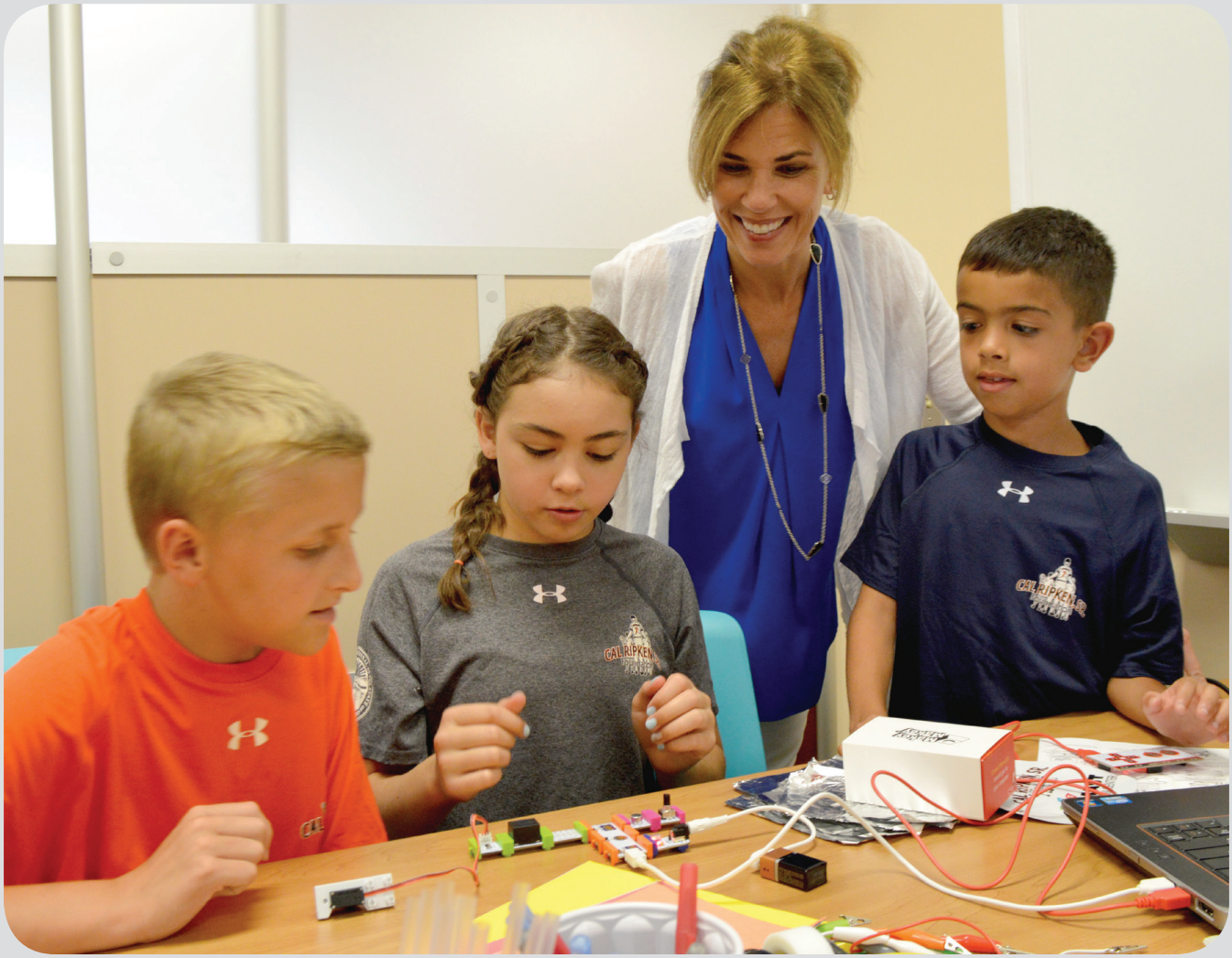
Ripken Foundation STEM Center

Curriculum Guidebook



CONTENTS

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 organizations across the country that directly impact the lives of at-risk youth. 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 mentors at community-based organizations to implement.

We have developed Ripken Foundation STEM Centers to facilitate STEM learning with community-based partners nationwide. Each Ripken Foundation STEM Center is equipped with this Ripken STEM curriculum guidebook paired with Ripken Foundation STEM Center products and activity kits which provide a comprehensive, experiential learning environment for kids. The activities in the guidebook are designed to offer mentors many ways to teach critical thinking and problem-solving skills, all while having fun and learning STEM in the process. The Ripken STEM curriculum is also available online at NO COST on the Ripken Foundation portal.

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.

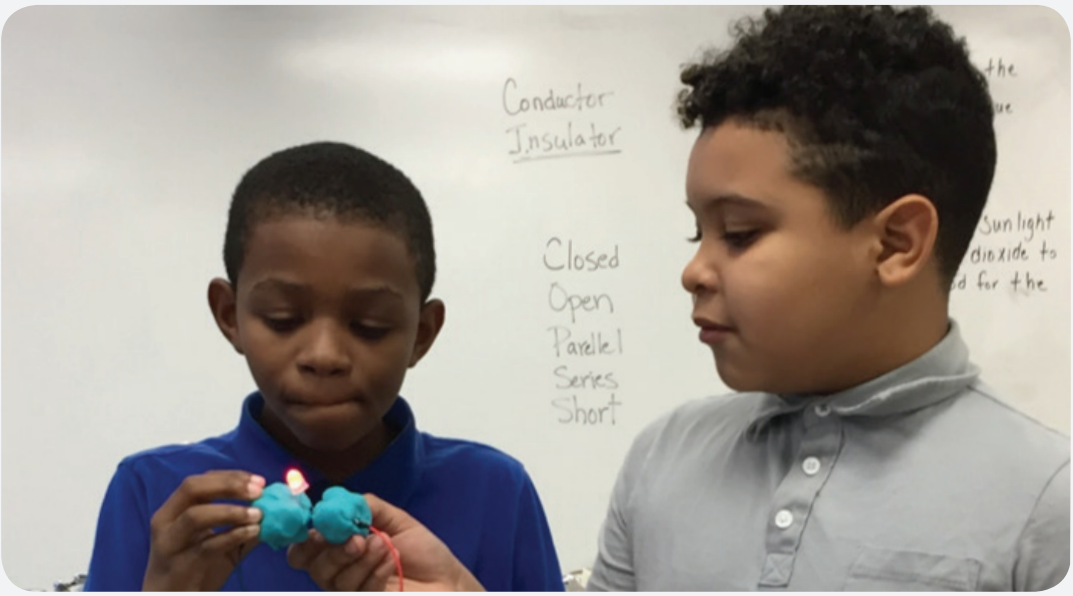
Celebrate The Individual

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.

