

# Unlocking Microcontroller Education:

Teaching Ethical Hacking On A Budget



# What Can We Unlock With Microcontrollers in Education?

- Ethical Hacking Lessons
- Keyboard Scripting
- Python for Hardware Control
- Rapid Prototyping
- Wi-Fi & Networking Lessons
- Soldering lessons
- Low Cost Beginner Kits
- Grant funding



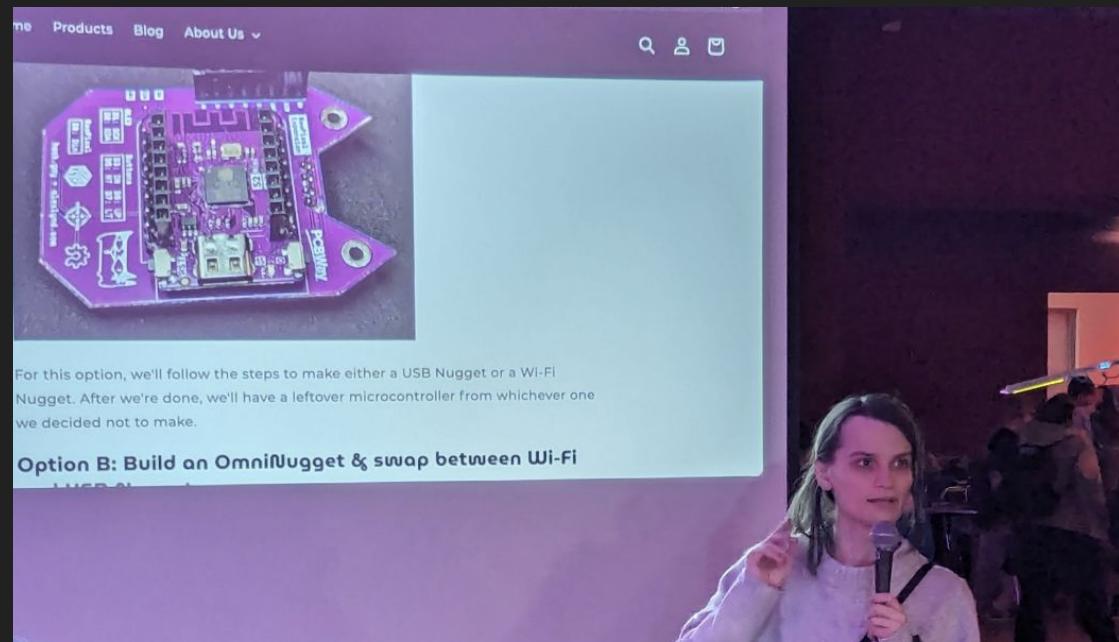
# Case Studies - Real-World Applications

- Null Space Labs Workshops
- Missoula Makerspace Classes
- Cyber Montana: Cybercat Academy



# Case Studies - This year

- 12 workshops in LA
- 7 workshops at C3
- 7 workshops in Montana,
- 1 week long cyber camp
- 75 hours of instruction time



# Who am I?

I'm Kody Kinzie

- Ethical hacker & educator
- Security researcher at Varonis
- Wi-Fi and open source intelligence specialist
- Creator of the Null Byte YouTube channel
- Host of Hak5 and SecurityFWD YouTube channels
- Designer of ethical hacking hardware tools



# Null Byte & Hak5

- Founded Null Byte Youtube
- Expanded Hak5 to cover hacking myths

The screenshot shows the YouTube channel page for "Null Byte". The channel has 916K subscribers and 231 videos. The description reads: "The official Null Byte channel for video content! We focus on creating videos for aspiring et... >" Below the description are links to "twitter.com/nullbyte" and "2 more links". A "Subscribed" button with a bell icon is visible. The main content area displays several video thumbnails:

- Thumbnail 1: A terminal window showing a search for phone numbers using various tools like grep, awk, and sort.
- Thumbnail 2: A terminal window titled "Things to do after installing Kali Linux" with a list of 10 items.
- Thumbnail 3: A terminal window titled "Hack Wi-Fi in seconds with Airgeddon" showing a command-line interface for attacking Wi-Fi.
- Thumbnail 4: A terminal window titled "Hunting Social Media Accounts with Sherlock" showing a list of targets.
- Thumbnail 5: A terminal window titled "Find information from a Phone Number Using OSINT Tools [Tutorial]".
- Thumbnail 6: A terminal window titled "The Top 10 Things to Do After Installing Kali Linux on Your Computer [Tutorial]".
- Thumbnail 7: A terminal window titled "Hacking Wi-Fi in Seconds with Airgeddon & Parrot Security OS [Tutorial]".
- Thumbnail 8: A terminal window titled "Hunt Down Social Media Accounts by Usernames Using Sherlock [Tutorial]".



Retia

Hak5

36 videos 11,563 views Last updated on Aug 27, 2022



The screenshot shows the YouTube channel page for "Hak5". The channel has 492K subscribers and 7.5K views. The description reads: "Hak5 • 492K views • 2 years ago". Below the description are links to "DEFEATING FACIAL RECOGNITION" and "How to use Postman to Reverse Engineer Private APIs". The main content area displays several video thumbnails:

- Thumbnail 15: A man in a red cap and black t-shirt sitting at a desk with a laptop, titled "Wi-Fi Half Handshake".
- Thumbnail 16: A man in a red t-shirt sitting at a desk with a laptop, titled "APIs".
- Thumbnail 17: A man in a black t-shirt sitting at a desk with a laptop, titled "Android Studio".
- Thumbnail 18: A man in a black t-shirt sitting at a desk with a laptop, titled "HakByte: Use Android Studio to Learn Android App Security Part 2".

# Raspberry Pi to the world of microcontrollers

- Only teach free or low-cost builds
- Limit to less than \$60
- Raspberry Pi ideal platform
- Perfect for teaching Linux, Networking, Python



Set Up an Ethical Hacking Kali Linux Kit on the Raspberry Pi 3 B+ [Tutorial]



Subscribed

38K



Share

Download

1.7M views 5 years ago

Earn \$\$: Learn What You Need to Get Certified (90% Off): <https://nulb.app/cwlshop>

How to Load Kali onto the Pi 3 Model B+ ...more

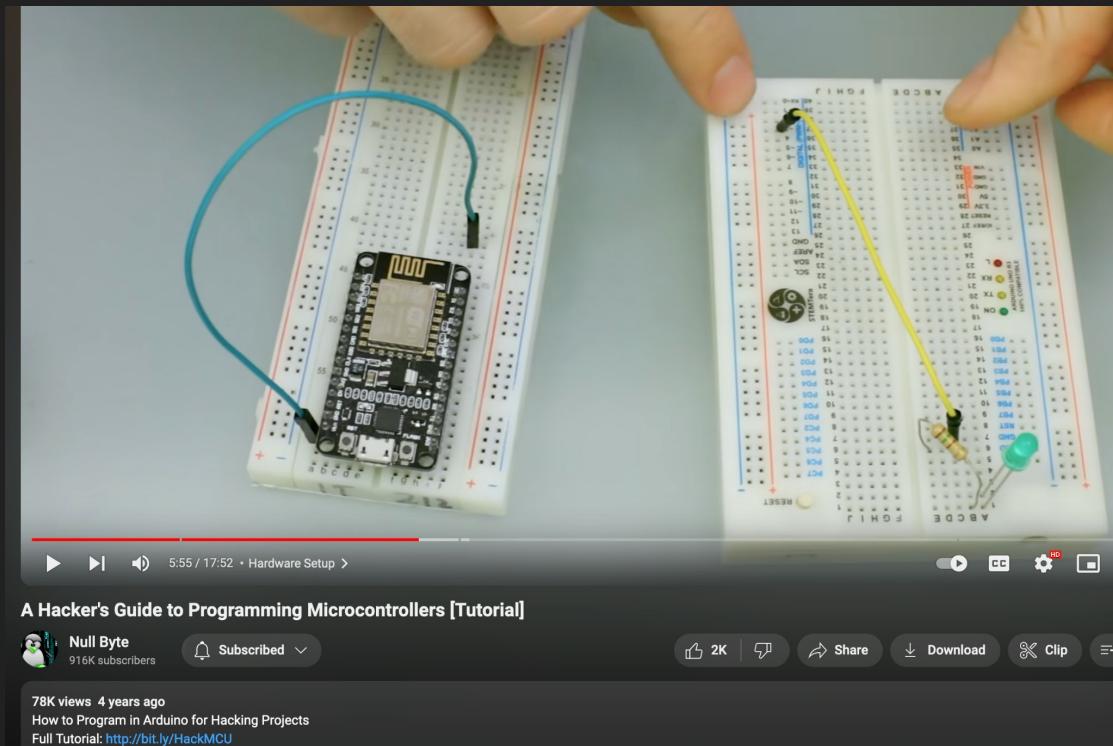
# Introduction to Microcontrollers

- Pasadena City College
- Also called “School of Worf” (actor Michael Dorn went here)
- Electrical engineering
- Hands-on projects appealed to me
- Manufacturing Industrial Technology, PCB Design, Arduino



# Experience in teaching

- Started teaching 4 years ago
- CTF's and workshops at PCC and LayerOne
- Discouraging for beginners
- Hard on instructors



# Challenges in Teaching Microcontrollers

- Every OS has a different software for serial, programming, flashing
- Kills class momentum when students have random errors
- No one solution works for everyone - OS Specific
- More assumptions = worse time

# Designing microcontroller workshops



# Why are microcontroller classes hard?

- Complicated setups
- Compiled language issues
- Classroom hardware struggles
- BIOS settings
- Serial terminal ease of use

# The Assumptions of Arduino classes

We assume everyone can:

- 1) **Access their serial ports (#1 issue)**
- 2) Work with a command line interface
- 3) Get a compiler working
- 4) Flash to the microcontroller
- 5) Install Arduino, import libraries and boards
- 6) Has a good USB cable
- 7) Enjoys the above



# The Game Changers

 WebSerial

Type here

Send



# CircuitPython



- Interpreted Python for hardware
  - Flash once, never compile
  - Easy to control hardware
  - Drag and drop/text editor
  - Easy for beginners to learn
  - Experience is smooth
  - Some limitations will frustrate experienced devs

