: LET'S PLAY!

Play the hot potato game with a group friends!

Did the game play as planned? If not, go back to your code to debug and determine what is causing the issue(s). Replay the game after each change you make to the program.

Watch the video below to see how the game is played!

▶ *https://youtu.be/MjqCq3hpSQQ*

CHALLENGE

Now that you've finished building the program, compare your pseudocode to the code you wrote.

- *How close was your pseudocode to the actual code you wrote for the hot potato game?*
- *Where was your logic off?*

REFLECTION

Reflect on what you learned with the Sphero BOLT:

- *How well did your pseudocode match the real code? What differences were there?*
- *What is a variable? Why is it necessary to use variables in a complex program?*
- *What is the difference between the loop, loop forever, and loop until statements? Which did you use in this game?*

DRAW 2: SPELLING

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Sopeed, and Color*

CONTENT THEME *Art*

OBJECTIVE

- **I can spell words using the Sphero BOLT.**
- **I can program the Sphero BOLT to navigate around an obstacle and return to the start.**
- **I can create and execute a Draw program.**

OVERVIEW

In this activity, you will you use the draw canvas to draw letters and words that represent code and execute that code using your Sphero BOLT. Complete the challenge by coding the Sphero BOLT to navigate around an obstacle to better understand how the Sphero BOLT moves through the space around you.

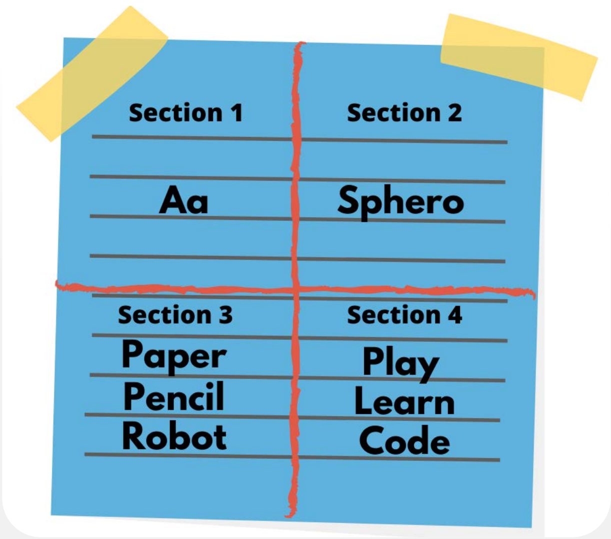
MATERIALS

- **Sphero BOLT**
- **Paper**
- **Pencils**
- **Crayons**
- **Markers**
- **Color pencils**

EXPLORATION: LOTS AND LOTS OF WORDS

Grab a piece of paper and fold it into four sections. Label each section 1, 2, 3, and 4. Complete the following steps:

- Section 1: Choose a letter and write that letter in both upper and lower case.
- Section 2: Practice writing your first name, using proper capitalization.
- Section 3: Write down the name of three objects you see in the room.
- Section 4: Write down the words for three actions, or things you do.



SKILLS BUILDING: LETTERS

Watch the video below to learn how to program the Sphero BOLT to write letters and words using the Draw Canvas.

▶ *https://youtu.be/EGDFUR3-YMs*

- Draw the letter from Section 1 of your paper. Try the uppercase letter first and run the program.
- Try the lowercase letter, but this time change the color.

SKILLS BUILDING: WORDS

Watch the video below to learn how to turn a group of letters into a programmed word.

▶ *https://youtu.be/8ADbjRUVTMs*

Practice spelling your name, first. Do your best to reduce the amount of travel between each letter (as described in the video). Don't forget to start your name with an uppercase letter.

Can you change colors for each letter? What happens to each letter if you change the speed?

CHALLENGE: NAVIGATE

Now you will use your mastery of the Draw canvas to navigate the Sphero BOLT around an object on the floor.

- Find something like a box of crayons or a shoe and place it three steps in front of you.
- Draw a path on the Draw canvas (like in the video) that takes the Sphero BOLT around the object and brings it back to where it started.
- Aim the robot and run the program.

How did it go? What do you need to change to be successful?

Watch the video below to see how to successfully navigate.

▶ *https://youtu.be/aBUthRsckVE*

CHALLENGE: OBSTACLE COURSE

Work with some classmates to create an obstacle course for the Sphero BOLT. Place a series of different objects around on the floor and decide on the approved path from object to object.

- Challenge your classmates to see who can make it through the obstacle course with the least amount of attempts.
- Once everyone has a successful path through, time each one to see who is the fastest.

REFLECTION

Reflect on what you learned with the Sphero BOLT:

- *How is programming letters in the Draw Canvas different than how you normally write letters?*
- *What did you learn about programming while working with your the Sphero BOLT today?*

SPHERO CITY

OVERALL TIME *4- to 6-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Art*

OBJECTIVE

- **I will construct a Sphero BOLT City or a city from history.**
- **I will create a program in the Block Canvas.**
- **I will execute the program using the Sphero BOLT.**

OVERVIEW

Design and construct your own Sphero BOLT City. Build roads, buildings, and all sorts of fun places for the Sphero BOLT to navigate through. Create a program to help the Sphero BOLT get around on its own.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Tape**
- **Any toys/tools you have**
- **A writing utensil**
- **Cardboard**
- **Space to construct your city**

EXPLORATION: CITY PLANNING

Let's design a city and then learn how to drive your Sphero BOLT through that city. Watch the introduction video below.

▶ *https://youtu.be/j8IHE3ApKkg*

You have two choices for your city design (your teacher may guide you in this area):

- Design your own unique Sphero BOLT City
- Design a city from history

After you've made your choice, think about what you want your city to look like. Begin by drawing a plan or diagram and determine what materials you will need. Conduct research on your city from history, if needed.

Construct your city using any materials and everyday items. Be creative!

EXPLORATION: CREATE YOUR CITY

Construct your Sphero BOLT City using the materials provided and everyday items. You'll be programming your Sphero BOLT to navigate through your city, so make sure your roads and pathways are large enough to fit your robot. You may want to test as you build by driving your Sphero BOLT through the roadways.

SKILLS BUILDING: PROGRAMMING THE SPHERO BOLT

Now that you have built your city, it's time for the Sphero BOLT to take a tour of the town. Navigating the Sphero BOLT through your city is similar to navitating it through a maze.

Watch the video below for an example of a city.

▶ *https://youtu.be/nwOGqm7Gvhg*

- *How far does the Sphero BOLT need to travel for each section? (ex: How far does the Sphero BOLT travel at a speed of 75 for 1 second)*
- *Is each turn 90 degrees or something else? Use a protractor to determine the heading.*

SKILLS BUILDING: NAVIGATE YOUR CITY

Test your program and durability of the city.

- *What worked?*
- *What did not work?*
- *Do you need to improve anything?*

Need inspiration on how to build your city? Take a look at the video below!

▶ *https://youtu.be/IZ49u7-IaAk*

CHALLENGE: CREATE DIRECTIONS

Have the Sphero BOLT make stops along the way. Maybe the Sphero BOLT drives from the Supermarket to the Sandwich Shop. Or, the Colosseum to the Pantheon.

- Determine the Sphero BOLT's path and take measurements of distances and angles.
- Using this data, write down step-by-step instructions for the Sphero BOLT to move through the city.
- **Make at least two stops in your city**, add narrations to your code using the Speak code block.
    - For example, when the Sphero BOLT stops at the Pantheon, the Sphero BOLT describes the Pantheon's purpose in Ancient Rome (use your research skills if needed!). Or, when the Sphero BOLT stops at the supermarket, the Sphero BOLT describes the purpose of that location in the the Sphero BOLT City.
- Use this information to start programming or share the directions with a partner to see if they can program the Sphero BOLT through your city.

Make sure to save your final program!

SWIM MEET

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Art*

OBJECTIVE

- **I will identify how the Sphero BOLT can "drive" in water aided by different materials.**
- **I will use the Draw or Block Canvas to program the Sphero BOLT to complete a water course with different Sphero BOLT 'swimsuits' to determine which yields the fastest lap times.**
- **I will learn to improve the Sphero BOLT's performance as the power source for a water-based vehicle.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

OVERVIEW

The Sphero BOLT is training for a swimming competition but doesn't have a swimsuit. Design one that will help the Sphero BOLT win the race.

MATERIALS

- **Sphero BOLT**
- **Rubber bands**
- **Tape**
- **Stopwatch**
- **Plastic tub**
- **String**
- **Washers**
- **Balloons**
- **Plastic folders**
- **Styrofoam**
- **Glue**
- **Other waterproof craft materials**

EXPLORATION: SWIM!

The Sphero BOLT loves to swim! Check out the video below to see how he races through the water.

▸ *https://youtu.be/UoF52-mbolo*

- *Why do you think the Sphero BOLT moves more quickly through the water with the nubby cover?*

EXPLORATION: TEACH THE SPHERO BOLT HOW TO SWIM

You can help the Sphero BOLT move through the water the same way you control it on land. Watch this video for more driving directions.