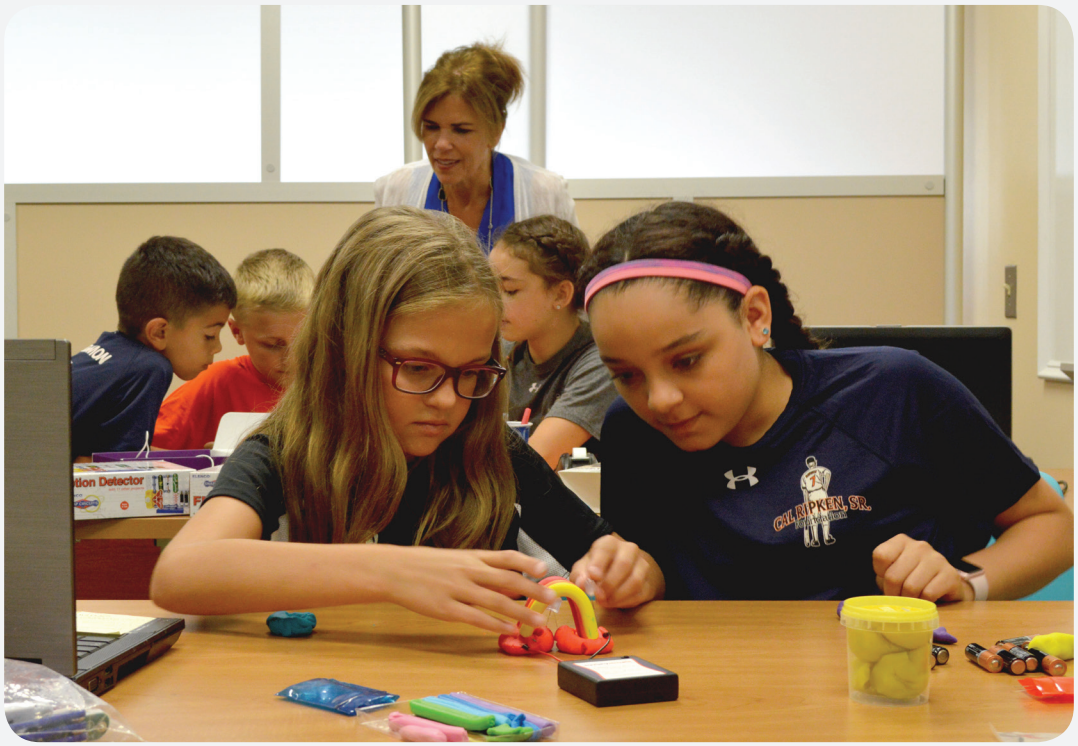
Want to hear Bill Ripken explain the guiding principles of the Foundation?
Go to **http://www.CRSFPortal.org** *and sign up for a free account today!*



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 youth 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

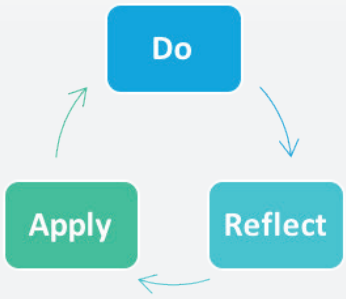
Ripken Foundation STEM Centers allow youth to learn and explore their curiosities without the confines of standardized lesson plans and testing. This curriculum guidebook is designed to give you background on the supplies we have provided, along with a set of lessons to enrich your mentoring program.

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:

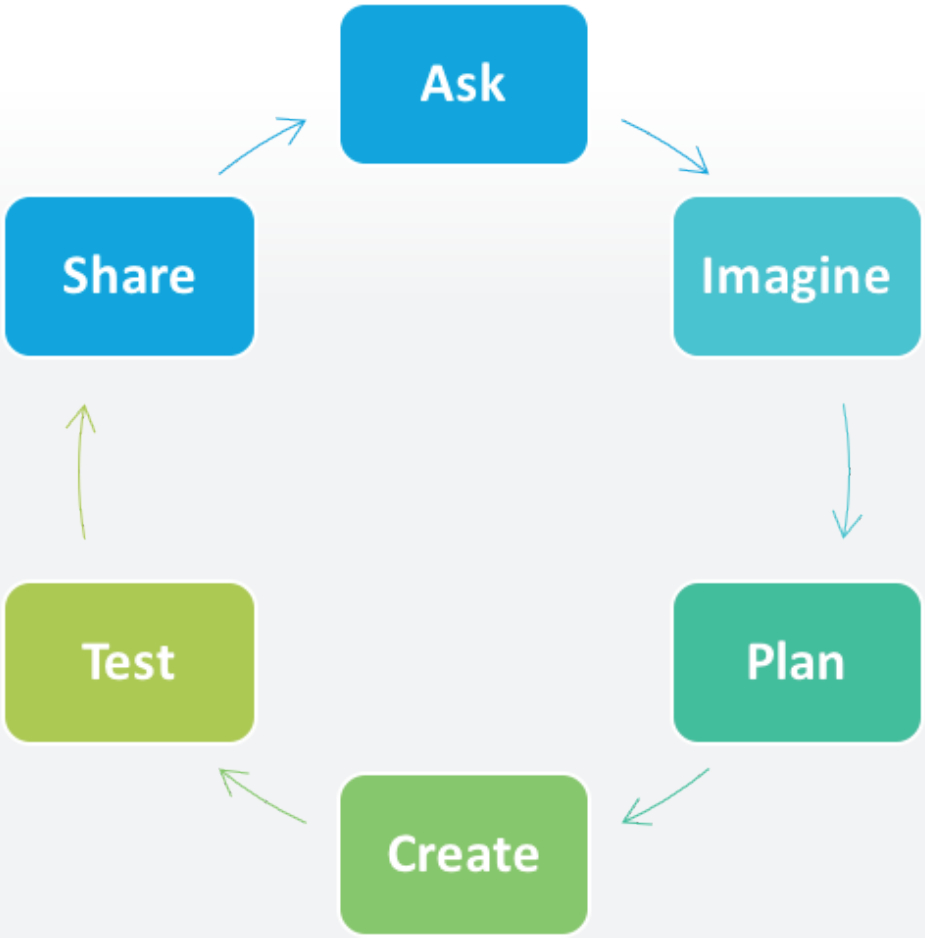
Conduct testing to determine if the plan meets the needs and solves the problem. Testing can identify improvements that need to be made and kids can go through the EDP until they are happy with a solution.