A photograph of a MacBook Air laptop displaying a Python code editor. The screen shows a script titled 'main.py' with code for a NeoPixel LED strip. To the left of the laptop, a custom-built electronic device resembling a lightsaber hilt is connected to the laptop via a USB cable. The device has a silver cylindrical body with blue glowing sections and a small orange button. The laptop screen displays the Python code editor interface with various toolbars and a code editor window showing the following Python script:

```
color = (0, 100, 255) # Cyan
# CUSTOMIZE SENSITIVITY HERE: smaller numbers = more sensitive to motion
ht_threshold = 350 # 250
skew_threshold = 125
# NeoPixel strip
num_pixels = 114
red_pin = board.D11
green_pin = board.D12
blue_pin = board.D13
switch_pin = board.D10
enable = DigitalInOut(board.D9)
enable.direction = Direction.INPUT
enable.value = False
red_led = DigitalInOut(board.D11)
red_led.direction = Direction.OUTPUT
green_led = DigitalInOut(board.D12)
green_led.direction = Direction.OUTPUT
blue_led = DigitalInOut(board.D13)
blue_led.direction = Direction.OUTPUT
audio = audioio.AudioOut(board.A0) # Speaker
mode = 0 # Initial mode = OFF
strip = neopixel.NeoPixel(red_pin, num_pixels, brightness=.1, auto_write=False)
strip.show()
switch = DigitalInOut(switch_pin)
switch.direction = Direction.INPUT
```

# Introduction to WebSerial



Source: randomnerdtutorials.com

# WebSerial Impact on Programming

Now, this can all be done from the browser:

- Flashing a microcontroller with a compiled BIN file
- Communicating with the microcontroller over serial
- Project organization
- Flashing and learning on the same website

Select Binary to Flash x

---

**USB Nugget**  
A versatile USB attack platform that lets you hack computers in seconds.

✓ Selected

---

**Packet Monitor**  
A simple GUI & serial interface tool to monitor WiFi packets, using the ESP32S2 WiFi microcontroller.

Select Binary

---

**Circuit Python**  
Current, working Circuit Python binary to flash to the USB Nugget. Circuit Python is a simple implementation of the Python programming language that is optimized for microcontrollers.

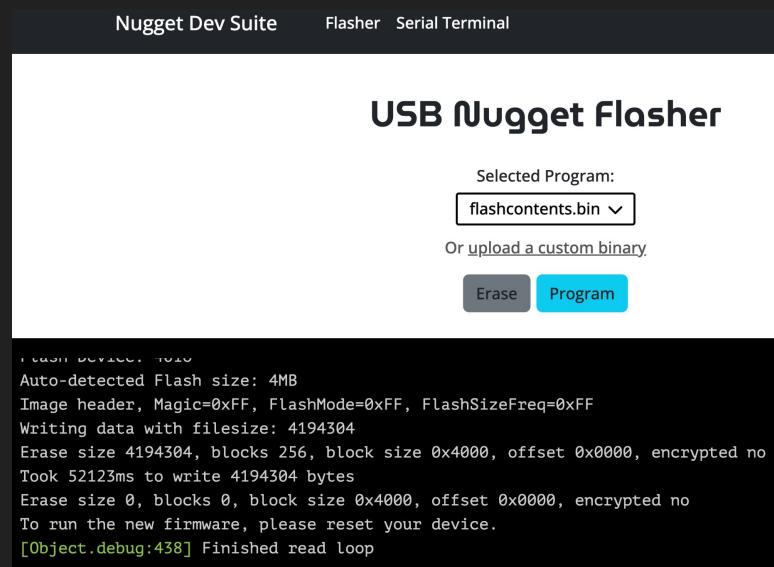
Select Binary

---

**WLED**  
Current, working WLED binary to flash to the USB Nugget. WLED is a webserver to control NeoPixel (WS2812B, WS2811, SK6812) LEDs.

# Now We Can Make Fewer Assumptions

- The student has Chrome
- The student has a data USB Cable
- Everyone can access their serial ports\*



\*Serial ports are still sometimes an issue

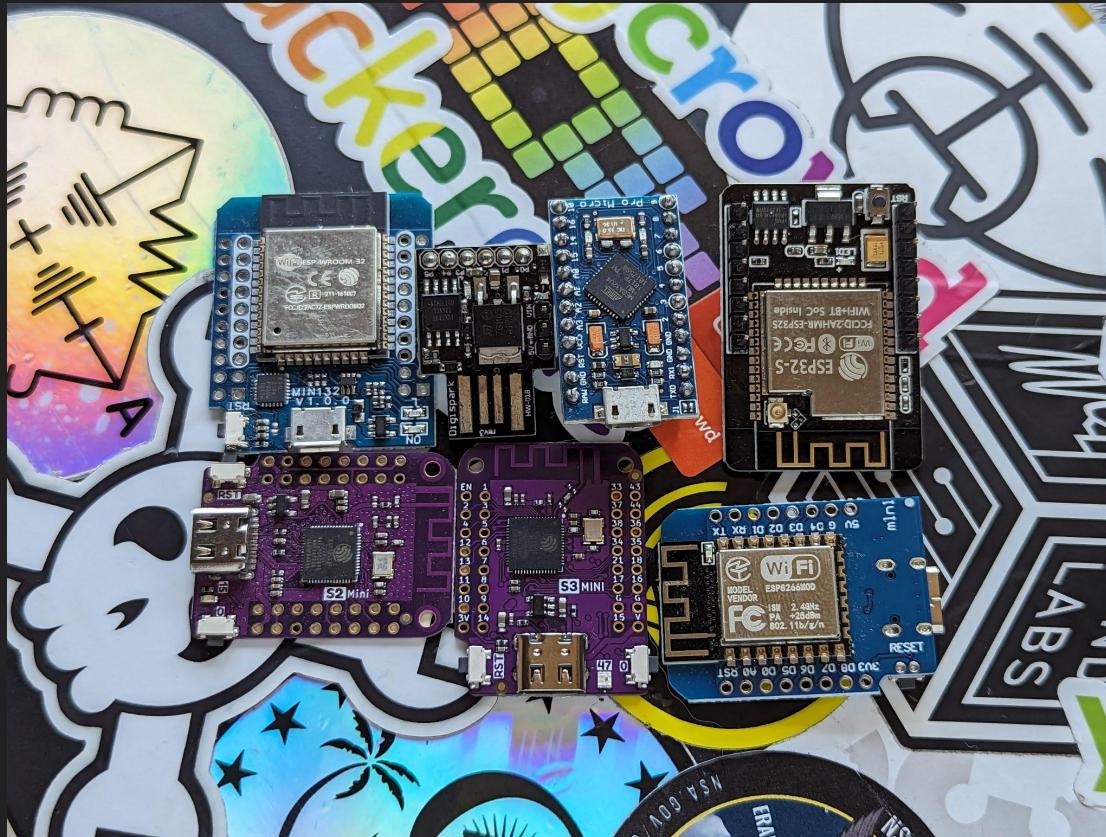
# Focus on Microcontrollers for Beginners

WebSerial opens up microcontrollers to new demographics



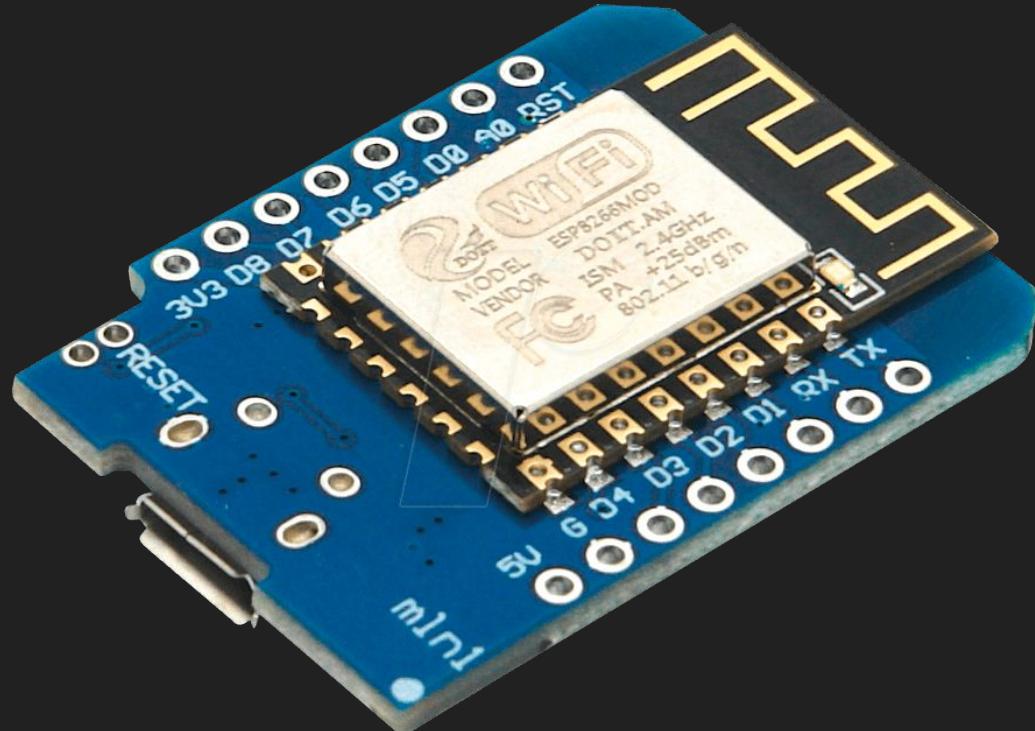
# Overview of beginner-friendly microcontrollers:

- esp8266
- esp32s2
- esp32s3
- Pi Pico
- Pi Pico W



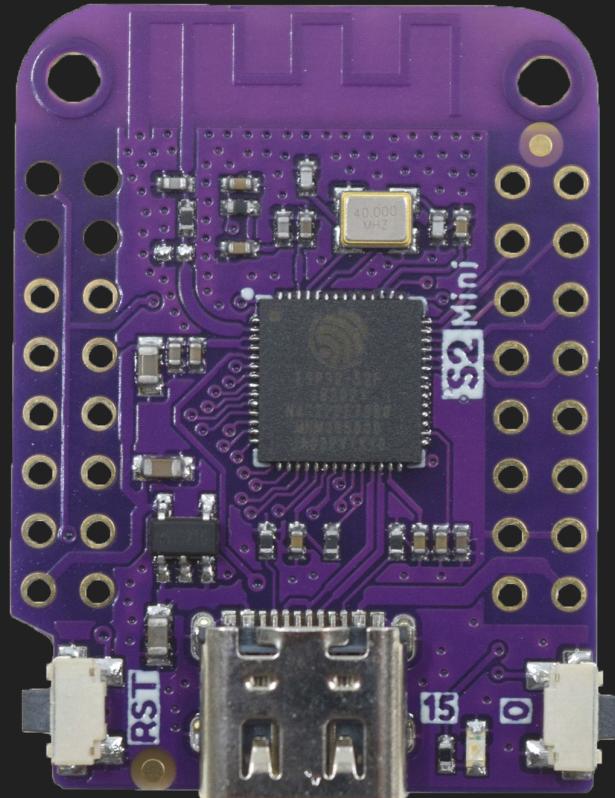
# ESP8266

- No native USB
  - Supports projects like WLED
  - Wi-Fi support
  - Supports packet injection
  - Only can see Wi-Fi packet metadata (no handshakes)
  - Arduino, MicroPython
  - No CircuitPython



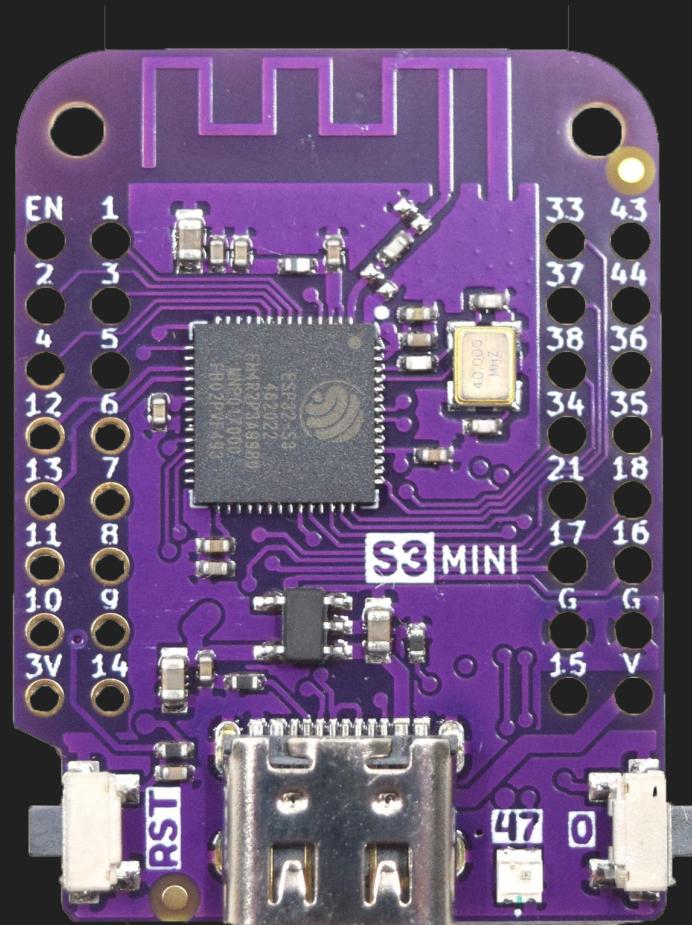
# ESP32s2

- Native USB, mounts as USB drive
- CircuitPython, Arduino, MicroPython Support
- No Packet Injection
- Perfect for HID/BadUSB attacks
- Has Wi-Fi, but does not support several types of attacks
- Single core



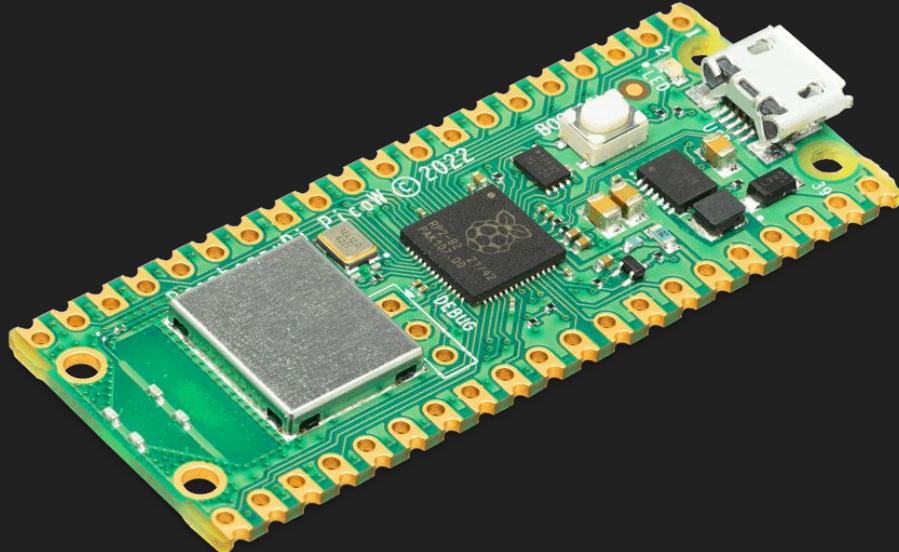
# ESP32s3

- Native USB, mounts as USB drive
- CircuitPython, Arduino, MicroPython Support
- No Packet Injection
- Perfect for HID/BadUSB attacks
- Has Wi-Fi, but does not support several types of attacks
- Dual core
- Supports Bluetooth!

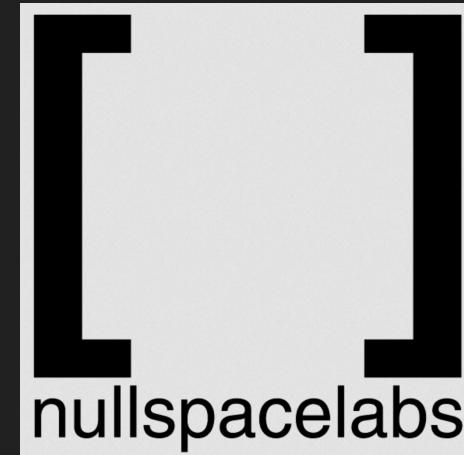
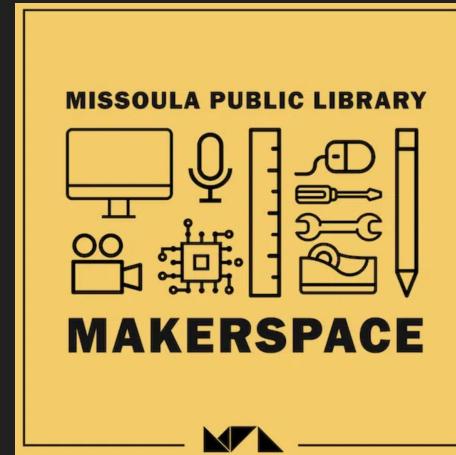


# Pi Pico/Pi Pico W

- Native USB, mounts as USB drive
- CircuitPython, Arduino, MicroPython Support
- No Packet Injection
- Perfect for HID/BadUSB attacks
- Has Wi-Fi, but does not support several types of attacks
- Single core



# Partners This Year



SAN FRANCISCO  
STATE UNIVERSITY

# 5 Day Cybercat Academy Camp



# Funded By \$15K Cyber Montana Grant

## Cyber STEM Summer Camp 2023 Locations

Montana's 2023 Cyber STEM Summer Camps exceeded expectations! State-wide participation has been growing as camps explored cybersecurity knowledge with our future cybersecurity leaders across the state. Information on 2024 STEM summer camps will be available after the new year.



K-12 Education ▾ Degrees & Certifications ▾

## The State Hub for Cyber Workforce Education

*Grow your cybersecurity skills with us in Montana.*

# How I Got The Grant

- Step 1: Do multiple free classes at the library
- Step 2: Invite entire board of Cyber Montana to classes
- Step 3: Repeat steps 1 and 2 until you get a grant



Sales Ended

Saturday, November 18

## Cat Got Your Password: A Wi-Fi Hacking Self-Defense Workshop

Part of the Kody Kinzie Collection collection

Join us for this fun and engaging Makerspace workshop on Wi-Fi cybersecurity, and leave with your own free hardware! (Registration required)

By MPL Makerspace

17 followers

Follow

Sales Ended

Explore similar events

# Schedule: Insanity

- Really did it this time
- 5 days, 5 hours each

1	Name	Day	Start Time	End Time	Subject	Description	Slides link
2	Areza/Kody	Day 1	9:00 AM	10:30 AM	Ethics - What makes ethical hacking ethical?	Explore ethical hacking principles, legal considerations, & how to report a problem	<a href="https://docs.google.com/presentation/d/1Ci6tzl03WEhUWeBp3KYgOJ257-koqkVfEOcqmWd4CEE/edit">https://docs.google.com/presentation/d/1Ci6tzl03WEhUWeBp3KYgOJ257-koqkVfEOcqmWd4CEE/edit</a>
3	David/Areza	Day 1	10:30 AM	12:00 PM	Hands On Online Privacy & Anonymity with Canarytokens	Learn how to protect your privacy online and see how sites track you	<a href="https://docs.google.com/presentation/d/1LYKHM2ncE1rkul-iiZvZAHI2M5qkljZXlxhotjMOP0/edit?pli=1#slide=id.g258756c45fa_1_65">https://docs.google.com/presentation/d/1LYKHM2ncE1rkul-iiZvZAHI2M5qkljZXlxhotjMOP0/edit?pli=1#slide=id.g258756c45fa_1_65</a>
4		Day 1	12:00 PM	1:00 PM	Lunch and break	Enjoy lunch and take a break.	
5	Mychal	Day 1	1:00 PM	2:00 PM	How to find anything: Google dorking, databases, & more!	Learn how to use search engines to find hidden information online	<a href="https://docs.google.com/presentation/d/1QeF6nKhkB2lsUldp4aUxUGdtm_iZfpI0lyBy3nuQvX8/edit?usp=sharing">https://docs.google.com/presentation/d/1QeF6nKhkB2lsUldp4aUxUGdtm_iZfpI0lyBy3nuQvX8/edit?usp=sharing</a>
6	Kody	Day 1	2:00 PM	3:00 PM	Sample OSINT Investigation - Use your research skills to solve challenges!	Research challenge to discover business, location, and owner information	
7		Day 1	3:00 PM	4:00 PM	Q&A and awards for the day	Discuss the day's activities and present awards.	

