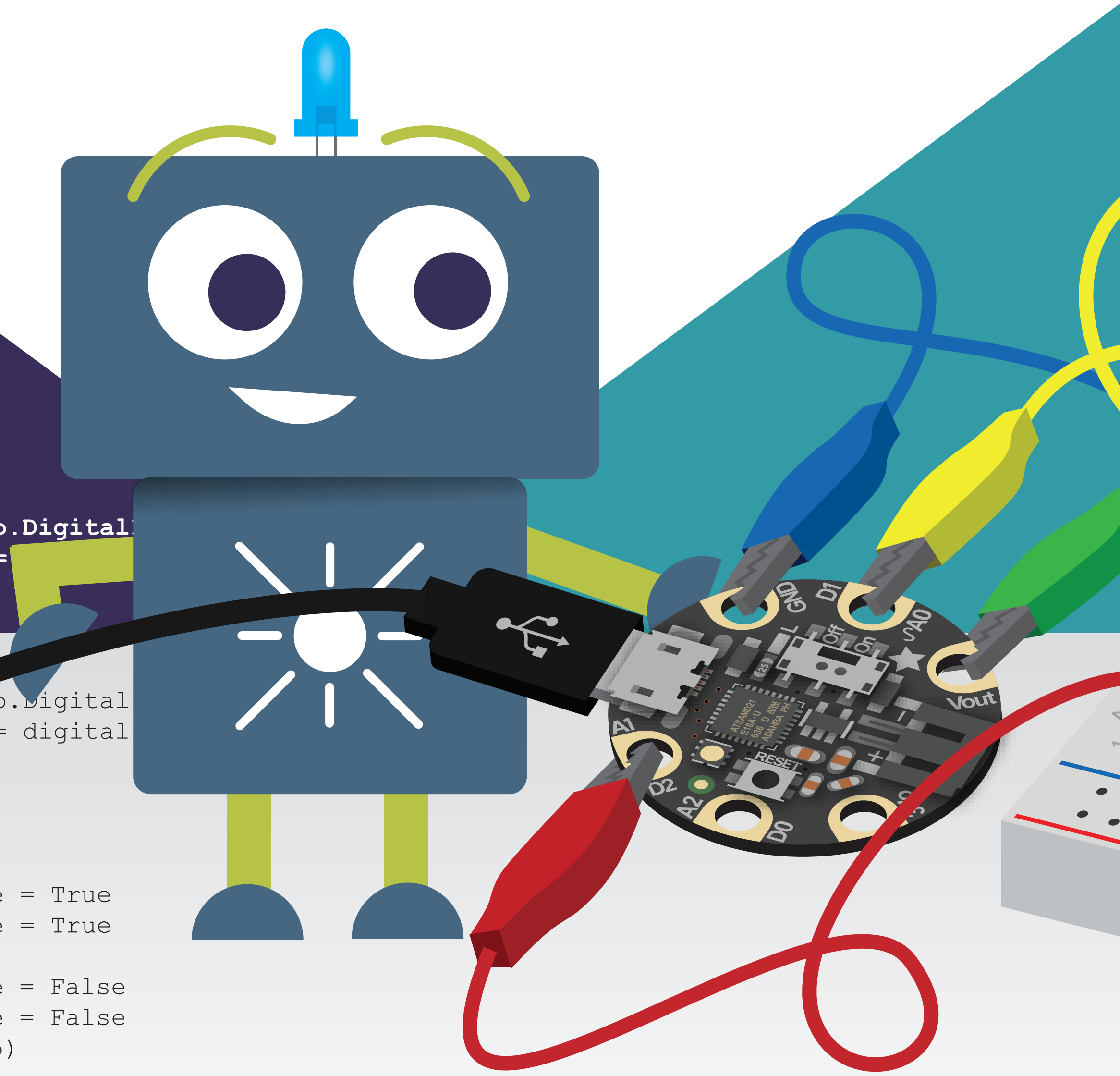
A creative and innovative way for young engineers to explore programming

NATIONAL PEER REVIEWED
01913

#2 DESIGN A POWER PARK:

SMART CIRCUITS




```
import board
import digitalio
import time


ledLarge = digitalio.Digital
ledLarge.direction =


ledSmall = di   alio.Digital
ledSmal   irection = digital


while True:
      ledLarge.value = True
      ledSmall.value = True
      time.sleep(2)
      ledLarge.value = False
      ledSmall.value = False
      time.sleep(3.5)
```