▸ *https://youtu.be/wVkrvlbiKJg*

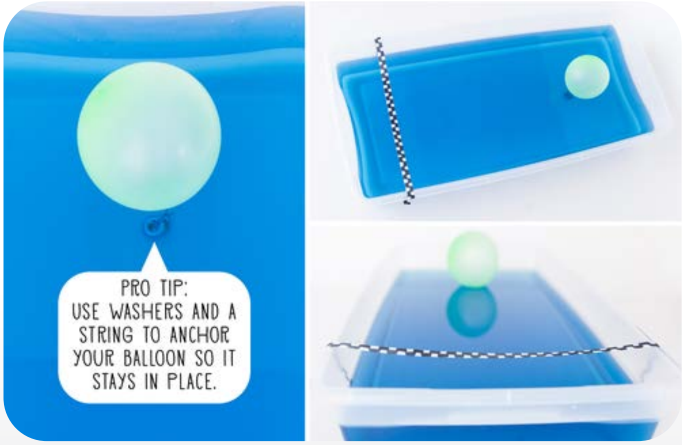
EXPLORATION: PRACTICE LAPS

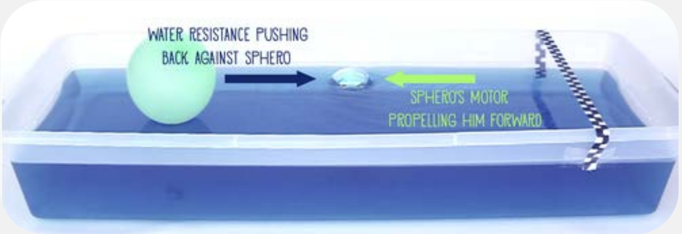
Set your swimming pool and practice racing your the Sphero BOLT around the buoy and back.

Answer the following questions:

- *What's it like driving the Sphero BOLT on water? What do you notice?*

- *Is it easy to control? Why or why not?*
- Think about the forces that are pushing and pulling on the Sphero BOLT. *What could you do to help the Sphero BOLT overcome the water resistance and swim faster?*
- Think about how you move through the water when you swim. *What helps move you forward?*





EXPLORATION: SWIMSUIT DESIGN

Now that you've taught the Sphero BOLT to swim, it's time for a challenge! We're going to see who can design a swimsuit that helps the Sphero BOLT move through water the fastest.

Take a blank piece of paper and fold it in half. Fold it in half the other way so you have four sections. Based on what you know and have learned about how the Sphero BOLT operates in water, draw some ideas of different swimsuits that might help the Sphero BOLT swim faster. Be creative and don't be afraid to have wacky ideas. Watch this video below if you need a little inspiration.

https://youtu.be/BP2HhTgp7gE

SKILLS BUILDING - EXPERIMENT WITH YOUR DESIGNS

Take a look at each of your drawings and ask yourself:

- *What will I make this swimsuit out of?*
- *How will I make this swimsuit?*
- *What features of this swimsuit will help the Sphero BOLT swim faster?*

Experiment with materials and designs to determine which performs best by using the drive function within the Sphero Edu app. *Which elements should you include in your design?*

Which of your ideas do you think will work the best? Make and test those swimsuits. Remember to record how fast the Sphero BOLT swam while wearing each one.

SKILLS BUILDING: CHOOSE A DESIGN

Think about which swimsuit worked best by asking yourself:

- *Which swimsuit made the Sphero BOLT swim the slowest?*
- *Why did that swimsuit slow the Sphero BOLT down?*
- *Which swimsuit helped the Sphero BOLT swim the fastest?*
- *Why did that swimsuit help the Sphero BOLT go faster?*

- *What could you do to improve your design and make the Sphero BOLT go even faster?*
- Finalize and perfect your design for the big competition.

SKILLS BUILDING: BUILD A PROGRAM FOR YOUR THE SPHERO BOLT

To make the laps in the pool more consistent and less subject to variations when driven, write a program using the Blocks canvas that gets the Sphero BOLT around the buoy and back.

You may have to alter the program when you change the swimsuit design. *Why is that?*

CHALLENGE: SWIM MEET

When all the teams are happy with their designs, start the competition!

1. Have each team show off their best swimsuit by explaining how they designed it and why they think it will help their Sphero BOLT win the race.
2. Time how long it takes for each team's Sphero BOLT to swim across the pool, around the buoy, and back across the finish line.
3. The team with the fastest time wins!

REFLECTIONS

Write your reflections on this activity and discuss with the class.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What happened when you changed the swimsuit design?*

CHARIOT CHALLENGE

OVERALL TIME *4- to 6-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Art*

OBJECTIVE

- **I will identify how the Sphero BOLT can power a land-based vehicle constructed with inexpensive materials.**
- **I will drive the Sphero BOLT around a defined course with a chariot attached.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

OVERVIEW

Learn how chariots have been used throughout history. Design and create a unique Sphero BOLT chariot, then create a program for the Sphero BOLT to navigate the race course.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Tape**
- **Cardboard**
- **LEGO®**
- **K'nex**
- **CDs**
- **Cups**
- **Large space on the floor for building the track**
- **Tin foil**
- **Felt**
- **Hot glue**
- **Craft sticks**
- **Straws**
- **Paper clips**
- **Other available found materials**

EXPLORATION: HISTORY OF CHARIOTS

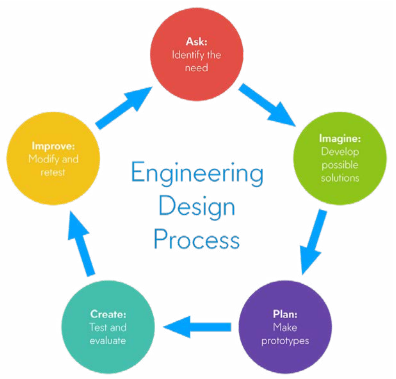
In ancient times, people used something called a "chariot" (a cart, usually pulled by horses) to haul materials, build things or even race against each other.

Draw a sketch of what a horse-drawn chariot looks like. Be as detailed as possible, but draw based on what you already know. Don't look online (yet!)

Your challenge is to design and build a Sphero BOLT chariot. Watch the video below for a quick glimpse into what you will be doing.

▶ *https://youtu.be/hB2Q5CHQTRQ*

Review the Engineering Design Process image below. Refer back to it throughout to better focus your efforts during the process.



EXPLORATION: RESEARCH DIFFERENT CHARIOTS

Research chariots online. Find photos and videos, noting their design and function. Consider these questions:

- *What materials were they made of?*
- *How many wheels did they have and how big were the wheels?*
- *How many horses/other animals were used to pull them?*

EXPLORATION: DESIGNING YOUR CHARIOT

How might the Sphero BOLT be used to pull a chariot? The video below is a good place to start.

▶ *https://youtu.be/IqYEcTHzA2Y*

Examine the chariot construction materials you have to build with. Brainstorm some possible designs by experimenting with the materials.

- *Will you use wheels?*
    - *What kind and size?*
    - *What will you use for an axle?*
- *Which chariot design might work best? Why?*

Select your favorite idea to share with your team.

EXPLORATION: BUILD YOUR DESIGN

Begin buildings your chariot. Consider testing it along the way. Be sure that the Sphero BOLT fits.

If you are running into issues:

- *Look to see what is touching or dragging on the ground.*
- *Is the chariot too heavy for the Sphero BOLT to pull?*
- *Are the wheels stuck?*
- *Check for anything else that may keep the Sphero BOLT from pulling the chariot.*

EXPLORATION: BUILD YOUR TRACK

If you or your class haven't already, build an oval track on the floor measuring 10 feet long and about 5 feet wide. Blue painters tape works great for this.

SKILLS BUILDING: AUTONOMOUS CHARIOT

Create a program, using the Draw or Blocks canvas, that enables the Sphero BOLT to complete the course autonomously; in other words, on its own. This program can be used as an oppenent during the upcoming chariot race.

At this point, you should take some time to practice driving your chariot around the track. Keep in mind that faster isn't always better when it comes to the Sphero BOLT and chariots. *Why might that be?*
Observe how your chariot and the Sphero BOLT move. *Is there anything you can adjust or change to make it better?*

CHALLENGE: CHARIOT RACE

Time to put your Sphero BOLT Chariot up against your autonomous program and your classmates chariots.

Be sure to take some pictures or record a video to share.

REFLECTION

Write your reflections on this activity and discuss with the class.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *Why do you think that the culture you studied used the chariot that they did?*
- *What materials worked best?*
- *What was the most challenging part of the activity?*
- *How did the size of the wheels or other design characteristics impact the results?*
- *What materials worked best?*
- *What was challenging and what worked well within your team?*

CHALLENGE - DATA ANALYSIS (OPTIONAL)

How can we make the Sphero BOLT Chariots faster? Let's gather data, evaluate the results, and make some predictions.

- Time the Sphero BOLT Chariots around the track.
- Compile best times in a spreadsheet.
- Evaluate each chariot by listing the materials and weighing it with and without the Sphero BOLT.
- Discuss what made that chariot faster or slower than the others.

Using this data, go back and make modifications to your chariot. Sometimes weight reduction helps. Other times shifting the balance of weight can help as well. Discuss the changes with a peer.

Once your updated chariot is ready, race again to see if the changes made any difference.

WHAT A CHARACTER!

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, complex Controls (If Then), and Comparators*

CONTENT THEME *Art*

OBJECTIVE

- **I can write or retell a story for the Sphero BOLT to tell.**
- **I can create a storyboard to guide my work.**
- **I can program original animations to enhance my story.**

OVERVIEW

The Sphero BOLT has a story to tell. Or maybe you do. Either way, let's tell it!