# Schedule: Insanity

## Day 2

Areza	Day 2	9:00 AM	10:30 AM	AI CTF - <a href="https://gandalf.lakera.ai">https://gandalf.lakera.ai</a>	Learn to defeat a Large Language Model like chatGPT.	<a href="https://docs.google.com/presentation/d/1DqmgZXxuKzGjtMmTzu9zrqiV7kcA1p0bxi-6LksOlo">https://docs.google.com/presentation/d/1DqmgZXxuKzGjtMmTzu9zrqiV7kcA1p0bxi-6LksOlo</a>
David	Day 2	10:30 AM	12:00 PM	Network Foxhunt - Use Nmap to find a hidden web server	Use networking tools to hunt a secret web server	<a href="https://docs.google.com/presentation/d/1QYY7Nhuf6taOQRvl_rHrFluEUXliXEk5wPAAn00ZDq8/edit#slide=id.g231213c81d4_0_184">https://docs.google.com/presentation/d/1QYY7Nhuf6taOQRvl_rHrFluEUXliXEk5wPAAn00ZDq8/edit#slide=id.g231213c81d4_0_184</a>
	Day 2	12:00 PM	1:00 PM	Lunch and break	Enjoy lunch and take a break.	
Kody	Day 2	9:00 AM	10:30 AM	Electronics basics and Breadboarding	Learn soldering techniques and breadboard a circuit	<a href="https://docs.google.com/presentation/d/1J5sa_MOrt99IEPc6OO1ME_XW-cSyXcgWmkQC6yKf0A/edit?usp=sharing">https://docs.google.com/presentation/d/1J5sa_MOrt99IEPc6OO1ME_XW-cSyXcgWmkQC6yKf0A/edit?usp=sharing</a>
Areza/Kody	Day 2	10:30 AM	12:00 PM	Soldering RGB Meow Mixer Boards	Assemble and solder a RGB Meow Mixer Board	<a href="https://docs.google.com/presentation/d/1PTFcP3rpRp8Or7oHsg_oV4RlgkyeCJIPZFLdVad1aY">https://docs.google.com/presentation/d/1PTFcP3rpRp8Or7oHsg_oV4RlgkyeCJIPZFLdVad1aY</a>
	Day 2	3:00 PM	4:00 PM	Closing awards and best solutions	Recognize outstanding achievements and solutions.	

## Day 3

Mychal	Day 3	9:00 AM	10:30 AM	Visualize the invisible world of Wi-Fi with airgraph-ng	Create maps of the Wi-Fi work and learn about Wi-Fi relationships	<a href="https://docs.google.com/presentation/d/1J0jyvIjBhXnUuXWzJzXU2atJXabiBh">https://docs.google.com/presentation/d/1J0jyvIjBhXnUuXWzJzXU2atJXabiBh</a>
Kody	Day 3	10:30 AM	12:00 PM	Cat got your password - Learn Wi-Fi Password Security CTF	Learn why strong Wi-Fi passwords matter with a fun CTF	
	Day 3	12:00 PM	1:00 PM	Lunch and soldering catch-up	Enjoy lunch and catch up on soldering tasks.	
Mychal	Day 3	1:00 PM	2:00 PM	Assembling a 3d printed IoT lightbox	Assemble a 3d printed, IoT lightbox!	<a href="https://docs.google.com/presentation/d/1JSExyo8YFyGIm5J8cn7JzX-U2atJXabiBhnUcB2ESE/edit?usp=drive_link">https://docs.google.com/presentation/d/1JSExyo8YFyGIm5J8cn7JzX-U2atJXabiBhnUcB2ESE/edit?usp=drive_link</a>
David	Day 3	2:00 PM	3:00 PM	Programming and customizing 3d printed lightbox	Flash and connect IoT light box to Wi-Fi and play animations	
	Day 3	3:00 PM	4:00 PM	Q&A and awards for the day	Discuss the day's activities and present awards.	

# Schedule: Insanity

## Day 4

Mychal	Day 3	9:00 AM	10:30 AM	Visualize the invisible world of Wi-Fi with airgraph-ng	Create maps of the Wi-Fi work and learn about Wi-Fi relationships	<a href="https://docs.google.com/presentation/d/1Jt0Yuf4tKgVCjK_ai53McTz4c7fwXSaxphBc_0_24/edit#slide=id.g23140990909ec_0_24">https://docs.google.com/presentation/d/1Jt0Yuf4tKgVCjK_ai53McTz4c7fwXSaxphBc_0_24</a>
Kody	Day 3	10:30 AM	12:00 PM	Cat got your password - Learn Wi-Fi Password Security CTF	Learn why strong Wi-Fi passwords matter with a fun CTF	
	Day 4	12:00 PM	1:00 PM	Lunch and break	Enjoy lunch and take a break.	
David	Day 3	1:00 PM	2:00 PM	Programming and customizing 3d printed lightbox	Flash and connect IoT light box to Wi-Fi and play animations	<a href="https://docs.google.com/presentation/d/1OYuf4tKgVCjK_ai53McTz4c7fwXSaxphBc_0_24/edit#slide=id.g23140990909ec_0_24">https://docs.google.com/presentation/d/1OYuf4tKgVCjK_ai53McTz4c7fwXSaxphBc_0_24</a>
Kody	Day 4	2:00 PM	3:00 PM	Learning USB Scripting with Catscratch & the USB Nugget	Learn to script simple keyboard and mouse actions with Catscratch	<a href="https://docs.google.com/presentation/d/1am_eykzUBb27MEG75feaTEYJtwplDTJ3R5sDu9AA5U/edit?usp=sharing">https://docs.google.com/presentation/d/1am_eykzUBb27MEG75feaTEYJtwplDTJ3R5sDu9AA5U/edit?usp=sharing</a>
	Day 4	3:00 PM	4:00 PM	Q&A and awards for the day	Discuss the day's activities and present awards.	

## Day 5

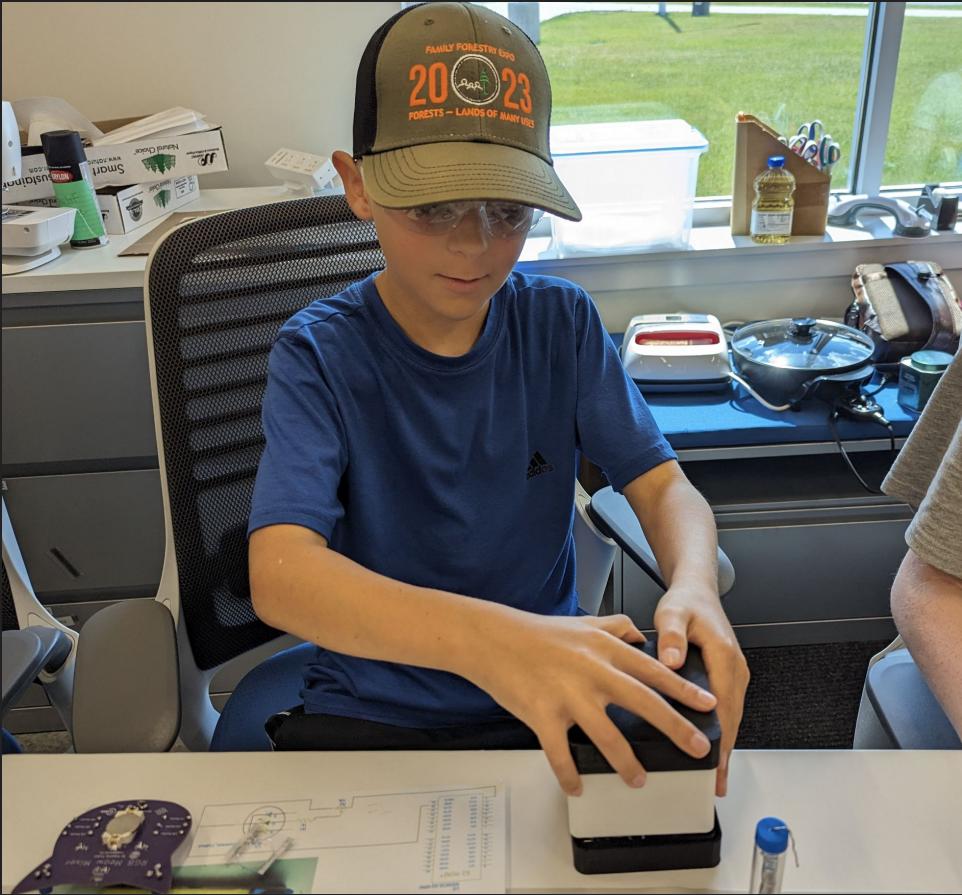
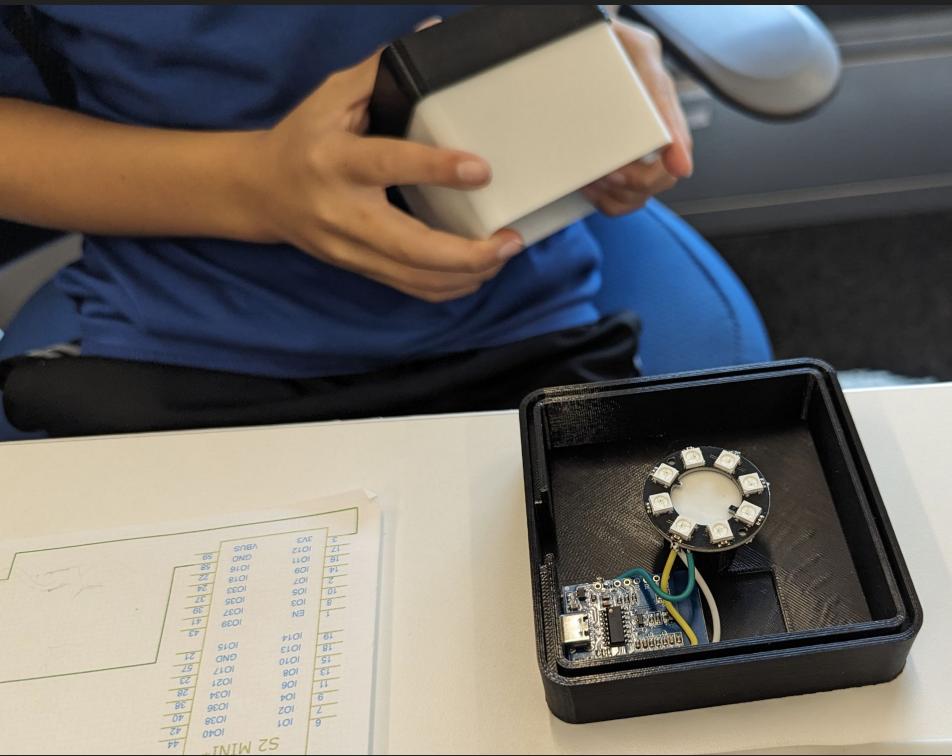
David	Day 4	9:00 AM	10:30 PM	CTF Game - Hack the Raspberry Pi with Catscratch!	Write a script to automate actions on a Raspberry Pi for points	<a href="https://docs.google.com/presentation/d/1am_eykzUBb27MEG75feaTEYJtwplDTJ3R5sDu9AA5U/edit?usp=sharing">https://docs.google.com/presentation/d/1am_eykzUBb27MEG75feaTEYJtwplDTJ3R5sDu9AA5U/edit?usp=sharing</a>
Areza	Day 4	10:30 AM	12:00 PM	Python on hardware basics: Introduction to CircuitPython	Use Python on microcontrollers to program LED's	<a href="https://docs.google.com/presentation/d/1xBerSY1dBQBwMyMgD7nTwzQkz05S2GtPxXE_gFNrdJlk/">https://docs.google.com/presentation/d/1xBerSY1dBQBwMyMgD7nTwzQkz05S2GtPxXE_gFNrdJlk/</a>
	Day 5	12:00 PM	1:00 PM	Lunch and break	Enjoy lunch and take a break.	
Areza	Day 5	1:00 PM	2:00 PM	Wi-Fi Hacking 101 - What do common attacks look like?	Learn about Wi-Fi networks and common attack methods.	<a href="https://docs.google.com/presentation/d/1R">https://docs.google.com/presentation/d/1R</a>
Mychal	Day 5	2:00 PM	3:00 PM	Challenge: Foxhunting - Locate a hidden Wi-Fi device by signal strength	Learn to track down a suspect Wi-Fi network or client by signal strength	
	Day 5	3:00 PM	4:00 PM	Q&A and awards for the day	Discuss the day's activities and present awards.	<a href="https://docs.google.com/presentation/d/14ugER0seXYxedr_H40rAVy00urgGkaKRJMEI67aws/edit?usp=sharing">https://docs.google.com/presentation/d/14ugER0seXYxedr_H40rAVy00urgGkaKRJMEI67aws/edit?usp=sharing</a>