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. Youth 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 IN A RIPKEN FOUNDATION STEM CENTER?

We at the Cal Ripken, Sr. Foundation continue to serve at-risk youth through developing new and relevant programs. In keeping with that goal, we have created the Cal Ripken, Sr. Foundation STEM Program. According to a 2011 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 afterschool setting presents an opportunity to reach the vulnerable populations we need to bring into the STEM pipeline through experiences that supplement and complement the school day.

Ripken Foundation STEM Centers provide community-based partners with:

PRODUCTS

Mentoring 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 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 **http://www.CRSFPortal.org**

PRODUCTS GUIDE

Each Ripken Foundation STEM Center will receive a set of STEM Center Equipment, along with a STEM Kit.

RIPKEN FOUNDATION STEM CENTER EQUIPMENT

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:

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.

Computers:

Each Center has a choice of computers to meet their needs. Some of the models include: Dell Desktops, Notebooks, or Chromebooks.

Projector:

LCD projectors help to display projects onto one screen for the entire group to see what is happening at one time.

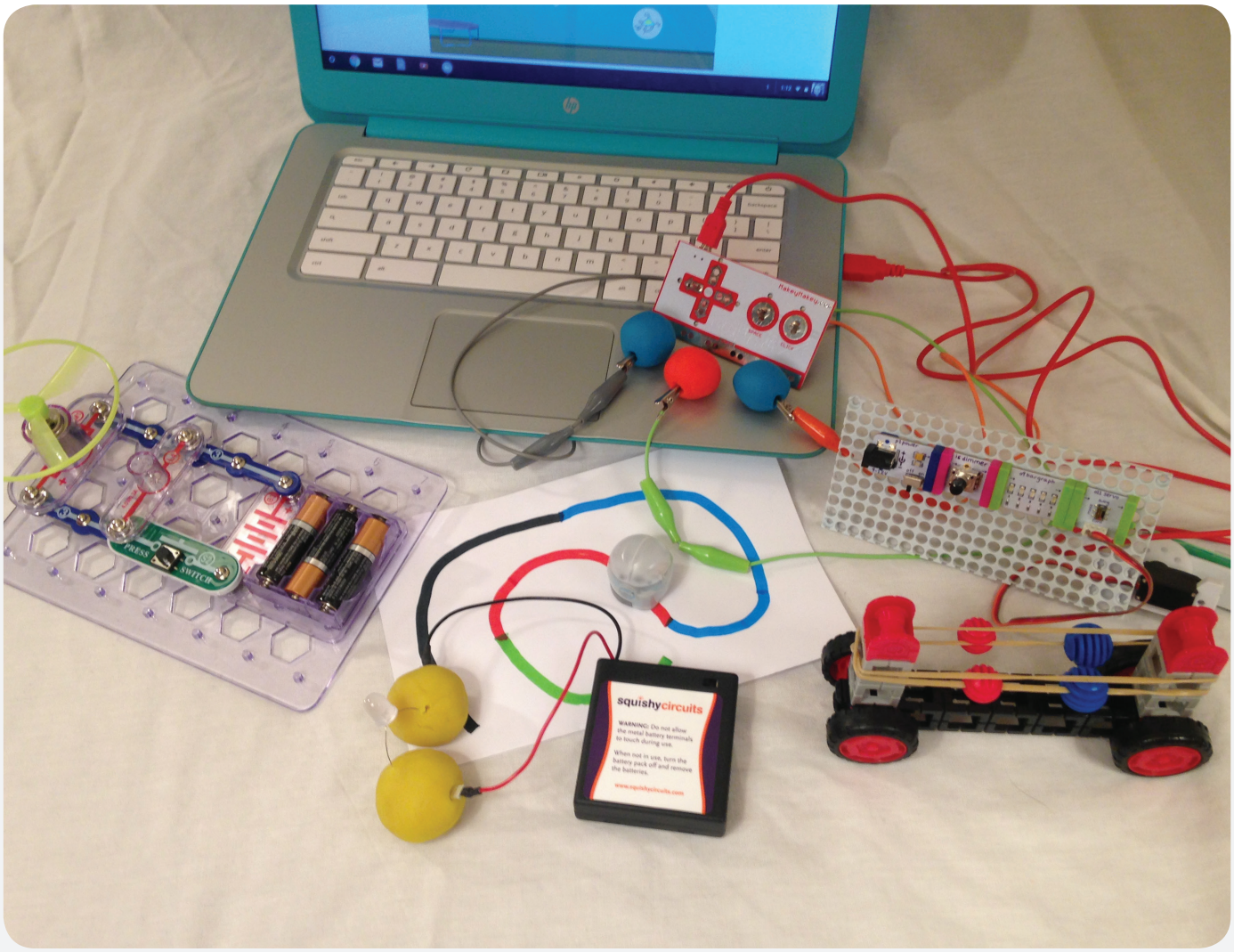
TI Innovator:

The TI innovator hub uses prototyping and coding properties to allow kids to create and invent to their hearts content.