Create a program to animate the Sphero BOLT to act the part and tell a story for all to hear. Take advantage of all that the Sphero BOLT has to offer, from simple movements to lights and sounds. We can't wait to see it!

MATERIALS

- **Sphero BOLT**
- **Craft materials for building characters (18oz cups work great and fit right over the Sphero BOLT)**
- **Green screen**
- **Video editing software (optional)**

EXPLORATION: PERSONIFICATION

Personification is when you give a human characteristic to something nonhuman. You will be using this literary technique to help tell your story through the Sphero BOLT. You will give it traits and characteristics that would normally be given to a human character. Start thinking about how you will do this with a robot and the Sphero Edu.

The videos below are great resources to see how personification can be used.

▸ *https://youtu.be/VqBZMR83wCg*

▸ *https://youtu.be/1Mb6NxixRk8*

EXPLORATION: CHARACTER TRAITS

Whether you are retelling a story or writing something new, consider how you will program the Sphero BOLT to show emotion, communicate with others, and show off its personality.

Brainstorm some ideas on some scratch paper. To help guide you, consider some of the following questions:

- *How can you use the Sphero BOLT's* ***Main LED*** *and associated programming blocks?*
- *How can you use* ***Sound*** *and* ***Speak*** *blocks?*
- Throughout a story, characters express mood and emotion. *How can you program these into the story?*
- *How can you show the Sphero BOLT's character's personality in a way that engages your audience?*

EXPLORATION: STORY ARC

Every basic story has a beginning, middle, and end. They tend to follow a predictable **story arc**. The video below explains what a story arc is using the classic example of Romeo and Juliet.

▸ *https://youtu.be/BaPR0y89s6Y*

As you choose your story (retold or new), think about the different dialogue and actions that will happen during each part of your story. These things can be conveyed using the Sphero BOLT's lights, movements, and/or sounds.

SKILLS BUILDING: STORYBOARD

Time to work on your story!

As you begin to develop (or retell) the plot and character development, use a storyboard to help you plan. You can use the storyboard to diagram important moments and plan for specific animations, movements, lights, and sounds. Use the storyboard.pdf below or grab a piece of scrap paper and fold it into nine equal parts.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/99/cf/storyboard.pdf

Take a picture of your storyboard(s) and attach to the end of this step.

SKILLS BUILDING: ONCE UPON A ... SPHERO!

You've planned your story and how you want to tell it. Now it's time to get the Sphero BOLT involved.

Remember that you can program the Sphero BOLT's main LED, its movement, and add sounds and speech. Using what you know about blocks and a combination of blocks, start to create the moods, emotions, and actions of the Sphero BOLT.

If you need a little help, take a look at the program attached to this activity. It includes some storytelling functions that you could use or look at for inspiration.

If you've chosen to decorate or build around the Sphero BOLT with craft materials, be sure to practice your programs with these on it. The added mass will affect how the Sphero BOLT moves.

CHALLENGE: CENTER STAGE

Let's hear your story! Get the Sphero BOLT ready for the big show.

Practice your story a few times through to get your timing down. Once you're ready, grab a partner to film it all. Start your program and tell your story.

As an added challenge, consider using a green screen. With some simple video editing, you could wisk your audience away to far away lands. Ask your mentor about this.

AVOID THE MINOTAUR

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, complex Controls (If Then), and Comparators*

CONTENT THEME *Art*

OBJECTIVE

- **I will learn how to control the Sphero BOLT using precise code.**
- **I will illustrate how to decide which blocks to make the Sphero BOLT achieve a goal.**
- **I will create and execute a program that moves the Sphero BOLT along a changing path.**
- **I will analyze the program with supporting facts and reflect on the learning.**

OVERVIEW

Our hero, the Sphero BOLT, is trapped by a creature from Greek mythology, the Minotaur! In Greek mythology, many heroes used their brains rather than their brawn to outwit their foes. Together with your team, create a program to show how the Sphero BOLT could outwit the Minotaur and escape the maze.

MATERIALS

- **Sphero BOLT**
- **Something to create a simple maze: blocks of wood or boxes, tape, etc.**
- **Cardboard cutout representing the Minotaur.**

EXPLORATION: MINOTAUR'S MAZE

Oh no! The Sphero BOLT is trapped in the Minotaur's maze! Watch this video to find out how you can help it escape:

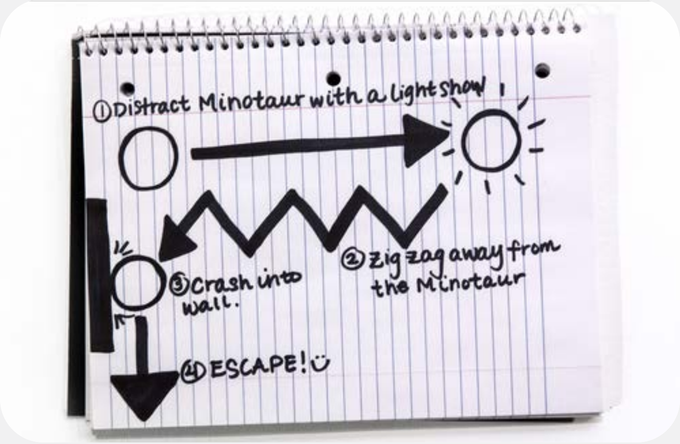
▶ *https://youtu.be/1pnmvGkuH7o*

EXPLORATION: MAKE A PLAN

In order to escape, you and your teammates must design a program that causes the Sphero BOLT to pull off some fancy moves to confuse the Minotaur.

Start by thinking about what you want your Sphero BOLT to do to accomplish this.

Plan it out by writing or drawing your ideas, like this:



EXPLORATION: DESIGN A MAZE

What should the Minotaur's maze look like? Draw some ideas on paper and evaluate the materials available to you.

EXPLORATION: EXPERIMENT WITH BLOCKS PROGRAMMING

Using the Block Canvas, experiment with code to make the Sphero BOLT move in different ways, illuminate lights, etc. - the crazier, the better. Your goal is to confuse the Minotaur so you can escape!

Write down each block you used and what it made the Sphero BOLT do. You'll use this list to build your program to escape from the Minotaur.

SKILLS BUILDING: CREATE A MAZE

Using available materials, construct the maze around your block program's logic in which the Sphero BOLT will encounter the Minotaur.

Watch this video to inspire your getaway!

▶ *https://youtu.be/N7ihLhL4RN8*

CHALLENGE: PROGRAM YOUR ESCAPE

Using the draw or Block Canvas, develop code that moves the Sphero BOLT erratically yet purposefully - remember, it still has to make its way out of the maze!

Test your program.

Can you improve it? How?

CHALLENGE: CHECK YOUR PROGRAM

Run your program. Did the Sphero BOLT escape the Minotaur? What changes can you make?

Write your reflections on this activity and discuss with the class:

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What code worked best?*
- *What was the hardest or most fun part of the challenge?*

DRAW 1: SHAPES

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Math*

OBJECTIVE

- **I can identify and describe shapes.**
- **I can distinguish between two and three-dimensional shapes.**
- **I can compose simple shapes to form larger shapes.**
- **I can create and execute a Draw program.**

OVERVIEW

Welcome to your first Draw activity! This is a great follow-up activity to "Introduction to Sphero Edu." This lesson introduces you to the Draw canvas by drawing shapes that represent code and executing that code using your Sphero BOLT.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Pencil**
- **Crayons**
- **Markers**
- **Colored pencils**

EXPLORATION: SHAPES AROUND YOU

- Two-Dimensional shapes are flat and have only two dimensions: length and width. For example, a square.
- Three-Dimensional shapes are solid and have three dimensions: length, width, and height. For example, a sphere.

Look around the room and find an object that interests you.

- *What shapes make up this object?*
- *Are the shapes that make up your object two-dimensional or three-dimensional?*

Now look at your Sphero BOLT.

- *What shapes make up this robot?*
- *What other robots have you seen? What types of shapes make up those robots?*

SKILLS BUILDING: YOUR FIRST DRAWING

The Draw programming "canvas" is designed to teach primary principals of programming like sequencing and basic logic through basic swipes that represent JavaScript code. Watch the video below to learn how to draw basic, two-dimensional shapes with the Sphero BOLT.

▶ *https://youtu.be/hC99exI8TVw*

SKILLS BUILDING: COLORS AND "WHOOPS"

You can use different colors to make your shapes more unique. Watch the video below and follow along. You'll also learn how to fix a mistake on the Draw Canvas.

▶ *https://youtu.be/W8Z4YSp9zkM*

CHALLENGE: ROBOT DRAWING

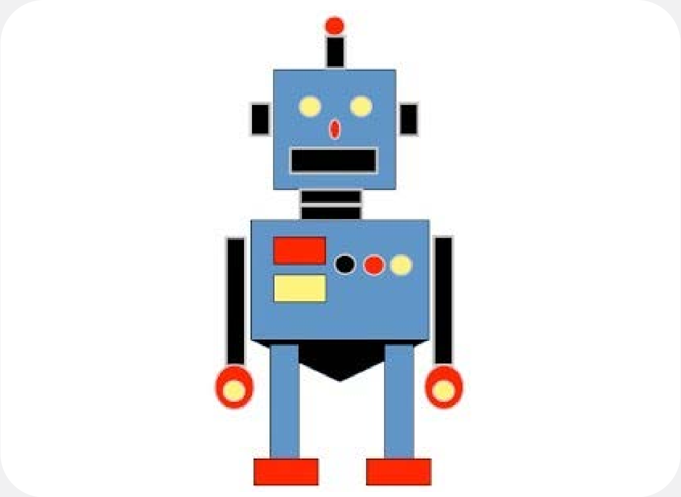
Now it's time to use your newfound programming skills to draw something different. Grab some paper and something to draw with.