# Barriers

- Ethics - Teachers had a lot of concerns
- Addressed concerns during meeting with ethics plan
- School wanted to take more of the grant
- Negotiated a middle ground for funding
- Getting the grant was complicated
- A lot of back and forth and cost spreadsheets
- Helpers were hard to find, several that were referred by the college flaked

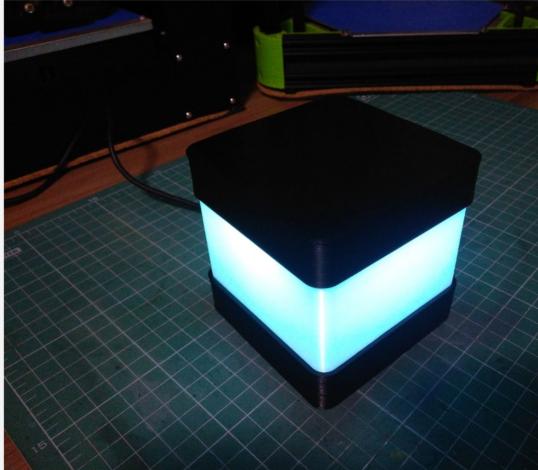


# \$5 3D Printed Builds

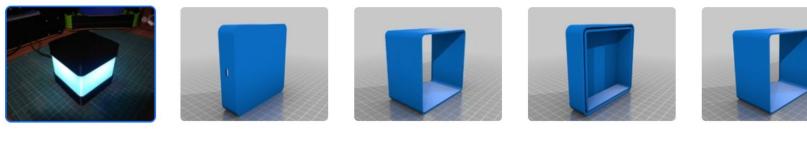


# IoT Light Boxes with WLED

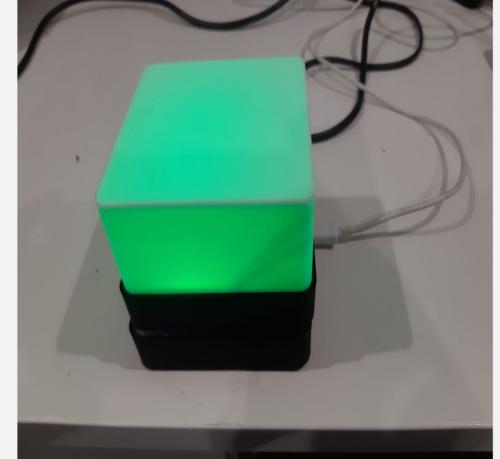
UltiMaker Thingiverse https://www.thingiverse.com/thing:2078139 120%  Light Cube  
mccarmo February 01, 2017



◀ ←



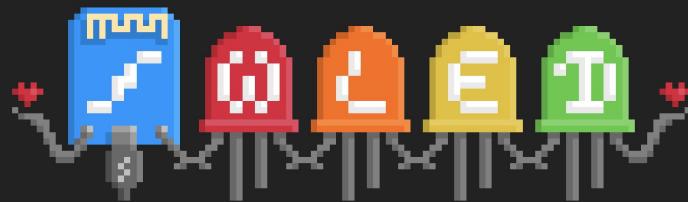
UltiMaker Thingiverse https://www.thingiverse.com/thing:3859506 120%  Wireless Powered Light Cube  
andrewsofia September 13, 2019 



◀ ←



# Parts Are Very Cheap



## Welcome to the WLED web installer!

1. Plug in your ESP to a USB port. We will install WLED 0.14.1-b1 to it.
2. Hit "Install" and select the correct COM port. [No device found?](#)
3. Get WLED installed and connected in less than 3 minutes!

0.14.1-b1

Plain Audioreactive Ethernet

Install

Powered by [ESP Web Tools](#)  
[GitHub](#) [kno.wled.ge](#)

## Completed

TSTAR TECH Store > [...](#)



100pcs D1 mini - Mini NodeMcu 4M bytes Lua WIFI Internet of Thin...

\$188.00 x2

## Completed

SAMIORE Store > [...](#)



RGB LED Ring 1Bit 8Bit 12Bit 16Bit 24Bit WS2812 5050 RGB LED + Integ...

8 Bit WS2812

\$0.46 x50

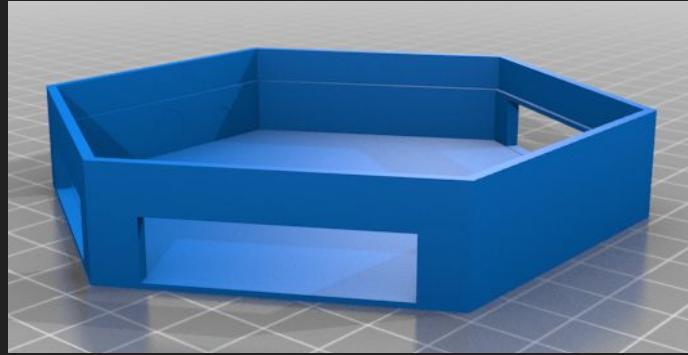
Fast Delivery

# Winning Strategy:

- Use printers at a makerspace, college, or other host
- Provide filament, get finished parts for the workshop
- Use low-cost parts to make simple IoT devices
- Teach soldering, flashing, and use for ethical hacking target
- Teach networking tools to locate box on Wi-Fi
- Some candy for “finding” their lost Nugget on the network
- Use Warm White for diffusers - NOT cold white

# Future Modifications:

- Hexleaf Project on Thingiverse
- Use even cheaper LED strips
- First time at C3!