The hands-on activities in this book introduce coding, microcontrollers, and sensors to circuitry projects. This is the second book in a collection of three. While we advise all readers to go through the first book before using this one, this is not a requirement, though we do assume the reader has basic electrical circuit skills and knowledge. Coding experience is helpful, but not necessary. The pages in this book are full of opportunities for exploration and challenge young designers to problem-solve and think creatively and critically. As readers explore the relationships between voltage, current, and resistance, and ways to control them with code and sensors, their circuits will be filling this book with lights and sound. Power engineers spend their careers making electricity reliable and available to people all over the world. They use smart devices to increase reliability and decrease costs, and report a thrill every time the lights come on. We want this same thrill, literally and metaphorically, to inspire the next generation of scientists, engineers, and makers.

AUTHORS

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ILLUSTRATION, LAYOUT, & DESIGN

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ACKNOWLEDGMENTS

We love to tinker and code, and we love learning about new ways to combine hands-on investigation and computer programming. We thank all of the creative individuals and groups who have brought these exciting ideas to young (and young at heart) people at home and in classrooms through more accessible materials, supplies, and activities. We have been inspired by the work done by educators and makers at Adafruit, SparkFun, the Exploratorium, the MIT Media Lab and High-Low Tech group, Chibitronics, the 21st Century Notebooking group, and by many teachers and students.

Images of Gemma M0 and the Mu dashboard are used with permission.

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ILLINOIS

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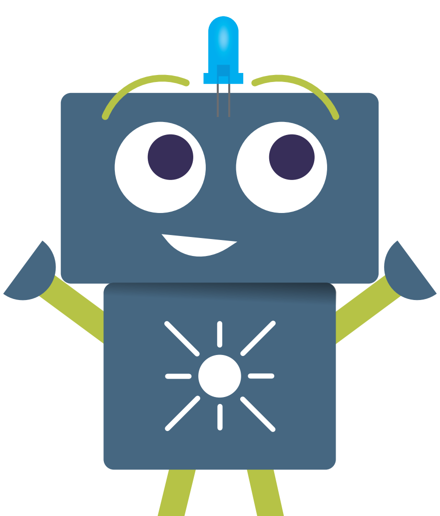
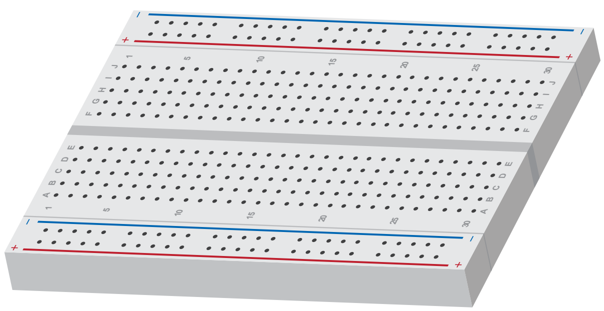


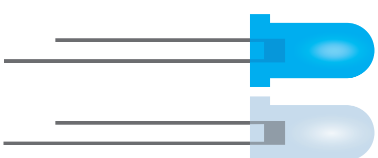
BOOK MATERIALS

The materials listed on the following pages include everything you will need to complete the activities in this book. Many of these materials may be purchased in a kit accompanying the book or purchased separately. Household items such as clear tape, scissors, and paper clips are not included in the kits.