Imagine a robot and think about which shapes make it up. On your piece of paper, draw a simple robot using shapes that you are familiar with. Some you may have already programmed the Sphero BOLT to draw today.

Consider the following before drawing your program:

- *How can you draw the robot to make the Sphero BOLT move as little as possible between shapes?*
- *Do you need to redesign the shapes of your robot?*
- *Could you make larger shapes into smaller shapes or combine shapes to make a larger shape?*
- *Should you make your robot different colors?*

Take a picture of your drawing and attach it to this step.



DRAW 3: PERIMETER

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Math*

OBJECTIVE

- **I can calculate the perimeter of multiple shapes using an equation.**
- **I can use the Sphero BOLT's sensors to gather data.**
- **I can create and execute a Draw program.**

OVERVIEW

This lesson introduces you to the sensor data in the Draw Canvas. Use this data to calculate the perimeter of a square, rectangle, triangle, and rectangle with unknown side length.

MATERIALS

- **Sphero BOLT**
- **Writing utensil**

EXPLORATION: PERIMETER

Perimeter is the path around a two-dimensional shape. We will be using the Sphero Edu app's sensor data to calculate an approximate perimeter of three different shapes.

SKILLS BUILDING: SQUARE PERIMETER

Think about these questions on your own or with a partner before watching the video below.

▶ *https://youtu.be/K0tU3an6Bcw*

- *What is a perimeter?*
- *How do you calculate a perimeter?*
- *Which sensor data do you think could help you measure the perimeter of a shape that the Sphero BOLT draws?*

Follow the instructions in the video above to draw a square. Make sure it is two blocks by two blocks.

Use the location graph in the sensor data to calculate the perimeter of this square. (Remember that perimeter is the sum of all sides).

- *What unit of measure does the location graph show?*

Draw a representation of the same square on the Draw 3_Perimeter.pdf handout (*https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/c4/6f/Draw%203_Perimeter.pdf*). Be sure to label the sides of your square.

Use the location sensor data from the graph to measure each side of the square. Remember that a square has four equal sides. Now calculate the perimeter of this square using the blank equation on the handout. *How big is your square?*

SKILLS BUILDING:PROPERTIES OF A RECTANGLE

Start a new Draw program and name it "Rectangle."

A rectangle has four straight sides like a square, but can have one pair of opposite sides that are longer than the other pair.

Draw a rectangle and have your partner check your rectangle for accuracy. Make it three squares by five squares. Run the program so your Sphero BOLT makes a rectangle.

Watch the sensor data. *How is it the same and different from the square?*

Now, just like you did with the square, draw your rectangle on the handout. Use the location data to help you calculate the perimeter of your rectangle. Show your work on the handout.

EXPLORATION: PROPERTIES OF A TRIANGLE

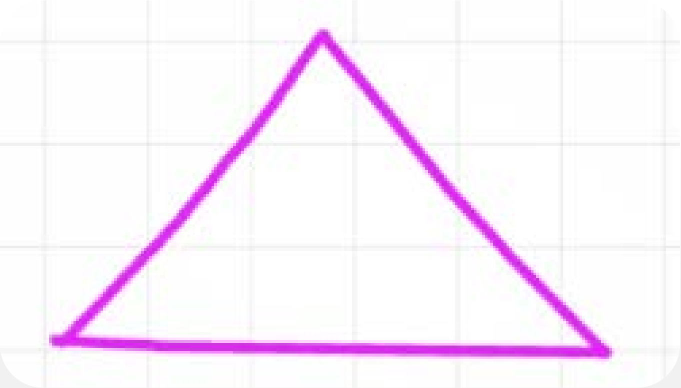
Start a new Draw program and name it "Triangle."

A triangle has 3 straight sides and 3 points (or vertices).

Draw a triangle and be sure to have your partner check your triangle for accuracy. Run the program so your Sphero BOLT makes a triangle.

Watch the sensor data. *How is it the same and different from the square and rectangle?*

Now, just like you did with the square and rectangle, draw your triangle on the handout. Use the location data to help you approximate the perimeter of your rectangle. Show your work on the handout.



CHALLENGE: DIFFERENT SHAPES

Draw a shape with 6 sides in the draw canvas and calculate the perimeter of the shape the Sphero BOLT makes.

What is the name of a shape with six sides?

REFLECTION

Reflect on what you learned with the Sphero BOLT:

- *How do you calculate the perimeter of a shape?*
- *When would you need to calculate the perimeter of a shape in real life?*

AREA OF A RECTANGLE

OVERALL TIME *1- to 2-hour lesson*

GROUPS *Three to four kids*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Math*

OBJECTIVE

- **I will calculate the area of multiple shapes using an equation.**
- **I will use the Sphero BOLT's sensor and location graph features to gather data.**
- **I will create and execute a program using the Draw canvas.**

OVERVIEW

Explore the area of a rectangle. Use the sensor data in the Draw canvas to calculate the area of a rectangle in various unit measures. Discover how the calculation of area is used in real life situations.

MATERIALS

- **Sphero BOLT**
- **Graph paper**
- **Pencils**

EXPLORATION: FIND RECTANGLES

Look around the room and find objects in real life that are made of rectangles. Remember a rectangle has four straight sides like a square but can have one pair of opposite sides that are longer than the other pair.

- *Is a square a rectangle?*
- *Is a rectangle a square?*

Point these out to your partner and discuss:

How do you tell if one rectangle is larger or smaller than another rectangle?

EXPLORATION: PROGRAM A RECTANGLE

Tap on the "New Program" icon at the top of the activity and select the Draw canvas. Give the program a name like "Rectangle A" and tap "Create."

Draw a rectangle that is 2 blocks by 3 blocks. If you need any help with the Draw canvas, watch the video clip below.

▶ *https://youtu.be/ldjdVF97uVo*

Have your partner check your rectangle for accuracy. Run the program so your Sphero BOLT makes the 2 blocks by 3 blocks rectangle. As the program is running, notice the sensor data that appears. If you are using a Chromebook, tap the three dots in the top right corner and select "Sensor Data" after Sphero BOLT has completed the program. The sensor data is saved each time you run the program. The Sphero Edu app will keep the five newest version of the data.

Take a look at the "Location Data" and describe what you see. *Does it show the rectangle you expected?*

Draw a few more rectangles. Make each a different size. Have your partner check to make sure each drawing is in fact a rectangle. Talk about the following:

- *Which of your rectangles was the largest? How can you tell?*
- *How can you uses the sensor data to determine which was larger?*

SKILLS BUILDING: WHAT IS AREA?

The **area** of a two-dimensional object is the amount of space it covers or takes up. You can figure out the actual size of a rectangle by calculating its area. You can do this with other two-dimensional shapes, as well.

Watch the video below with a partner and answer the following questions:

▶ *https://youtu.be/1dqAOKdJmRI*

- *What is area?*
- *What is the formula of area for a rectangle?*
- *Do you think you could use the location graph and sensor data to calculate the area of the rectangles you programmed?*

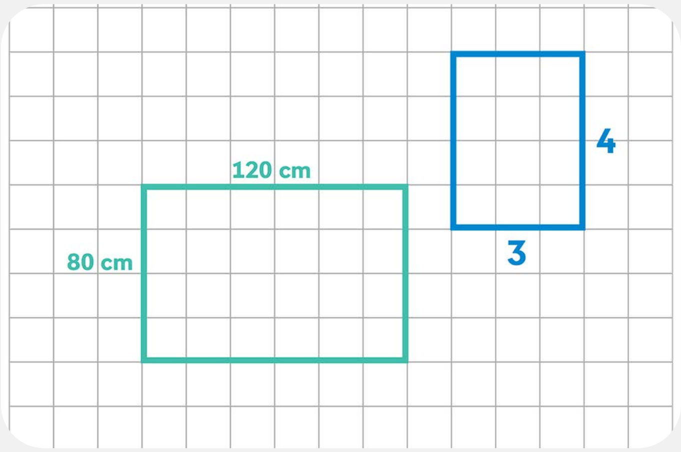
CHALLENGE: FIND THE AREA, PART 1

You can use the first Draw program you created earlier or create a new one. On the Draw canvas, draw two different sized rectangles. Be sure to use the grid on the canvas to help you draw each one. If it helps, use a different color for each rectangle.

Looking at these drawings, determine how many square units each rectangle measures. This is one way to measure the area of each rectangle.

Now, run the program. Watch the location data for each rectangle. After the program stops, tap the three dots in the right corner, and open "Sensor Data."

- Notice that that location data measures the path of the Sphero BOLT in centimeters (cm).
    - On some graph paper, do your best to recreate each rectangle that you drew on the Draw canvas.
    - Using the location data and measurements, approximate the length and width of the two rectangles in centimeters.