STEM KIT PRODUCTS

Along with the STEM Center products, Ripken Foundation STEM Centers receive additional STEM resources. The Ripken Foundation STEM Kit includes fun and captivating activities that teach STEM concepts that cater to a variety of ages. The Ripken Foundation STEM Kits include:

- **littleBits**
- **Makey Makey**
- **Ozobot**
- **Rokenbok**
- **Snap Circuits**
- **Squishy Circuits**



LITTLEBITS

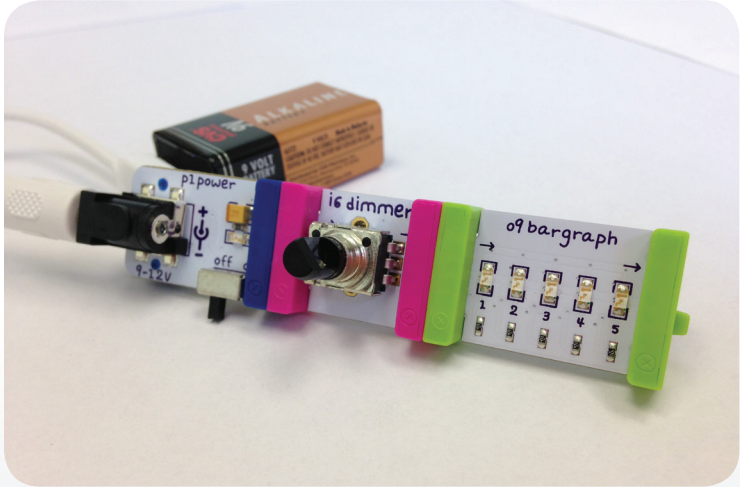
OVERVIEW

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

STEAM Education Class Pack includes:

- **19 bits and 45 accessories**
- **Teacher's Guide**
- **Introduction and littleBits Basics Guides**
- **Invention Guidebook tied to the Next Generation Science Standards (NGSS) and Common Core Standards**
- **Online resources**



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.

A great introductory lesson to using littleBits is included in the littleBits Educator's Guide that is available for a free download at **http://littlebits.cc/education**
The lessons titled "mini-lessons" begin on page 17 of the Educator's Guide.

ONLINE RESOURCES

- **http://littlebits.cc/**
- **http://littlebits.cc/education**
- **http://littlebits.cc/education/resources**

MAKEY MAKEY

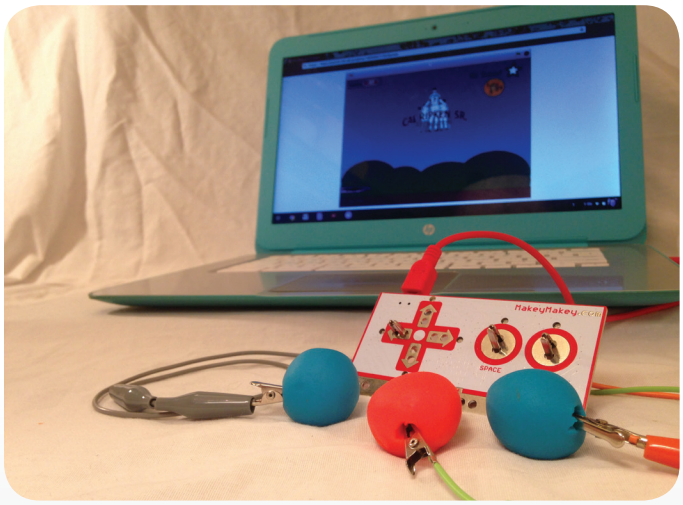
OVERVIEW

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 STEM Classroom Kit includes:

- **12 Makey Makey Classic boards**
- **Connecting wires**
- **USB computer connecting wires**
- **Graphite pencils optimized for use with Makey Makey**
- **Organizing carrying case**
- **Basic instruction guides**



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**
- **http://www.makeymakey.com/forums/**
- **http://makeymakey.com/lessons/**
- **http://makeymakey.com/guides/**
- **https://scratch.mit.edu/**

OZOBOT

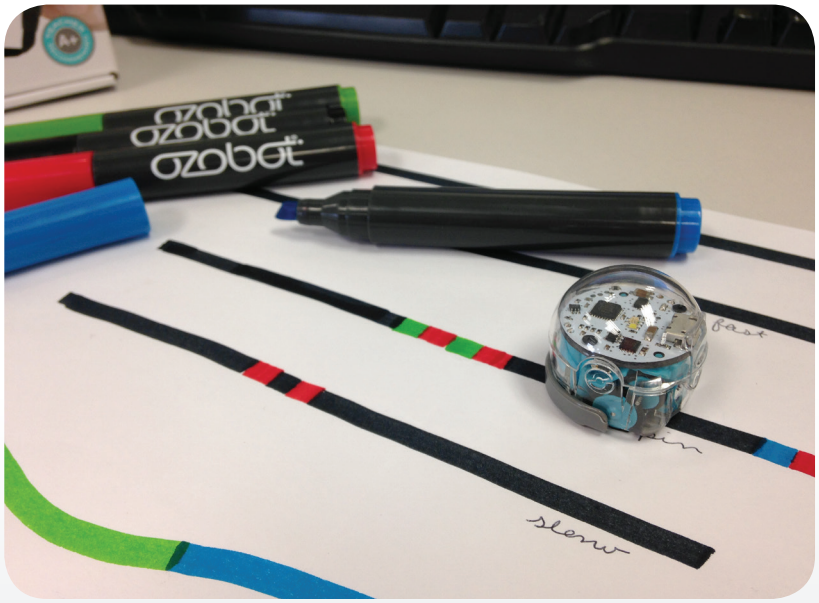
OVERVIEW

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 Classroom Kit includes:

- **18 Ozobot Bit robots**
- **Multi-port chargers**
- **18 sets of markers**
- **Tip sheets**
- **Teacher's guide**
- **Storage boxes**
- **Online resources**



MENTOR NOTES

Ozobot's Classroom Kit comes with some lessons and classroom resources. Ozobot has on 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/**

ROKENBOK

OVERVIEW

Rokenbok is 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

Rokenbok SnapStack Mobile STEM Lab, which includes:

- **6 stackable modules (cases) which hold various pieces and parts**
- **1 base with wheels**
- **Access to online lesson plans**

MENTOR NOTES

Rokenbok 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

- **https://rokenbokeducation.org/**
- **https://rokenbokeducation.org/education/stem-curriculum-teacher-resources**

SNAP CIRCUITS

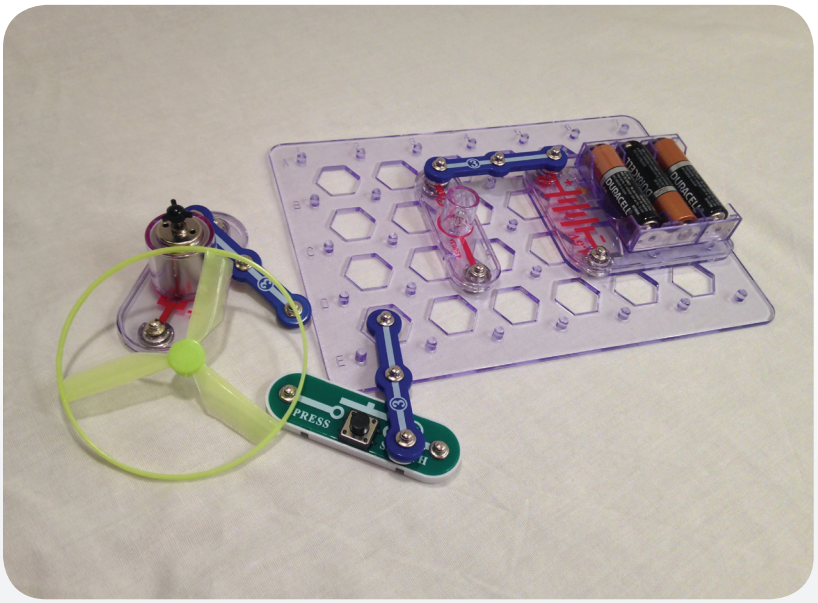
OVERVIEW

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 Jr.® Educational 100 Exp includes:

- **Snap circuit pieces such as:**
  - **Wire**
  - **Resistor**
  - **Speaker**
  - **Motor**
  - **LED**
  - **Switch**
- **Snap Circuits platform board**
- **Project instruction guide**



MENTOR NOTES

Snap Circuits allow kids to learn the concepts of electronics through easy-to-use components. The activities in the guide provided offer 100 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

- **http://www.snapcircuits.net/**
- **http://www.snapcircuits.net/learning_center**

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 – Standard Kit

- **Conductive dough**
- **Insulating dough**

***Note:** *The doughs provided are not enough to sustain an entire class. This consumable product will need replacing periodically. We wanted to provide you with a small amount of dough to test the product before use with the kids. You can purchase more dough from the Squishy Circuits store, or make it using recipes included with the kit or found online.*

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.

LESSONS

We have 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 meant for an older elementary to middle school age range.

The lessons are as follows:

Lesson 1 – Rokenbok Cargo Racer Challenge

Lesson 2 – Squishy Circuits Conductive Creations

Lesson 3 – Snap Circuits Electric Bingo

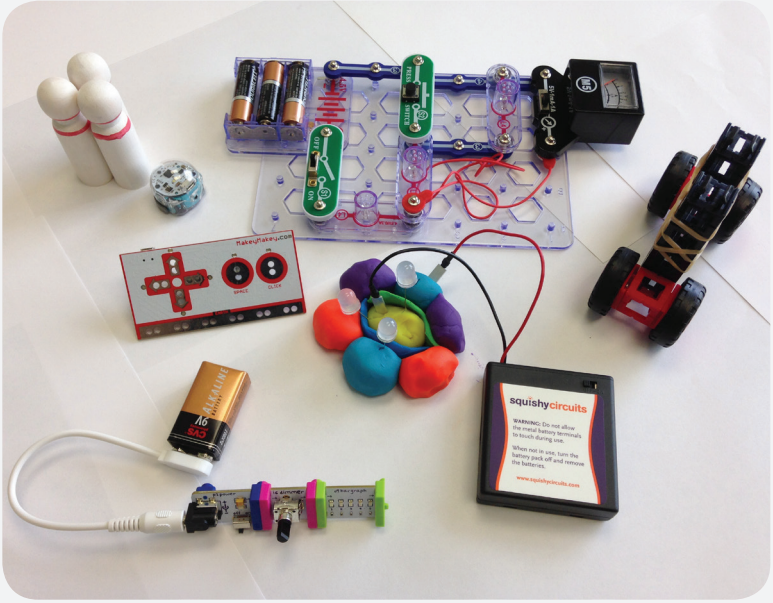
Lesson 4 – Makey Makey Music and Fun!