# Beginner-Focused Microcontroller Dev Boards

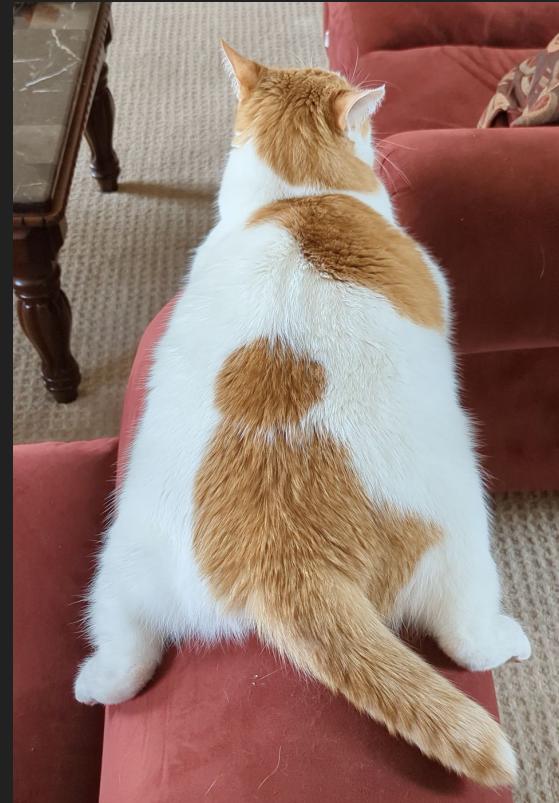
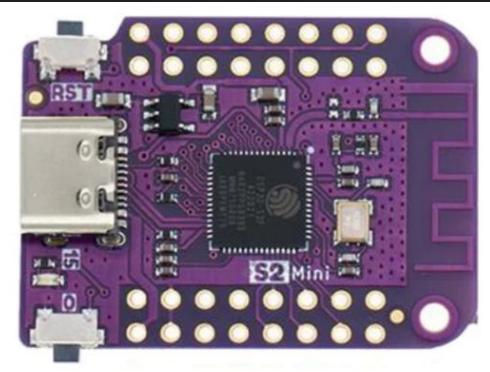
The USB Nugget is a hardware tool that makes it easy for beginners to learn **hacking techniques and hardware development!**

## Features:

- Built-in screen
- RGB LED
- 4 D-Pad style buttons
- WiFi Microcontroller
- Plug-and-play expansion pins

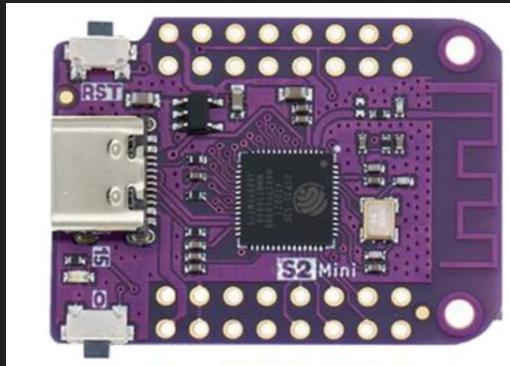


# What's The Inspiration?



# What's under the hood?

The USB Nugget is powered by the ESP32s2, a Wi-Fi enabled microcontroller



## ESP32-S2 Features

ESP32-S2 is a highly integrated, low-power, single-core Wi-Fi Microcontroller SoC, designed to be secure and cost-effective, with a high performance and a rich set of IO capabilities.



### Unparalleled Security for Your Connected Devices

- RSA-3072-based secure boot
- AES-128/192/256-XTS-based flash encryption
- Protected private key and device secrets from software access
- Cryptographic accelerators for enhanced performance
- Protection against physical fault injection attacks



### Display, Touch Capabilities and Rich IO

ESP32-S2 integrates a rich set of peripherals, with 43 programmable GPIOs which can be flexibly configured to provide USB OTG, LCD interface, camera interface, SPI, I2S, UART, ADC, DAC and other common functionality. With LCD interface and 14 configurable capacitive touch GPIOs, ESP32-S2 provides the optimal HMI solution for touchscreen and touchpad-based devices.



### Solid Wi-Fi Performance at Extreme Temperatures

ESP32-S2's operating temperature ranges from -40 to +125 degrees Celsius, thus facilitating a variety of industrial, consumer and lighting applications.

# What can the USB Nugget do?

- Run USB Attacks
- Teach programming
  - CircuitPython
  - Arduino
- Control Hardware / Sensors
- Run Community Projects
- Display cute animations!



# What is the USB Nugget OS software?

The USB Nugget is a program that lets you run USB Attacks in seconds using the USB Nugget!

## Current Features:

- CatScratch Compatible
- Built-in flash drive storage
- Quick Payload deployment
- WiFi Control
- Built in Demos!



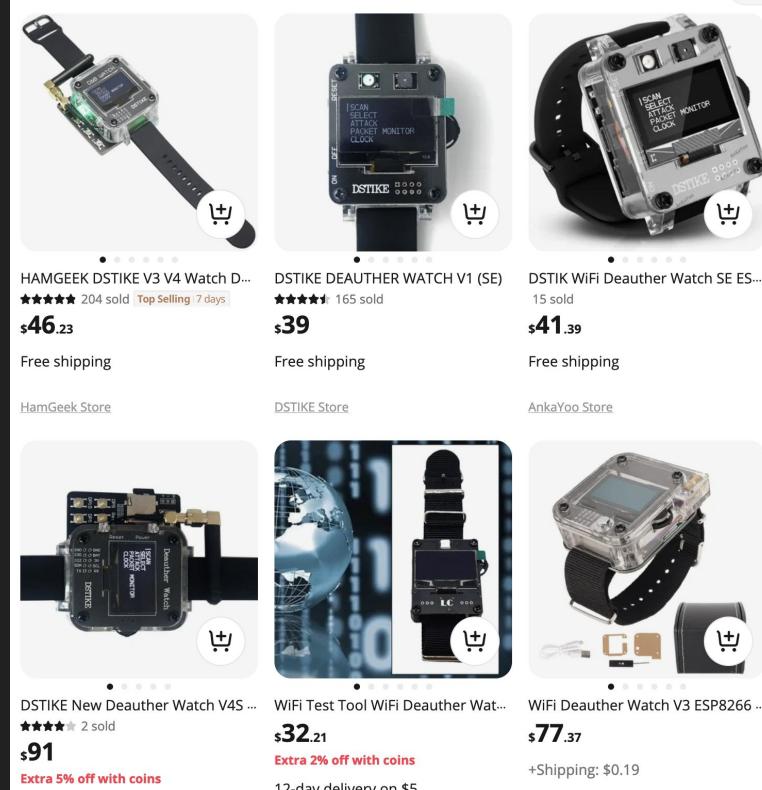
# Concept, Design, & Functionality

- Break out microcontrollers to be more useful for teaching
- Design is cute, cat-themed, & beginner friendly
- Simple, but not utilitarian or weaponized
- Built in basic components needed for prototyping



# Inspiration: Deauther Watch

- Most successful deauther variant
- Main functions available without computer
- Form factor makes beginners comfortable
- Base microcontroller is more useful
- Fragile, battery is hard to ship, bulky
- Not a great watch, but on to something



# Designing Educational Experiences: Nugget.dev

Find available projects, flash them, and communicate with boards all in one place.



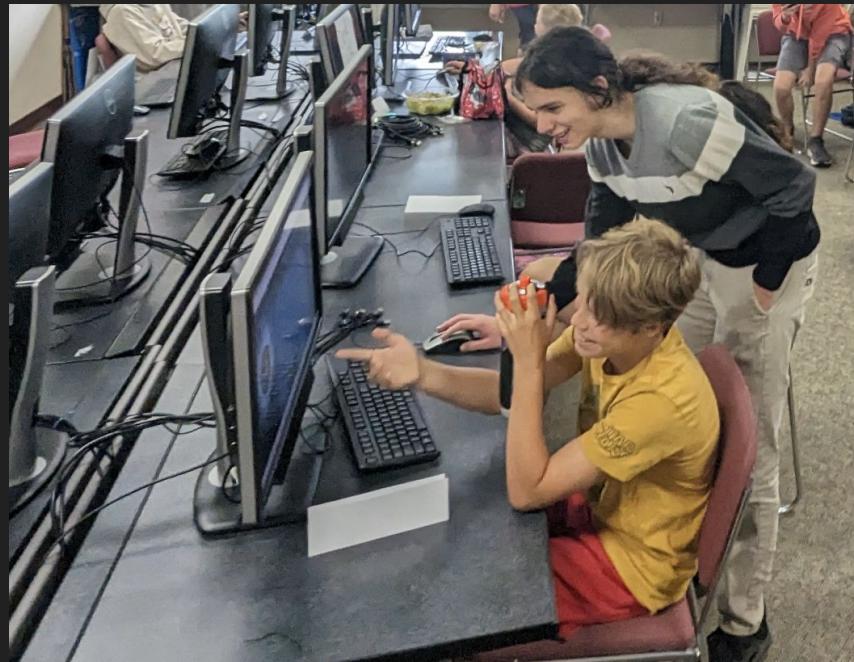
## Nugget Dev Suite

Developer Site for the Nugget: A Cat-Shaped Hacking Tool

CONNECT YOUR NUGGET

# Result: Cat-ch Up In 3 Minutes

When someone arrives late to a hardware class, our helpers can get them caught up in 3 minutes or less on average.