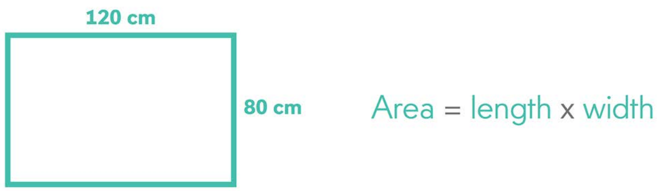


CHALLENGE: FIND THE AREA, PART 2

Use the measurements you collected from the Location Data now to calculate the approximate area of each of your programmed rectangles.

Remember that the equation used to find area is: **A** = **l** x **w**.

Show your work on your graph paper and take a picture to attach at the end of this step.



CHALLENGE: FIND THE AREA, PART 3

Look around your classroom again. Select a few items that are rectangles and go measure them.

On a new piece of graph paper, do your best to recreate the items. Use the grid lines to help you accurately draw each side of the object. Label the length and width of the item on your graph paper.

Now calculate the area of these items. However, this time, you and your partner will do your own calculations on a separate piece of paper. When both of you are done, compare your answers and discuss the following:

- *How did you calculate the area?*
- *Are our answers the same? If not, why?*
- *When else would you ever need to find the area of an object or space?*

OVERALL TIME *100- to 120-minute lesson (can be split over two class periods)*

GROUPS *Two to three kids per indi*

Next Generation Science Standards

K-2-ETS1-1

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

OBJECTIVE

Kids will identify what each color tile tells indi to do. Kids will create different sequences or patterns for indi to travel using the color tiles.

OVERVIEW

The indi robot is designed to introduce early learners to the fundamentals of computational thinking, STEAM, and computer science principles while encouraging open-ended, imaginative play-based learning with real-life scenarios as students build custom paths and solve puzzles.

MATERIALS

Day One

- **indi**
- **color tiles**
- **green-go, yellow-slow down, red-stop, purple-celebrate**

Day Two

- **indi**
- **color tiles**
- **Pink- 90˚ left, blue 90˚ right**
- **Optional: orange 45˚ left, teal 45˚ right**

KEY TERM(S)

Algorithm: a list of steps to complete a task

Program: an algorithm that contains a series of coded instructions to be followed by a computer or other machine

Programming: designing and creating a program

Code: the language the computers speak

VOCABULARY

- 45˚ turn
- 90˚ turn
- backward
- blue
- communication
- forward
- go
- green
- left
- orange
- pink
- purple
- red
- right
- slow
- teal
- turn
- yellow

PREPARATION

1. Create groups ahead of time.
2. Make sure to charge the indi in advance so it is ready for use.
3. Have a plan for clean-up to make sure all materials are put away.
4. Clear a large open space for groups to be able to spread out to use the indi.

LAUNCH *10 to 15 minutes*

Session 1
Have kids form a circle and ask the following questions:

- *What does it mean to communicate?*
- *How do people communicate with computers?*

Tell kids that today they are going to be communicating with a robot by giving it detailed instructions to make it move. Show kids the indi and identify the various parts of the robot (power switch, color sensor, wheels, LED lights front and on top). Then, one at a time, place each of the assorted color tiles on the floor and put the indi on the tile to demonstrate how it reacts to each color (green, yellow, red, purple).

Discuss how the indi reacts with each of the color tiles. Ask the following questions:

- *What do you hear?*
- *What did you see?*

Session 2
Have kids partner up for a turn and talk. Ask the following question: *What did you learn about the indi robot in the previous lesson?* Introduce the new color tiles the same as in the previous session. (pink, blue, *optional orange*, teal)

Discuss how the indi reacts with each of the color tiles. Ask the following questions:

- *What do you hear?*
- *What did you see?*

EXPLORATION *20 to 30 minutes*

Have kids form groups. Give kids the first 10-15 minutes to free explore using the indi robot.

During the last 10-15 minutes of exploration, share the challenge.

Session 1 Challenge: Create an indi sequence using six or more tiles.

Session 2 Challenge: Create an indi sequence using six or more tiles, including at least three assorted colors and one turn (right or left).

CLOSING *10 to 15 minutes*

Bring kids back together and have each group share the sequence they created for the challenge. Choose one or more of the following questions to ask:

- *What did your group learn about the indi?*
- *Did anything happen that you did not expect?*
- *Was your group able to complete the challenge?*
- *What would you do differently next time?*
- *What did your group do well?*

CLEAN-UP *(5 min.)*

Allow time to make sure all the materials are put away.

RESOURCES
https://Sphero.com

ENRICHMENT AND NEXT STEPS
Challenge kids to create a sequence for the indi to travel using more than eight of the color tiles.

SPHERO INDI MAZE RACE

OVERALL TIME *50- to 70-minute lesson*

GROUPS *Two to three kids per indi*

Next Generation Science Standards

K-2-ETS1-1

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

OBJECTIVE

Kids will connect indi to the Shero Edu Jr. app. Kids will drive the indi through a maze using the three drive programs.

OVERVIEW

This is an introductory lesson using the Sphero Edu Jr app.

VARIATIONS

Have kids create criteria for building a maze. Design one giant maze or racetrack.

MATERIALS

- **indi**
- **Color tiles**
- **Sphero Edu Jr app**
- **Classroom supplies to create a maze**
- **Challenge two will need timers, whiteboards, dry erase markers, or paper**

PREPARATION

1. Create partners or groups ahead of time.
2. Make sure that the indi is charged and ready for use.
3. Clear a large open space for groups to be able to spread out to use the indi.
4. Load the Sphero Edu Jr app on devices.
5. Set up a model maze.

LAUNCH *15 to 20 minutes*

Gather kids in a large circle. If available (smartboard, document camera), use technology to project the Sphero Edu Jr app so kids can view and follow along on their device. Demonstrate how to connect the indi device to the Sphero Edu Jr app. Once the indi is connected, tap on the three dots in the bottom left corner. Four buttons will display RC Drive, Arcade Drive, Sphero Drive, and the Programming Board. Show kids how to change the indi's speed, eye color, and volume using the Settings icon. Then, select one of the drives and model how to move the indi. Share with kids that today they will be building a maze to race the indi. Choose one or two kids to race the indi through the model maze. Then, give teams 10 minutes to design and build a maze with classroom materials (blocks, books, pencil boxes, tape).

EXPLORATION *30 to 40 minutes*

Bring kids back together and explain that teams will rotate through the different mazes. Decide how much time they will have at each maze. Introduce challenge one or two. Prepare to have fun!

Challenge one:
Race through the maze without touching a wall or border with the indi robot.

Challenge two:
Race through the maze without touching a wall or border with the indi robot. Best time wins!

For this challenge, introduce job roles and how to use a timer. Kids can take turns with each of the different job roles.

Job Roles
Organizer: helps decide roles, holds all kids accountable and keeps track of time between mazes.

Technician: times the race and records the data (whiteboard or paper)

Programmer: races the indi through the maze.

CLOSING *5 to 10 minutes*

Have each group of students respond to one or more of the following questions:

- *How did your team work together?*
- *Was one maze more difficult? Why?*
- *Would your team make any changes to your maze?*

CLEAN-UP *(5 min.)*

Allow time to make sure materials are safely put away.

SPHERO INDI ALGORITHM DETECTIVES

OVERALL TIME *50- to 60-minute lesson*

GROUPS *Two to three kids per indi*

Next Generation Science Standards

K-2-ETS1-1

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

OBJECTIVE

Kids will work in groups to sketch and design an algorithm puzzle challenge card.

MATERIALS

- **indi**
- **Color tiles**
- **Beginner's Programming Challenge Cards**
- **Challenge Card Template (one for each group)**
- **Colored pencils, crayons, or markers**

PREPARATION

1. Create partners or groups ahead of time.
2. Make sure that the indi is charged and ready for use.
3. Clear a large open space for groups to be able to spread out to use the indi.
4. Copy blank challenge card templates

LAUNCH *10 to 15 minutes*

Have kids form a circle. Each group will need a blank challenge card template and colored pencils, crayons, or markers. Review the challenge card model from the previous lesson or choose one of the challenge cards from the kit. Explain to the kids that today they will design an algorithm, test it, and then record it on the blank challenge card remembering to leave out one step to create a puzzle.

EXPLORATION *20 to 30 minutes*

Give groups 10 to 15 minutes to design, test, and sketch a challenge card puzzle. Then, invite groups to trade their challenge card with another group. Give groups an additional 10 to 15 minutes to solve the new puzzle.

CLOSING *5 to 10 minutes*

Bring kids back together in a large group. Choose one or two algorithms to share. If possible, use technology (smartboard, document camera) to display. If technology is not available, use the color tiles on the floor to display the sequence leaving a space for the missing tile. Have kids partner up to solve the puzzle. Call on a couple of kids to share their thinking. Encourage language that uses directional words to describe how the indi traveled.

CLEAN-UP *(5 min.)*

Allow time to make sure materials are safely put away.

ENRICHMENT AND NEXT STEPS

Challenge kids to create an algorithm puzzle with more than one missing tile.

SPHERO INDI CARD CHALLENGE

OVERALL TIME *50- to 60-minute lesson*

GROUPS *Two to three kids per indi*

Next Generation Science Standards

K-2-ETS1-1

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

OBJECTIVE

Kids will solve algorithm puzzles using the indi robot. Kids will identify the outcome of each combination or sequence of color tiles.