Lesson 5 – Ozobot Bowl-o-Rama

Lesson 6 – Introduction to 3D Printing Concepts

All of our lessons were developed to meet the Next Generation Science Standards. The Next Generation Science Standards is a national set of educational standards for STEM fields. These standards align 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 other who do not align their programs to national standards showing a dedication to education and youth development. For more information, visit **https://www.nextgenscience.org/**

***Note:** Several of the products teach circuitry. The skills and knowledge learned from one product can transfer to others creating a deeper learning experience. A recommended "plan of study" for electronics would have kids start with Squishy Circuits, progress to Snap Circuits, then Makey Makey, and concluding by using littleBits.*



LESSON 1
ROKENBOK CARGO RACER CHALLENGE

OVERALL TIME - *60 to 75 minute lesson*

GROUPS - *3 to 4 kids per kit*

Next Generation Science Standards
(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.
(3-5-ETS1-3)

OBJECTIVE

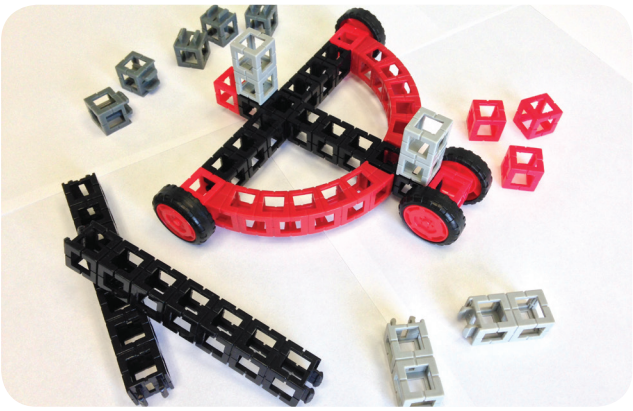
Kids will apply the Engineering Design Process to solve a problem.

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

- **Rokenbok kit**
- **Ramp (optional)**
- **Tape Measure**
- **Paper**
- **Pencils**
- **Masking Tape**
- **Chart Paper**



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:

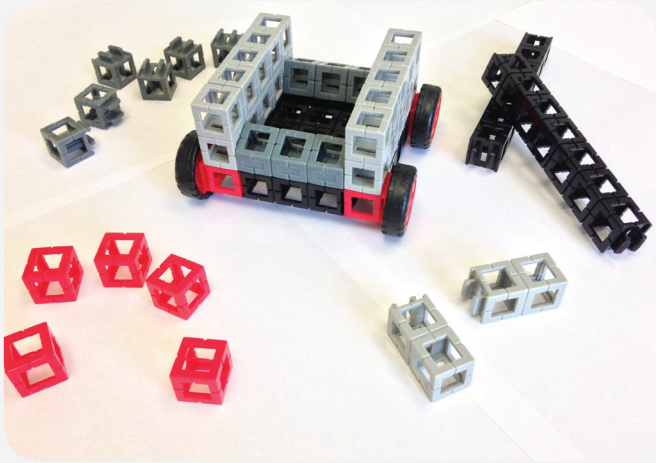
- What are your ideas for the design?

- 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?

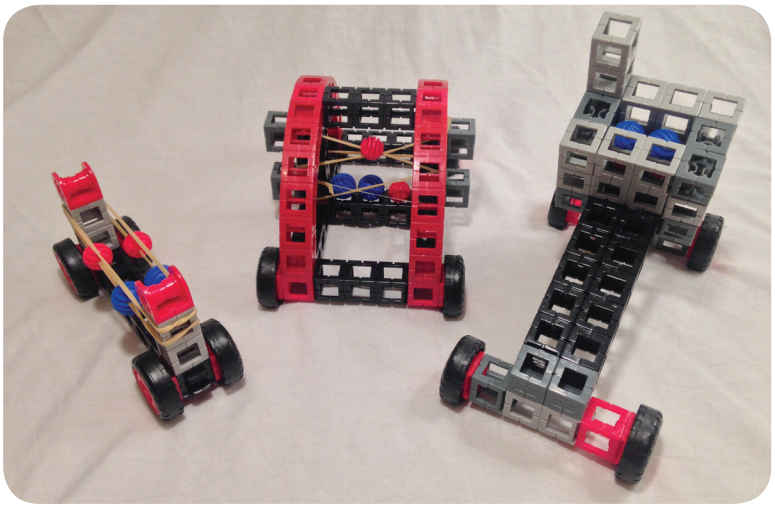
Take time for teams to thank each other for being a part of their learning community.

CLEAN UP - *5 minutes*

Have children break apart vehicles and use the Rokenbok 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!



LESSON 2
SQUISHY CIRCUITS CONDUCTIVE CREATIONS

OVERALL TIME - *60 minute lesson*

GROUPS - *3 to 4 kids per kit*

Next Generation Science Standards

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

(Energy 4PS3-4)

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 in the order of their sequence.

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.

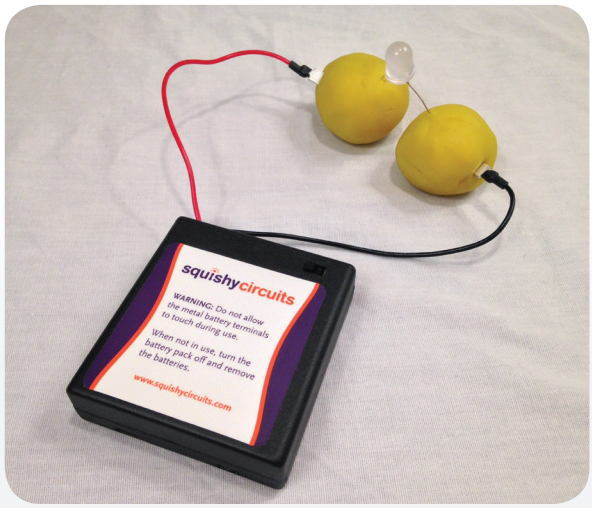
Review the materials that come in the kit (battery holder, wires, motor, switch, Playdoh, modeling clay, LED lights). Hold up the LED light and show kids the longer terminal. This terminal will need to go in the dough with the positive (red) wire. Have kids sketch and label each of the circuits created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

CLOSING - *5 minutes*

Have youth 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

LESSON 3
SNAP CIRCUITS ELECTRIC BINGO

OVERALL TIME - *60 minute lesson*

GROUPS - *3 to 4 kids per kit*

Next Generation Science Standards

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.)

(Energy 4PS3-4)

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 in the order of their sequence.