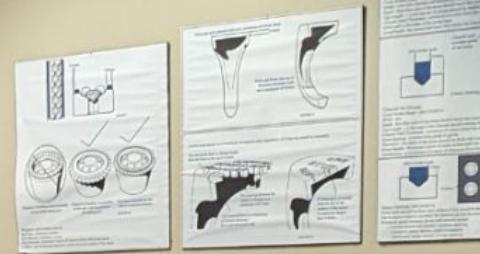
# Bad-USB Scripting Class

## Basic CatScratch Commands

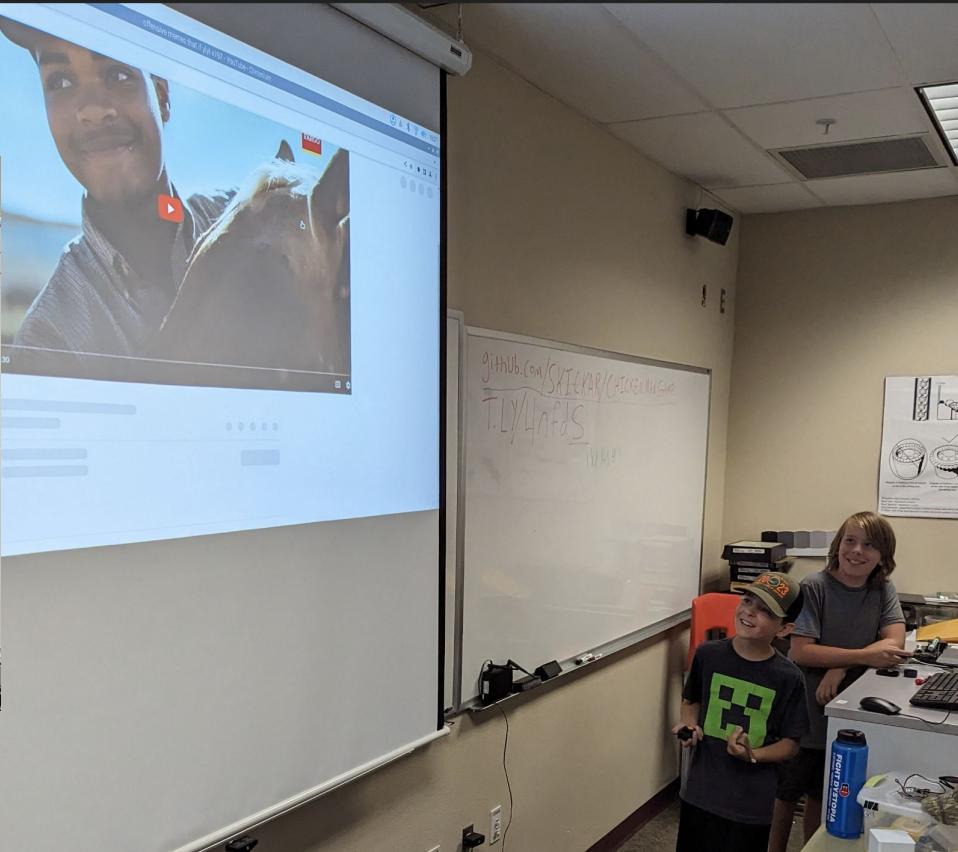
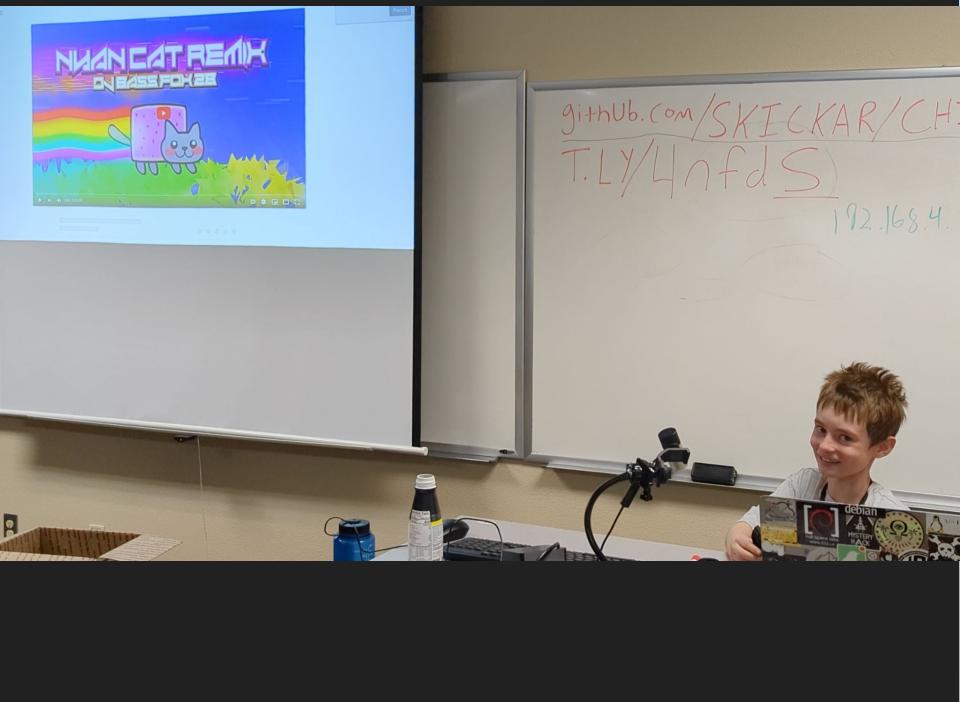
<https://usbmugget.dev/docs/guides/write-first-payload/>

Key	Command	Example	Description
A - Z	AT	AT reset	This is used to have commands, and is not connected to the serial
0 - 9	DATA[0-9]	DATA 0000	This sets the default time to use hexidecimal numbers
F1 - F12	TYPE [key]	TYPE A	Type's whatever string follows the command
Space	WRT [key]	WRT A	This is a one-line delay to type
Shift	SHFT C	SHFT C	Changes the value of the USB Current Register to 0x00, 0x1000, 0x2000, 0x3000, 0x4000, 0x5000, 0x6000, 0x7000, 0x8000, 0x9000, 0xA000, 0xB000, 0xC000, 0xD000, 0xE000, 0xF000
Ctrl	CTRL C	CTRL C	Shutting the array after the command on the USB Mugget's screen
Alt	ALTR [key]	ALTR A	Shutting the array after the command on the USB Mugget's screen
Backspace	BS	BS	Type the BS key and then the key
Enter	ENTER	ENTER	From the Shift key and then the key or the space
Print	PRNT	PRNT	Type "PRNT"

KODY.COMPUTER  
hackername: SKICKA  
NULLROUTE 192.168.4.1

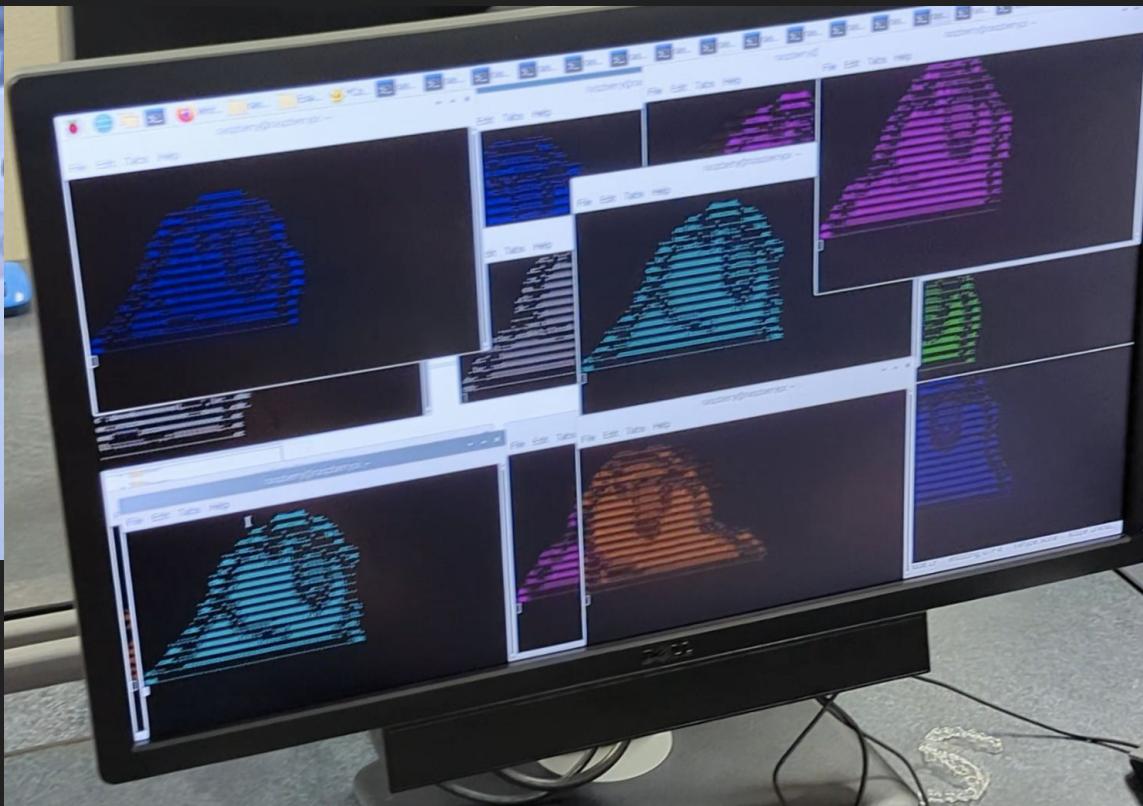


# Kids took devices home, wrote more scripts unprompted

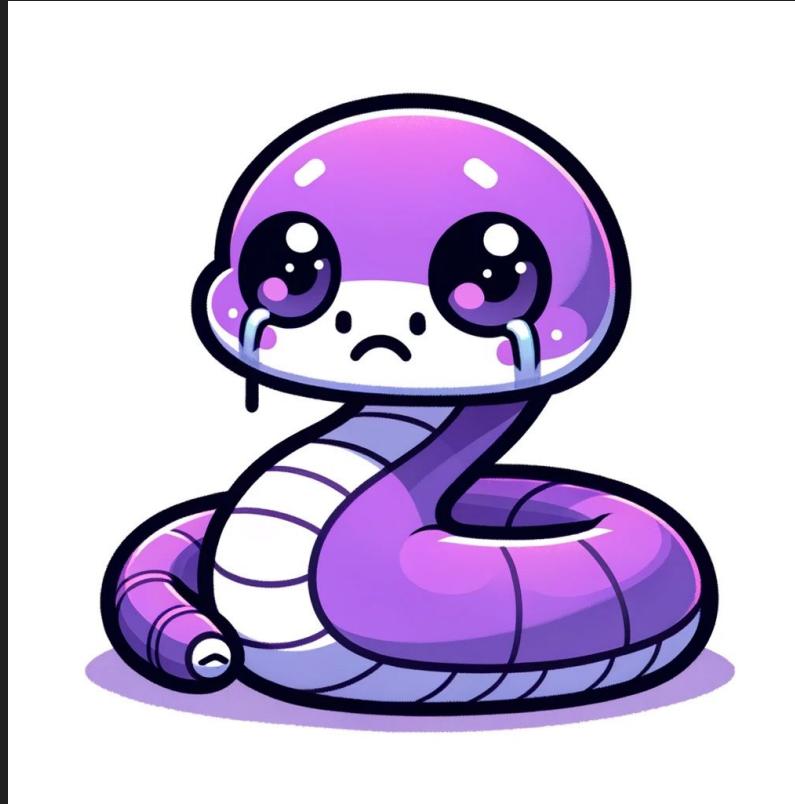


# Kids learned serial terminal commands to run memes

```
*rainbowparrott.txt - /media/raspberry/0021
new Document Project Build Tools Help
RickRoll.txt x RickRoll.txt x gru3000
CTRL ALT T
WAIT 1000
TYPE curl parrot.live
WAIT 2000
ENTER
```