MATERIALS

- **indi**
- **Color tiles**
- **Beginner's Programming Challenge Cards (cards are numbered)**

VOCABULARY

- backward
- forward
- go
- left
- right
- stop
- turn

PREPARATION

1. Create partners or groups ahead of time.
2. Make sure that the indi is charged and ready for use.
3. Clear a large open space for groups to be able to spread out to use the indi.
4. Use chart paper or technology (smartboard, document camera) to enlarge one of the challenge cards from the kit to use as a model.

LAUNCH *5 to 10 minutes*

Explain to kids that today they will be using the indi robot to solve algorithm puzzles. Display the challenge card model and point out the path sequence's missing step. Then, have the class predict the movements the indi will need to take to complete the path. Next, lay down the tiles from the challenge card on the floor, ensuring that each color tile is one tile length apart. Show students how to use one of the other tiles to measure a tile length apart. Then, place the indi on the path to test the groups' prediction.

Ask kids, was our prediction correct? Choose one or two kids to share with the group. Encourage kids to use directional language to explain the path the indi traveled; for example, the indi first moved forward from green and then stopped on red.

EXPLORATION *20 to 30 minutes*

Assign each group a challenge card that they will be responsible for sharing the missing step(s) during the closing. The challenge cards are numbered. Once the group has identified the sequence on their challenge card, have them try to solve as many of the other challenge cards that time will allow. Take this time to walk around and observe.

CLOSING *10 to 15 minutes*

Have each group share the answer to their assigned challenge card. Encourage language that uses directional words to describe how the indi traveled.

CLEAN-UP *(5 min.)*

Allow time to make sure materials are safely put away.

CHALLENGE CARD

STEM RESOURCES

STEM RESOURCES

These resources listed are websites and products that exist which could assist with facilitation of STEM programming.

CODING AND COMPUTER SCIENCE

Code Academy – learn coding for free

- *http://www.CodeAcademy.com*

Code.org – learn coding and programming with popular characters and games

- *http://www.Code.org*

Scratch Visual, Block-based programming language

- *http://scratch.MIT.edu*

Khan Academy Computer Science Courses

- *http://www.KhanAcademy.org/CS*

CodeCombat.com - game using coding principles, free and paid versions

- *http://www.CodeCombat.com*

Mozilla Thimble – online code editor teaching HTML, CSS, and JavaScript

- *https://support.mozilla.org/en-US/products/webmaker/thimble*

AppInventor.org – learn to build Android apps

- *http://www.AppInventor.org*

MIT App Inventor

- *http://appinventor.mit.edu/explore*

ROBOTICS

Robotics activities come in all shapes and sizes. Here are a few resources to research if interested in starting a robotics program!

LEGO® Mindstorms

SeaPerch

NASA Robotics

- *https://robotics.nasa.gov/*

Sphero BOLT

VEX Robotics

3-D PRINTING

TinkerCAD – online 3D design program. Offers free lessons and design tools

- *http://www.TinkerCAD.com*

Thingverse – website with 3D design files to download and print on your own

- *http://www.Thingiverse.com*

Tinkerine U – online lessons to introduce 3D printing. Has challenges and ideas for kids to design

- *http://www.u.tinkerine.com*

SketchUp – 3D design software, has both a free and paid version

- *http://www.SketchUp.com*

BIOLOGICAL AND EARTH SCIENCES

Howard Hughes Medical Institute

- *www.hhmi.org/biointeractive*

EarthWatch Institute

- *http://earthwatch.org/Education*

Earth Science Activities & Experiments

- *http://www.Education.com/activity/earth-science*

MATH

MathChip – math games and activities

- *http://www.MathChimp.com*

STEMCollaborative.org – math games

- *http://www.STEMCollaborative.org*

Math Playground – math games and activities

- *http://www.MathPlayground.com*

MathSnacks.com – math games and videos

- *http://mathsnacks.com/*

TECHNOLOGY AND ENGINEERING

Engineering.com – news and articles related to engineering

- *http://www.Engineering.com*

Rube Goldberg Challenges – create elaborate inventions to accomplish a simple task!

- *http://www.RubeGoldberg.com*

Engineering is Elementary – lessons and activities for educators available for purchase

- *http://www.eie.org*

TryEngineering.org – information and lesson plans related to engineering

- *http://www.TryEngineering.org*

TeachEngineering.org – lesson plans and activities that tie into the Next Generation Science Standards

- *http://www.TeachEngineering.org*

PHYSICAL AND CHEMICAL SCIENCES

PhysicsGames.net – games related to physics

- *http://www.Physicsgames.net*

Science Kids – simple experiments and activities

- *http://www.ScienceKids.co.nz/physics.html*

myPhysicsLab.com – interactive online physics simulations

- *http://www.MyPhysicsLab.com*

Algodoo – free physics simulation software

- *http://www.algodoo.com*

ChemCollective.org – online simulations and experiments related to chemistry

- *http://www.chemcollective.org/*

GENERAL STEM RESOURCES

STEM Works – articles, activities, and information about all things STEM!

- *http://www.STEM-works.com*

New Mexico State University Learning Games Lab- fun and educational games on a variety of topics

- *http://www.LearningGamesLab.org*

4-H National Youth Science Experiment – a new experiment released annually related to various STEM concepts

- *http://www.4-h.org/NYSD*

National Geographic Kid's Website

- *http://Kids.NationalGeographic.com*

IXL.com – quizzes and activities to reinforce concepts and skills across disciplines. A preview is free but full site use requires subscription

- *http://www.ixl.com*

PBS – The Public Broadcasting Service has several pages related to education and learning

- *http://www.PBSLearningMedia.org*
- *http://www.PBSKids.org/DesignSquad*
- *http://www.PBSKids.org/*

BrainPOP – online educational videos and games. Some videos and games are free, but most require a subscripton

- *http://www.BrainPOP.com*
- *http://www.brainpop.com/games/*

Makerspaces.com – Online community for the Maker movement of invention and creativity. Get and share ideas of what to create and make next!

- *https://www.makerspaces.com/*

SEA Research's STEM Mentoring Program

- *http://stemmentoringprogram.org/*

Common Sense Media – resource with ratings and information on various technology media such as games, cyber safety, and other web resources

- *https://www.commonsensemedia.org/*

LITERATURE CONNECTIONS TO STEM STORIES

- **The Little Red Fort**
  by Brenda Maier
- **The Vast Wonder of the World**
  by Melina Mangal
- **Shark Lady**
  by Jess Keating
- **Follow the Moon Home**
  by Philippe Cousteau
- **Hidden Figures**
  by Margot Lee Shetterly
- **Jabari Tries**
  by Gaia Cornwall
- **Anything Is Possible**
  by Giulia Belloni
- **What Do You Do With An Idea?**
  By Kobi Yamada
- **Harlem Grown**
  by Tony Hillery
- **What Do You Do With A Chance?**
  By Kobi Yamada
- **The Girl with Big, Big Questions**
  by Britney Winn Lee
- **The Dot**
  by Peter H Reynolds
- **What To Do With A Box**
  by Jane Yolen

You are on the front lines, empowering kids in your community each and every day. You're there through life's challenges, just as Cal Ripken, Sr. was for his kids and his players: teaching them how to make the best of every situation, leading by example, and encouraging them to swing for the fences.

At the Cal Ripken, Sr. Foundation, we see our role as supporting you in this shared mission. This guidebook is just a stepping-stone to start your STEM program! We hope you find ways to expand and keep your program going in perpetuity. Here are some resources to encourage program growth.

ADDITIONAL CAL RIPKEN, SR. FOUNDATION RESOURCES

For more information about the Cal Ripken Sr. Foundation, visit our website at
http://www.ripkenfoundation.org

Follow us on twitter at http://www.twitter.com/CalRipkenSrFdn

Find us on Facebook at http://www.facebook.com/CalRipkenSrFdn

Check out our YouTube Channel at http://www.youtube.com/CalRipkenSrFdn

ACKNOWLEDGEMENTS

We would like to thank all of our sponsors for their support.