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:

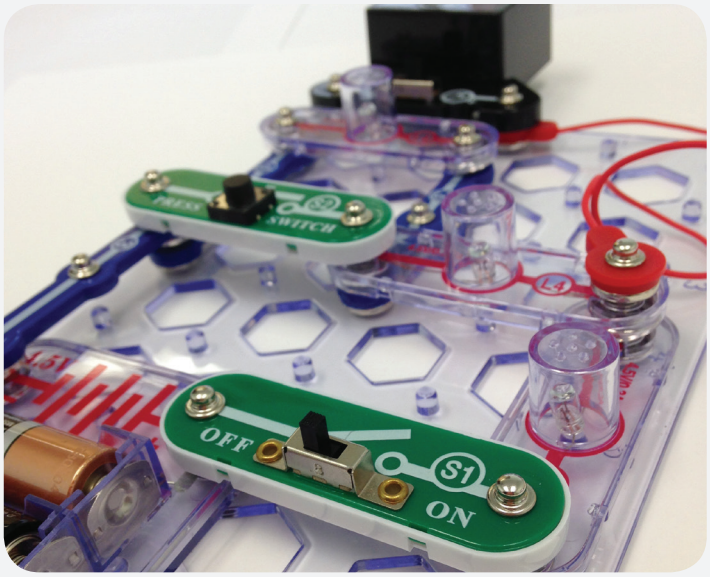
- *What new learnings did you have?*
- *What circuits were challenging to make? Why?*
- *Was your team able to make real life circuit connections?*

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**

LESSON 4
MAKEY MAKEY MUSIC AND FUN

OVERALL TIME - *60 to 75 minute lesson*

GROUPS - *3 to 4 kids per kit and computer*

Next Generation Science Standards

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.

(3-5-ETS1-3)

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

- **STEM Lab Computers – 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.

MAKEY MAKEY
MUSIC AND FUN CHALLENGE

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.

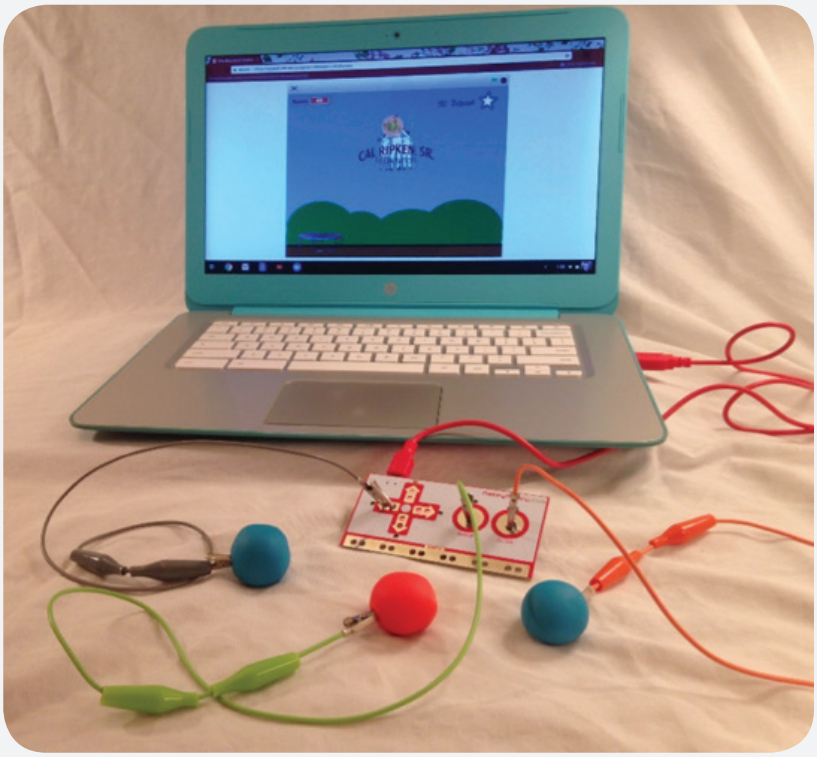
When time is up, share your design with another team and learn how to use their design!

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.



LESSON 5
OZOBOT BOWL-O-RAMA

OVERALL TIME - *60 minute lesson*

GROUPS - *Activity 1: partners*
- *Activity 2: groups of 3 to 4*

Next Generation Science Standards

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.

(3-5-ETS1)

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.

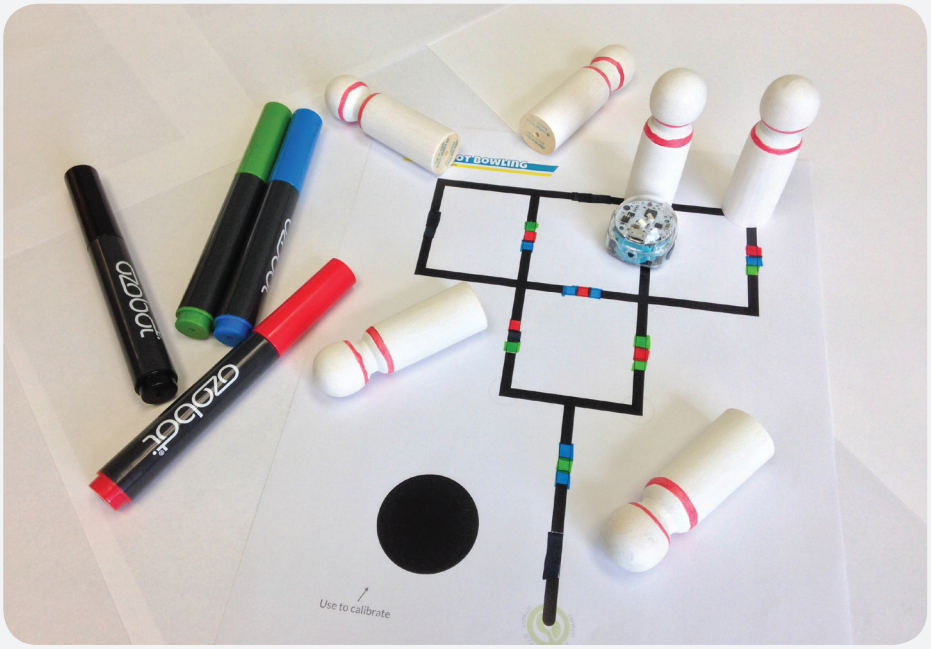
Coding: A set of signals called code are sent to a device to provide specific instructions on how to perform an action. With Ozobot, the robot reads the code via colored dots on a piece of paper.