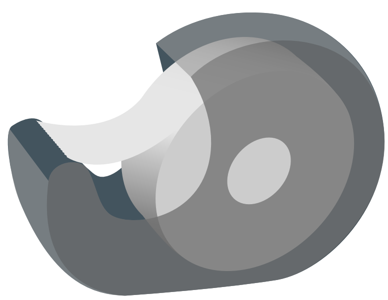


1 Half-Size Breadboard

1 Roll of Conductive Tape

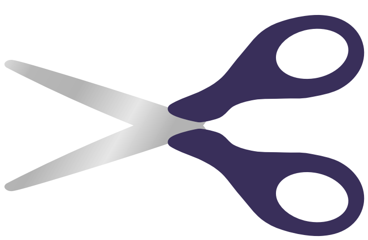


15 Colored LEDs

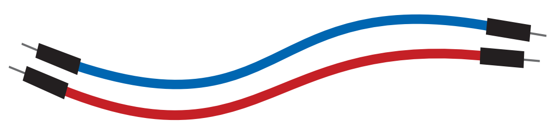


Some Clear Tape

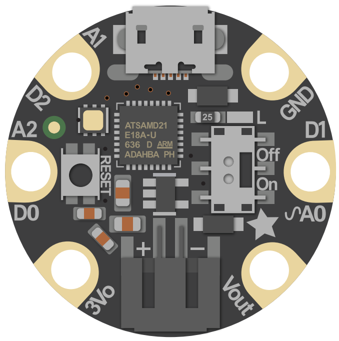
Some Paper Clips



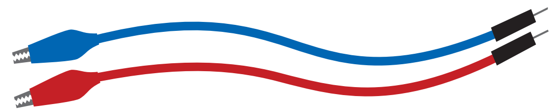
Pair of Scissors



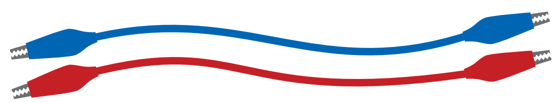
3 Jumper Wires



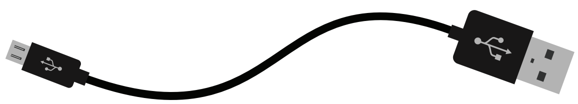
1 Adafruit Gemma M0



6 Alligator Clip to Jumper Wires

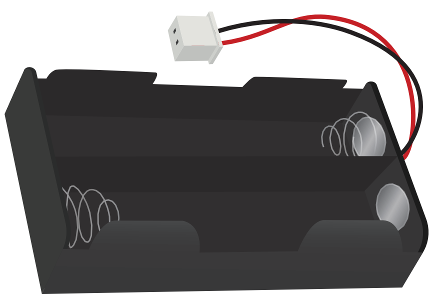


3 Alligator Clip Wires

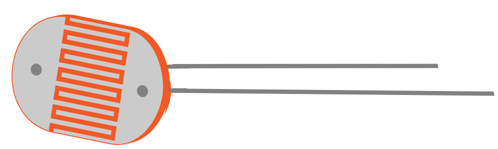


1 Micro USB Data Cable

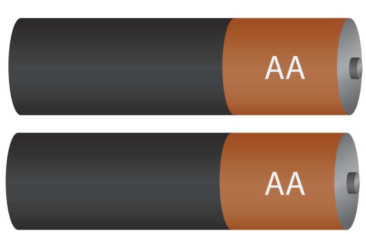
1 10 KΩ Resistor



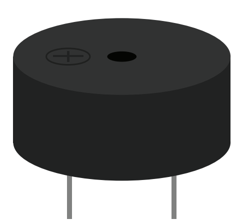
1 Battery Holder with JST Connector



1 Photoresistor



2 AA Batteries



1 Piezoelectric Buzzer

FOR THE FACILITATOR

The hands-on activities in this book introduce coding, microcontrollers, and sensors to circuitry projects. It is an interactive workbook designed to be a hands-on experience that accompanies computer coding and reading. The pages are full of opportunities for exploration and challenge young designers to problem-solve and think creatively and critically. The activities are meant to ignite a young person's curiosity and imagination, opening the mind to new possibilities and moving him or her to play, tinker, and explore.

Short tutorials and background information accompany investigations and challenges. The activities build on each other and are designed to allow youth to learn by doing. Challenges provide opportunities for solving problems with multiple possible solutions or with less obvious solutions. Each curriculum book becomes a completed workbook full of solved puzzles, met challenges, and creative light-up projects.

As a facilitator of these projects, encourage youth to use their troubleshooting and problem-solving skills and to learn from every situation. Even when there is a "power outage" there is something to be learned. The activities have been designed to promote creative design and encourage empowered learners. The materials offer opportunities for collaboration and support redesign.

This curriculum was written for youth in Grades 6 and higher, based on experience.

Each book in the Power Park series was written using the International Society for Technology in Education (ISTE) Standards for Students, Next Generation Science Standards (NGSS), and Common Core State Standards (CCSS) for Mathematical Practice as guidance.