ANNUAL IMPLEMENTATION PLANS

K-2 Engineering Design

K-2 ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2 ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
K-2 ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices

K-2 ETS1-1	Asking Questions and Defining Problems
K-2 ETS1-2	Developing and Using Models
K-2 ETS1-3	Analyzing and Interpreting Data

Disciplinary Core Ideas

K-2 ETS1.A	Defining and Delimiting Engineering Problems
K-2 ETS1.B	Developing Possible Solutions
K-2 ETS1.C	Optimizing the Design Solution

Crosscutting Concepts

Patterns
Scale, Proportion, and Quantity
Structure & Function

Kindergarten STEM Lessons — Minutes

Kindergarten STEM Lessons	Minutes
CODE HOPPER	
Code Hopper	60-120
INDI	
Indi Basics (part 1 & part 2)	100-120
Indi Card Challenge	50-60
Indi Algorithm Detectives	50-60
Indi Maze Race	50-70
BEE-BOT	
Bee-Bot and/or Bee-Bots Diorama Storyboard	60-180
MAKEY MAKEY	
Makey Makey Introduction Lesson K-2 Basic Circuitry	60
Makey Makey K-2 Block Coding	60-120
ROK BLOCKS, FOUNDATIONAL FLUENCIES, AND STEM PATHWAYS	
Kid Spark – It's All About the Blocks!	
Yellow Block	30-40
Little Blue Block	30-40
Angled Red Block	30-40
Medium Green Block	30-40
Kid Spark – I Am an Engineer!	
What Is an Engineer?	30-40
Patterns & Pyramids	30-40
What's in The Lab?	30-40
Free Build	30-40
OZOBOTS	
Ozobot and Ozocodes Intro.	60
Basic Training Color Codes Lesson 1 and 2	100
Hungry Hungry Ozobot	45
I See Ozobot Sees	45
Code a Story – There Was a Cold Lady	45

SPHERO	
Light Painting	60-120
Draw 1: Shapes	60
Draw 2: Spelling	60
SQUISHY CIRCUITS	
Squishy Circuits Conductive Creations (consider having cross-grade buddies)	60
3D PRINTING	
Introduction to 3D Printing Concepts	60+
	1325-1765

**This is an estimated amount of time for these lessons, it could be more or less depending upon kids' needs. Indicates Cal Ripken, Sr. Foundation STEM Lesson. All other lessons are created by the manufacturer of these STEM products.*

Common Core State Standard Connections
ELA/Literacy-
SL.K.1 Participate in collaborative conversations with diverse partners about kindergarten topics.
W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.
Math-
K.G.1 Describe objects in the environment using names of shapes.
K.G.3 Identify shapes as two-dimensional or three-dimensional.
K.CC.5 Count to answer "how many?"

K-2 Engineering Design Performance Expectations

K-2 ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2 ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
K-2 ET1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices

K-2 ETS1-1	Asking Questions and Defining Problems
K-2 ETS1-2	Developing and Using Models
K-2 ETS1-3	Analyzing and Interpreting Data

Disciplinary Core Ideas

K-2 ETS1.A	Defining and Delimiting Engineering Problems
K-2 ETS1.B	Developing Possible Solutions
K-2 ETS1.C	Optimizing the Design Solution

Crosscutting Concepts

Patterns
Cause & Effect: Mechanism & Explanation
Scale, Proportion, and Quantity
Systems & System Models
Structure & Function

First Grade STEM Lessons	Minutes
CODE HOPPER	
Code Hopper	60-120
INDI	
indi Basics (part 1 & part 2)	100-120
indi Card Challenge	50-60
indi Algorithm Detectives	50-60
indi Maze Race	50-70
BEE-BOT	
Bee-Bot and/or Bee-Bots Diorama Storyboard	60-180
MAKEY MAKEY	
Makey Makey Introduction Lesson K-2 Basic Circuitry	60
Makey Makey K-2 Block Coding	60-120
Makey Makey Music and Fun!	60-120
OZOBOTS	
OzoBlockly Basic Training	40
Basic Training Color Codes Lesson 3 & 4	100
Write Your Name with Ozocodes	30
Ozo Expedition	30-45
Create	60-300
SPHERO	
Sphero Bolt Long Jump	60
Light Painting	60-120
Draw 2: Spelling	60
Sphero City	240-360
Draw 1: Shapes	60
ROK BLOCKS, FOUNDATIONAL FLUENCIES, AND STEM PATHWAYS	
Introduction to ROK Blocks	60
Kid Spark — Is It Strong?	
How Much Load Can It Hold?	30
The Long Haul	30
Make Your Castle Strong	30
Free Build	30-40

Kid Spark — Does It Move?	
Pushes & Pulls	30-40
Exploring Gravity	30-40
Make Your Castle Strong	30-40
Free Build	30-40
SQUISHY CIRCUITS	
Squishy Circuits Conductive Creations	60
3D PRINTING	
Introduction to 3D Printing Concepts	60+
	1710-2855

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Common Core State Standard Connections

ELA/Literacy-

SL1.1 Participate in collaborative conversations with diverse partners about grade 1 topics.

SL1.5 Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.

Math-

1.G.2 Compose two-dimensional shapes or three-dimensional shapes to create a composite shape, and compose new shapes from the composite shape.

K-2 Engineering Design Performance Expectations

K-2 ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2 ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
K-2 ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices

K-2 ETS1-1	Asking Questions and Defining Problems
K-2 ETS1-2	Developing and Using Models
K-2 ETS1-3	Analyzing and Interpreting Data

Disciplinary Core Ideas

K-2 ETS1.A	Defining and Delimiting Engineering Problems
K-2 ETS1.B	Developing Possible Solutions
K-2 ETS1.C	Optimizing the Design Solution

Crosscutting Concepts

Patterns
Cause & Effect: Mechanism & Explanation
Scale, Proportion, and Quantity
Systems & System Models
Structure & Function

Second Grade STEM Lessons

Second Grade STEM Lessons	Minutes
CODE HOPPER	
Code Hopper	60-120
INDI	
indi Basics (part 1 & part 2)	100-120
indi Card Challenge	50-60
indi Algorithm Detectives	50-60
indi Maze Race	50-70
BEE-BOT	
Bee-Bot and/or Bee-Bot Diorama Storyboard	60-120
SPHERO	
Sphero Bolt Long Jump	60
Bridge Challenge	120-240
Light Painting	60-120
Hydro Hypothesis	120-240
Maze Mayhem	60-120
Draw 1: Shapes	60
Draw 2: Spelling	60
Sphero City	240-360
MAKEY MAKEY	
Makey Makey Introduction Lesson K-2 Basic Circuitry	60
Makey Makey K-2 Block Coding	60-120
Makey Makey Music and Fun!	60-120
ROK BLOCKS, FOUNDATIONAL FLUENCIES, AND STEM PATHWAYS	
Introduction to ROK Blocks	60
Making Things Move	180
See Like a Designer, Think Like an Engineer	120
Make Things Strong	60
Design Perspectives	60
OZOBOTS	
OzoBlocky Basic Training	40
Basic Training Color Code Lessons	50-200

Mission to Mars	45
100 cm Ozo-Dash	30-60
President's Parade	30
Ozobot Dance Off	60
OzoBlocky Skills 1	45-55
OzoBlocky Skills 2	45-55
OzoBlocky Skills 3	50
OzoBlocky Skills 4	35-50
OzoBlocky Skills 5	35-50
SQUISHY CIRCUITS	
Sculpting Your First Circuit	35-60
Series & Parallel Circuits	35-60
Challenge Time	35-60
3D PRINTING	
Introduction to 3D Printing Concepts	60+
SNAP CIRCUITS	
Snap Circuits Electric Bingo	60
	2320-3585

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Common Core State Standard Connections
ELA/Literacy-
SL.2.1 Participate in collaborative conversations with diverse partners about grade 2 topics.
L.2.5a Identify real-life connections between words and their use.
Math-
2.MD.3 Estimate lengths using units.

3-5 Engineering Design Performance Expectations

3-5 ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
3-5 ETS1-2	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.
3-5 ETS1-3	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.

Science and Engineering Practices

3-5 ETS1-1	Asking Questions and Defining Problems
3-5 ETS1-2	Planning and Carrying Out Investigations
3-5 ETS1-3	Constructing Explanations and Designing Solutions

Disciplinary Core Ideas

3-5 ETS1.A	Defining and Delimiting Engineering Problems
3-5 ETS1.B	Developing Possible Solutions
3-5 ETS1.C	Optimizing the Design Solution

Crosscutting Concepts

Patterns
Cause & Effect: Mechanism & Explanation
Scale, Proportion, and Quantity
Systems & System Models
Structure & Function

Third Grade STEM Lessons	Minutes
MAKEY MAKEY	
Makey Makey Introduction Lesson 3-5 Basic Circuitry	60
Makey Makey 3-5 Block Coding	60-120
Makey Makey Music and Fun!	60-120
OZOBOT	
Ozobot Bowl-O-Rama	60
OzoBlocky Basic Training	25-50
Basic Training Color Code Lessons	50-150
Ellipses & Celestial Mechanics	45-55
Modeling Animal Habitats	30-60
ROK BLOCKS, FOUNDATIONAL FLUENCIES, AND STEM PATHWAYS	
Kid Sparks- Engineering Basics w/ROK Blocks	
Introduction to ROK Blocks	60
Mechanisms	120-180
The Design & Engineering Process	120
ROK Blocks Cargo Racer Challenge	60-75
SNAP CIRCUITS	
Snap Circuits Electric Bingo	60
Get Snapped with Snap Circuits 3	60-120
SQUISHY CIRCUITS	
Squishy Circuits Conductive Creations	60
3D PRINTING	
3D Printing	60 +
LITTLEBITS	
Introduction to littleBits: Input Circuits	60
Introducing the littleBits: Invention Cycle	60
Invent an Art Machine	60-120
Invent a Chain Reaction Contraption	120+
Constellation Viewer	60
Speed Racer	60
Environmental Sign	45
Inherited Traits	45

littleBits Engineering Design	60-90
SPHERO	
Sphero Bolt Long Jump	60
Bridge Challenge	120-240
Light Painting	60-120
Tractor Pull	120-240
Hydro Hypothesis	120-240
Organ Quiz	60
Planets Quiz	120-240
Blocks 1: Intro & Loops	60-120
Maze Mayhem	60-120
Blocks 2: If/Then/Else	60-120
Blocks 3: Lights	60-120
Blocks 4: Variables	60-120
Draw 2: Spelling	60
Sphero City	240-360
Swim Meet	60
Chariot Challenge	240-360
What a Character	60-120
Avoid the Minotaur	60-120
Draw 1: Shapes	60
Draw 3: Perimeter	60-120
Area of A Rectangle	60-120
	3360-5250

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Common Core State Standard Connections

ELA/Literacy-

L.3.5b Identify real-life connections between words and their use.