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 to4 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?*

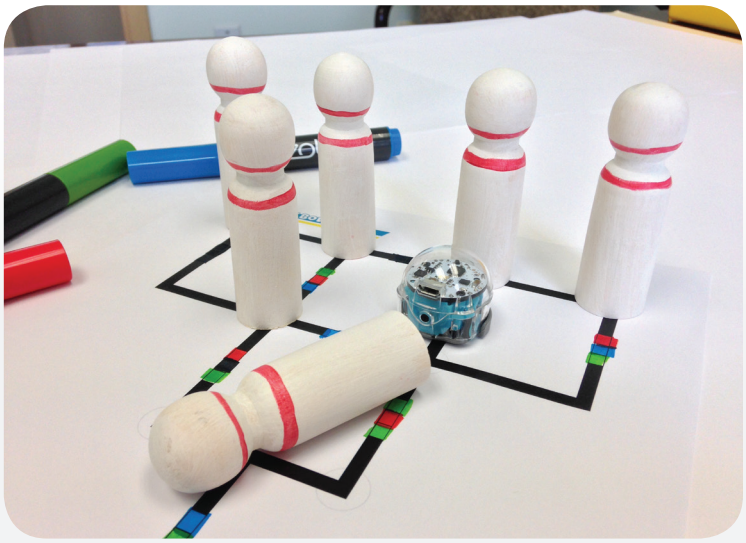
- *Was there a color-coding pattern that worked better? Why?*

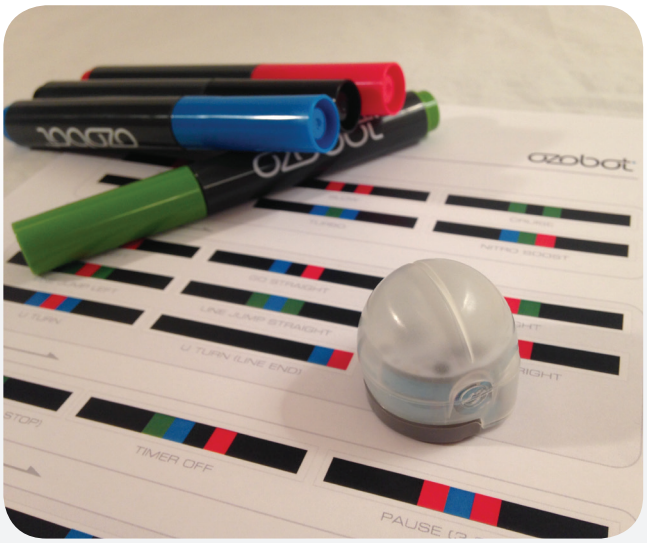
- *If you had an opportunity to make changes, what would you make, why?*

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.





LESSON 6
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 - *3 to 4 kids per group*

Next Generation Science Standards

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.

(MS-ETS1-4)

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-ETS1-1)

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, capable of using 3D printing to make. Kids will also observe a 3D object being printed using Matter Control software.

MATERIALS

- **3D Printer**
- **Downloaded .stl file to print**
- **Matter Control**
- **Playdoh**
- **Paper**

PREPARATION

- Matter Control is the software used to upload files to the Robo3D Printer. Be sure to install Matter Control and the 3D Printer drivers on the computer before beginning. When you are ready to print, download an object file compatible with your 3D printer.
- Warm up the printer. Place a blank sheet on the base of the printer and tape the ends down, so it doesn't move while it prints. Then after the printing is complete, the object should easily come off the paper.

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.crsfportal.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 CRSFPortal.org only take about 15 minutes.

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

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**

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.

ADDITIONAL 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

AppInventor.org – learn to build Android apps

- **http://www.AppInventor.org**

GameBlox – create and edit games with code

- **http://gameblox.org**

MIT App Inventor

- **http://appinventor.mit.edu/**

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

- **http://nasa.gov/audience/foreducators/robotics http://robotics.nasa.gov**

Sphero

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

McGraw Hill Virtual Labs

- **www.mhhe.com/biosci/genbio/virtual_labs_2K8**

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**

Adventures in Math

- **http://www.scholastic.com/regions**

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**

Magic School Bus – games, activities, and stories on a wide variety of topics

- **http://www.Scholastic.com/MagicSchoolBus**

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/**

Makerspace.com – Online community for the Maker movement of invention and creativity. Get and share ideas of what to create and make next!

- **http://www.MakerSpace.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/**

FINAL THOUGHTS

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**

Our online portal hosts additional curricula, materials, and lessons to use with your kids. To access these materials, visit: **http://www.crsfportal.org** *to sign up for a free account today!*

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

Ripken Foundation STEM Centers would not be possible without the support of our donors and sponsors. The idea for Ripken STEM Centers came about from a relationship with the Schwab Family who created the first MAST (Madison, Alexa, Sammy, Tina) STEM Center in Harrisburg, PA. MAST wanted to inspire STEM education in at-risk communities around the country that needed support from partner organizations. Our thanks to the Schwab Family and MAST for inspiring the first Ripken Foundation STEM Center, and paving the way for this STEM opportunity for many youth nationwide.

We would also like to thank our sponsor, Battelle who provided support making Ripken Foundation STEM Centers a reality.

MAST STEM CENTER

BATTELLE

NOTES

The Cal Ripken, Sr. Foundation helps to build character and teach critical life lessons to at-risk young people living in America's most distressed communities.