STANDARDS EXPLICITLY ADDRESSED:

ISTE Standards For Students:

Innovative Designer

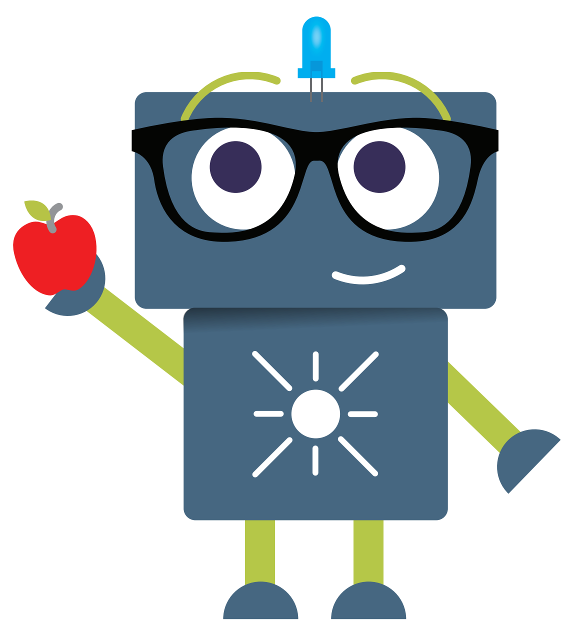
- Students develop, test and refine prototypes as part of a cyclical design process.
- Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

NGSS Science and Engineering Practices

- Asking questions *(for science)* and defining problems *(for engineering)*
- Planning and carrying out investigations
- Using mathematics and computational thinking
- Constructing explanations *(for science)* and designing solutions *(for engineering)*
- Obtaining, evaluating, and communicating information

CCSS for Mathematical Practices

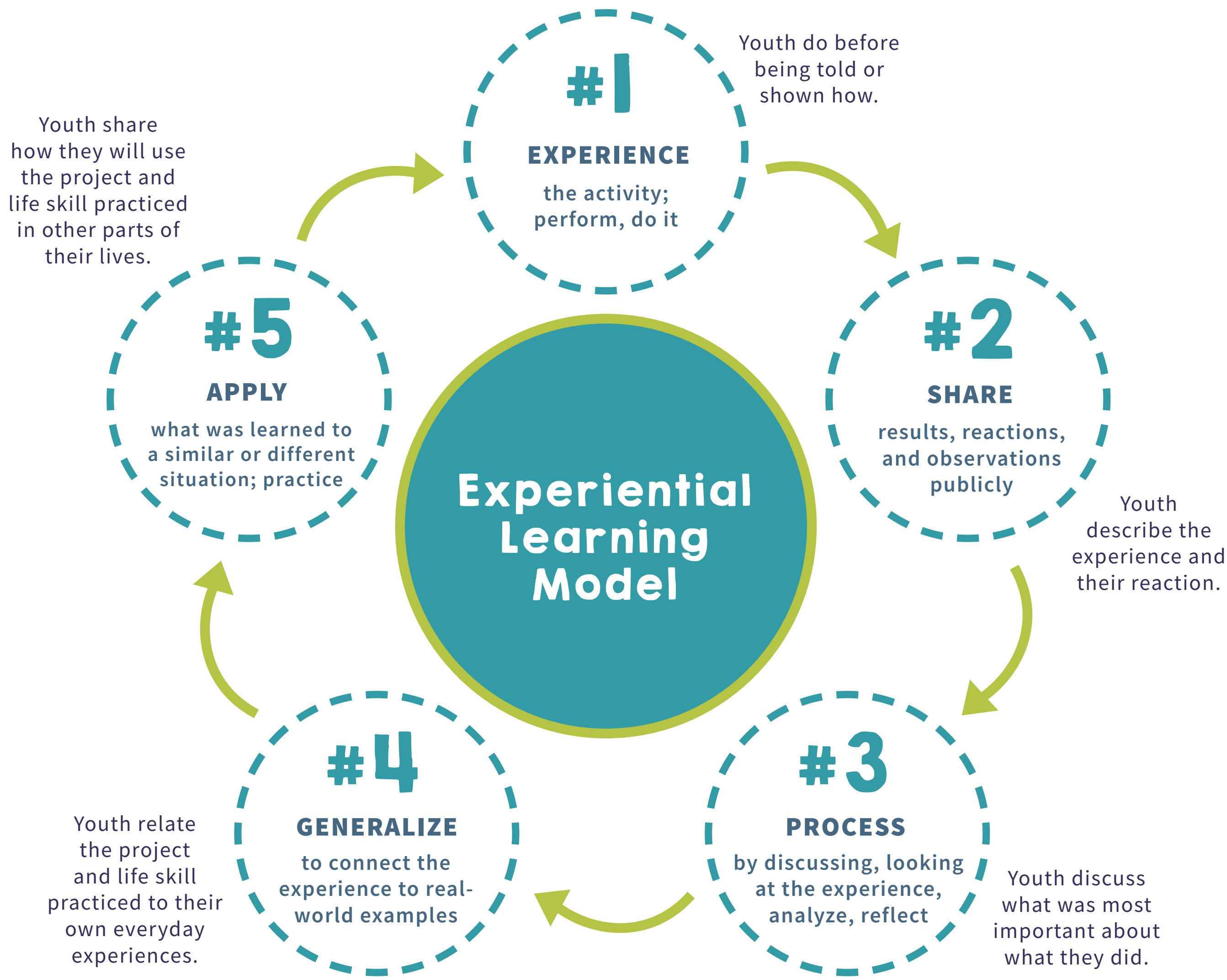
- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively
- **MP6:** Attend to precision