SL3.1 Engage effectively in a range of collaborative discussions with diverse partners on grade 3 topics and texts, building on other's ideas and expressing their own clearly.

Math-

3.MD.5 Recognize area as an attribute of plane figures and understand concepts of area measurement.

3-5 Engineering Design Performance Expectations

3-5 ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
3-5 ETS1-2	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.
3-5 ETS1-3	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.

Science and Engineering Practices

3-5 ETS1-1	Asking Questions and Defining Problems
3-5 ETS1-2	Planning and Carrying Out Investigations
3-5 ETS1-3	Constructing Explanations and Designing Solutions

Disciplinary Core Ideas

3-5 ETS1.A	Defining and Delimiting Engineering Problems
3-5 ETS1.B	Developing Possible Solutions
3-5 ETS1.C	Optimizing the Design Solution

Crosscutting Concepts

Patterns
Cause & Effect: Mechanism & Explanation
Scale, Proportion, and Quantity
Systems & System Models
Structure & Function

Fourth Grade STEM Lessons	Minutes
MAKEY MAKEY	
Makey Makey Introduction Lesson 3-5 Basic Circuitry	60
Makey Makey 3-5 Block Coding	60-120
Makey Makey Music and Fun!	60-120
SQUISHY CIRCUITS	
Squishy Circuits Conductive Creations	60
SNAP CIRCUITS	
Snap Circuits Electric Bingo	60
Get Snapped with Snap Circuits 4	60-120
ROK BLOCKS, FOUNDATIONAL FLUENCIES, AND STEM PATHWAYS	
Introduction to ROK Block (if needed)	60
ROK Blocks Engineering Design Challenge 2	60-90
Making Things Move	180
OZOBOT	
OzoBlocky Basic Training	25-50
Basic Training Color Codes (3 lessons)	50-150
Elementary School CS with Game Design	200
LESSONS 1-4	
Clean Energy Cruise	30-45
LITTLEBITS	
Busy Bees	60
Heart Beats	60
Chain Reaction Machine	50
Morse Code Devise	45
Energy Transfer	45
Plant Adaptations	60
Fortune Teller	45
Introduction to littleBits	60
Introducing the littleBits Invention Cycle	60
Invent a Self-Driving Vehicle	60-120
Hack Your Classroom	120+

EXTRA LITTLEBITS GENERAL LESSONS	
Turning Points (3 lessons)	135
VocaBilitary (2 lessons)	50-100
Let's Make a Techno Jungle (4 lessons)	200
Aesop's Fables (3 lessons)	135
3D PRINTING	
Introduction to 3D Printing Concepts	60+
SPHERO	
Sphero Bolt Long Jump	60
Bridge Challenge	120-240
Light Painting	60-120
Tractor Pull	120-240
Hydro Hypothesis	120-240
Organ Quiz	60
Planets Quiz	120-240
Blocks 1: Intro & Loops	60-120
Maze Mayhem	60-120
Blocks 2: If/Then/Else	60-120
Blocks 3: Lights	60-120
Blocks 4: Variables	60-120
Draw 2: Spelling	60
Sphero City	240-360
Swim Meet	60
Chariot Challenge	240-360
What a Character	60-120
Avoid the Minotaur	60-120
Draw 1: Shapes	60
Draw 3: Perimeter	60-120
Area of A Rectangle	60-120
	4070-5415

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Common Core State Standard Connections
ELA/Literacy-
SL.4.1 Engage effectively in a range of collaborative discussions with diverse partners on grade 4 topics.
W.4.2d Use precise language and domain specific vocabulary to inform about or explain the topic.
Math-
4.MD.2 Use the four operations to solve word problems involving,

3-5 Engineering Design Performance Expectations

3-5 ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
3-5 ETS1-2	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.
3-5 ETS1-3	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.

Science and Engineering Practices

3-5 ETS1-1	Asking Questions and Defining Problems
3-5 ETS1-2	Planning and Carrying Out Investigations
3-5 ETS1-3	Constructing Explanations and Designing Solutions

Disciplinary Core Ideas

3-5 ETS1.A	Defining and Delimiting Engineering Problems
3-5 ETS1.B	Developing Possible Solutions
3-5 ETS1.C	Optimizing the Design Solution

Crosscutting Concepts

Patterns
Cause & Effect: Mechanism & Explanation
Scale, Proportion, and Quantity
Systems & System Models
Structure & Function

Fifth Grade STEM Lessons

Fifth Grade STEM Lessons	Minutes
MAKEY MAKEY	
Makey Makey Introduction Lesson 3-5 Basic Circuitry	60
Makey Makey 3-5 Block Coding	60-120
Makey Makey Music and Fun Challenge	60-75
SNAP CIRCUITS	
Snap Circuits Electric Bingo	60
Get Snapped with Snapped Circuits 5	60-120
3D PRINTING	
Introduction to 3D Printing Concepts	60
ROK BLOCKS, FOUNDATIONAL FLUENCIES, AND STEM PATHWAYS	
Introduction to ROK Block (if needed)	60
ROK Creek Bridge	180
Kid Sparks-Applied Mathematics ROK Blocks	
Dimension & Measurement	60-90
Perimeter	60-90
Area	60-90
Volume	60-90
Ratios, Proportions, and Scale Drawings	60-90
OZOBOTS	
OzoBlocky Basic Training (if needed)	25-50
Basic Training Color Codes (if needed)	50-150
Space Exploration Game	180
EVO The Troll	55
Elementary School CS with Game Design	50-100
Game Design Supplementary Lesson	
LITTLEBITS	
Introduction to littleBits: Servo Circuits	60
Invent a Throwing Arm	60-120
Invent for Good	120+
Introducing the littleBits Invention Cycle	60

LITTLEBITS STEAM STUDENT SCIENCE LESSONS	
Keep It Cool	90
Ecosystem Dynamics	60
Snack Robot	45
Lunar Phases	60
EXTRA LITTLEBITS GENERAL LESSONS	
Turning Points (3 lessons)	135
VocaBilitary (2 lessons)	50-100
Let's Make a Techno Jungle (4 lessons)	200
Aesop's Fables (3 lessons)	135
SPHERO	
Sphero Bolt Long Jump	60
Bridge Challenge	120-240
Light Painting	60-120
Tractor Pull	120-240
Hydro Hypothesis	120-240
Organ Quiz	60
Planets Quiz	120-240
Blocks 1: Intro & Loops	60-120
Maze Mayhem	60-120
Blocks 2: If/Then/Else	60-120
Blocks 3: Lights	60-120
Blocks 4: Variables	60-120
Draw 2: Spelling	60
Sphero City	240-360
Swim Meet	60
Chariot Challenge	240-360
What a Character	60-120

Avoid the Minotaur	60-120
Draw 1: Shapes	60
Draw 3: Perimeter	60-120
Area of A Rectangle	60-120
	4195-6085

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Common Core State Standard Connections
ELA/Literacy-
SL.5.1 Engage effectively in a range of collaborative discussion with diverse partners on grade 5 topics.
SL.5.1d Review the key ideas expressed and draw conclusion in light of information and knowledge gained from the discussions.
Math-
5.MD.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement.

Sphero is proud to support the Cal Ripken Sr. Foundation with Sphero robots and littleBits kits in each of the Ripken Foundation STEM Centers, providing hands-on STEM and computer science learning opportunities for the youth in their program.

Kid Spark Education is proud to support the Cal Ripken, Sr. Foundation with the Foundational Fluencies and STEM Pathway kits in each of the Ripken Foundation STEM Centers. The Foundational Fluencies and STEM Pathway kits cover a wide range of STEM topics including mechanical engineering, structural engineering, applied mathematics, and rapid prototyping. Kid Spark Education allows robust, reusable engineering and robotics materials that support children as they grow in their learning.

The Ripken Foundation STEM Challenge Powered by XTO Energy

The Ripken Foundation STEM Challenge powered by XTO Energy provides youth at Ripken Foundation STEM Centers an opportunity to participate in a national competition. Using a real-world scenario, youth apply STEM skills and knowledge to develop innovative solutions to a designated problem.

The challenge topic changes on an annual basis with roots in a STEM-related field and provides context for the teams with regard to variables they need to consider in their approach to solving the problem. This exercise in teamwork teaches more than just STEM principles. By competing in this event kids gain valuable life skills which include critical thinking, problem-solving, teamwork, and communication, as well as using resources efficiently. Look for the prompt to be released in August from your Program Coordinator to participate in this year's Ripken Foundation STEM Challenge powered by XTO Energy!

CAL RIPKEN, SR. Foundation

TRANSFORM COMMUNITIES
CHANGE KIDS' LIVES

The Cal Ripken, Sr. Foundation helps to strengthen America's most underserved and distressed communities by supporting and advocating for children, building Youth Development Parks, partnering with law enforcement and youth service agencies, and addressing community needs through its national program initiatives.