EXPERIENTIAL LEARNING

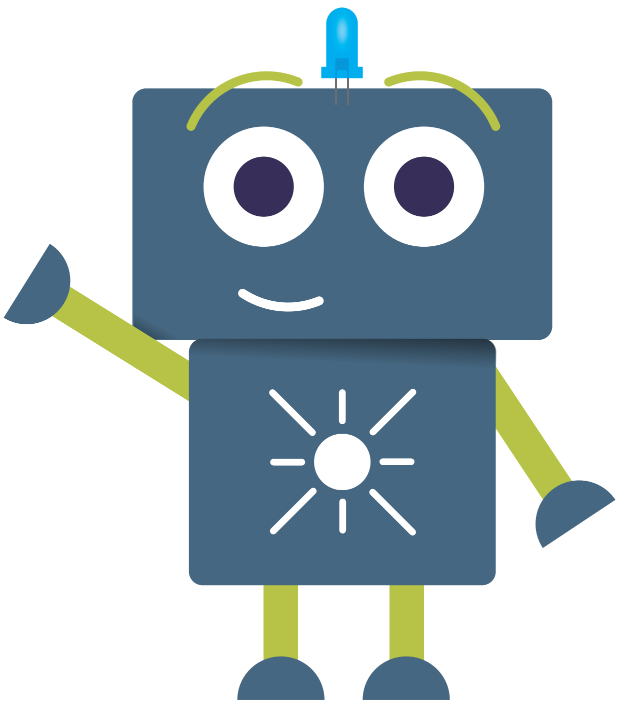
The **Experiential Learning Model of Instruction** provides learners an opportunity to become familiar with the content (**Experience**), explore a deeper meaning of the content (**Share and Process**), connect the learning to other examples or opportunities (**Generalize**), and apply it in real world situations.

The facilitator will guide youth through this process by helping them to focus on the activities, provide support and feedback for the learning, and debrief with them about their learning experience: what went well, what they could have done differently, what they could do next. This debriefing process fits hand-in-glove with the engineering design process used throughout the curriculum.



Pfeiffer, J.W., & Jones, J.E., “Reference Guide to Handbooks and Annuals”

WELCOME TO THE PARK



USING THIS BOOK

Welcome to the Power Park! I'm the friendly neighborhood robot.

This is an interactive workbook designed to give you a hands-on learning experience. You must do the activities to fully understand the concepts as you follow along.

Use the pages of this book for writing, taping, cutting, drawing, creating, and more!

- Describe your explorations.
- Record your thoughts and questions.
- Document images of your results.
- Challenge what you've learned.
- Create your own projects!

Create circuits in the blue dotted boxes.

Jot down notes and thoughts in the gray dotted boxes.

Pay attention to what the green boxes say!

Find interesting challenges in the blue boxes!

ABOUT THE POWER PARK SERIES

This series of three **Power Park** books provides opportunities to explore electrical circuits, power systems, sensors, coding, and microcontrollers. ***Explore a Power Park: Paper Circuits*** is an interactive notebook for investigating conductive tape circuits and alternative power sources. ***Design a Power Park: Smart Circuits*** introduces coding, microcontrollers, and sensors to circuitry projects. ***Build a Power Park: Lights On in the Neighborhood*** adds motors and controls to a three-dimensional neighborhood concluding with a carnival ride design challenge. These books invite you to create, explore, investigate, and tinker as you use science and engineering design to meet a series of challenges.