# Less Great - CircuitPython Class



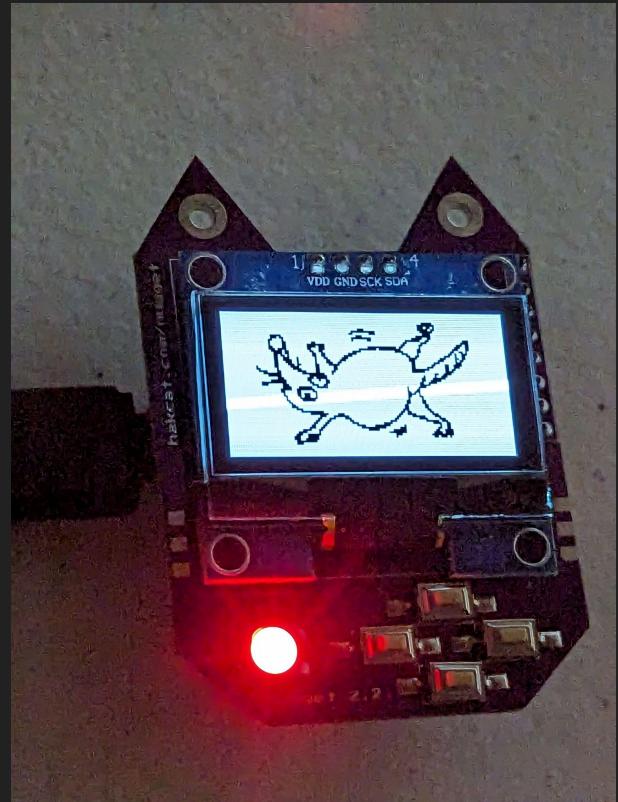
# Less Successful: CircuitPython



- Flashing CircuitPython erased BadUSB scripts and made kids cry
- Students used Raspberry Pi's which unzipped files differently
- Students had a hard time copying and pasting the right files
- It was too difficult to transfer code from Github
- Students only cared about making an auto-clicker to win at cookie clicker
- Next time, we'll flash pre-built images with CircuitPython examples built in (like we did for the bad USB class)

# Unexpected Win - Student Art

- Students drew on the white board
- Showed how to display their art on screen
- Personalization motivated them to learn



# Friendly Competition

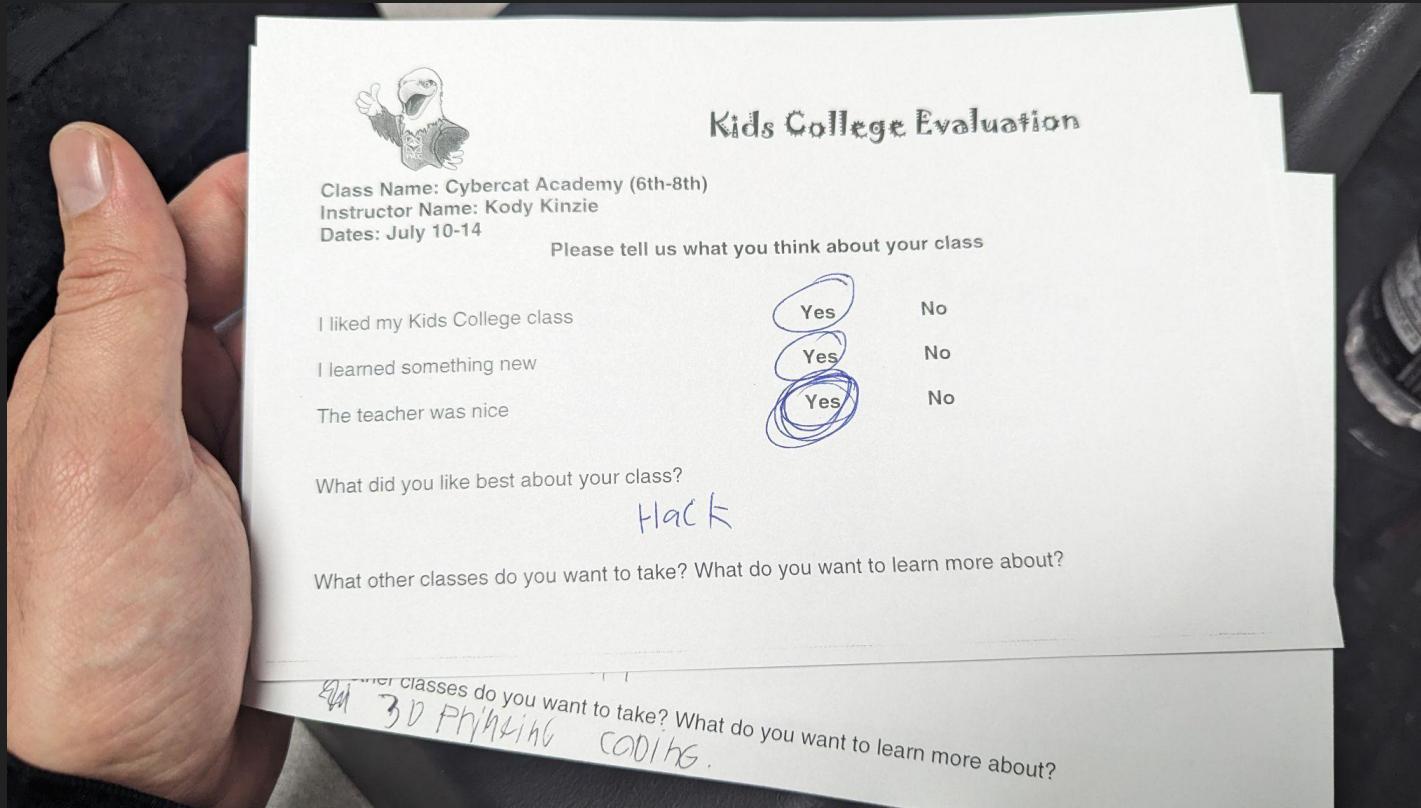
- AI Generated stickers were an unexpected win
- Prizes were 3d printed cases for Nuggets in white, gold, and red plastic
- Used stickerapp, 25 unique images per sheet (100 total) \$200 from grant
- Girls turned on each other over these



# Total Injuries: 1 Mild Soldering Burn



# Feedback



# Feedback

**Kids College Evaluation**

Cybercat Academy (6th-8th)  
Name: Kody Kinzie  
0-14

Please tell us what you think about your class

I liked my Kids College class       Yes       No

I learned something new       Yes       No

The teacher was nice       Yes       No

What did you like best about your class? *Tech Vgs*

What other classes do you want to take? What do you want to learn more about? *Hacking*

**Kids College Evaluation**



Class Name: Cybercat Academy (6th-8th)  
Instructor Name: Kody Kinzie  
Dates: July 10-14

Please tell us what you think about your class

I liked my Kids College class       Yes       No

I learned something new       Yes       No

The teacher was nice       Yes       No

What did you like best about your class? *The fact that theres cats*

What other classes do you want to take? What do you want to learn more about? *Cyber security*

# Feedback



Thank you so much  
for teaching Cybercat  
a-Cat-amy. Seriously though this  
is the best class I have/  
will/ever attend ~~not~~ Justin  
FREC but everywhere. I will  
bed FREC for a sequel.  
I WILL be coming next year.  
— price

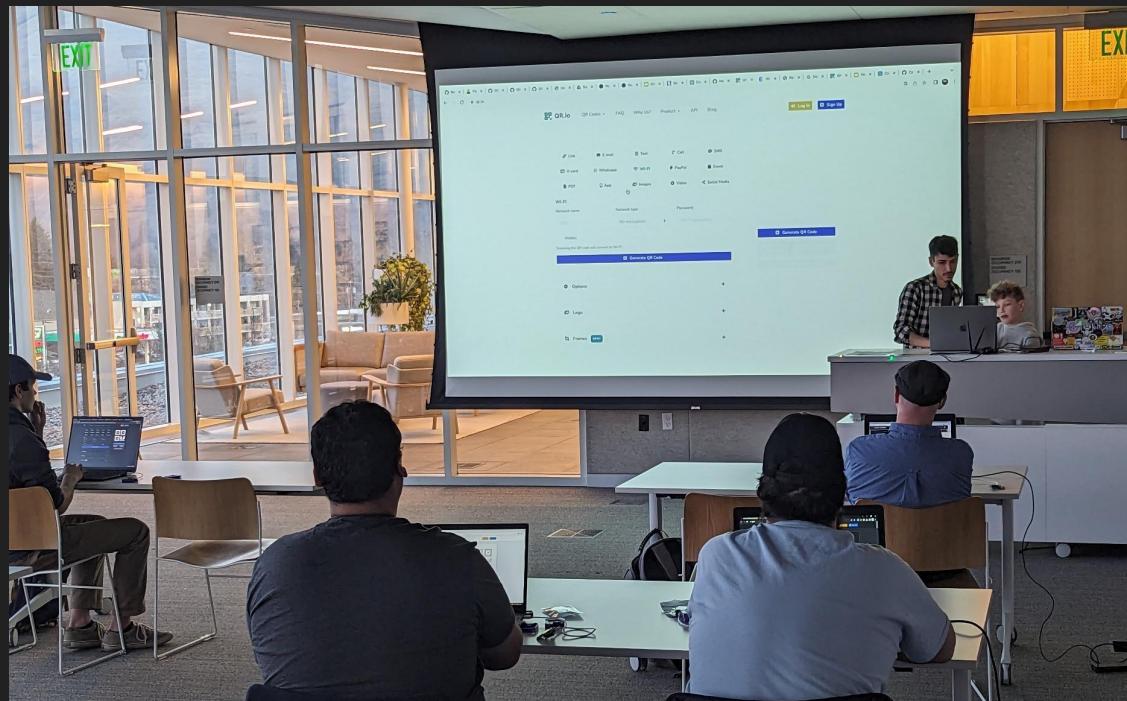
Cyber cat  
a-Cat-amy  
is the  
BEST!

Thank you for teaching  
cyber cat a-Cat-amy.  
seriously you guys are  
Atttier teachers.  
you guys are the  
best  
— price



Thank you so much for  
teaching Cybercat a-Cat-amy  
I had a fun time sandering and  
inhaling fumes of led (I think)  
seriously best class of my  
life. — price

# Missoula Makerspace



# Microcontroller Workshops in Missoula

Sales Ended



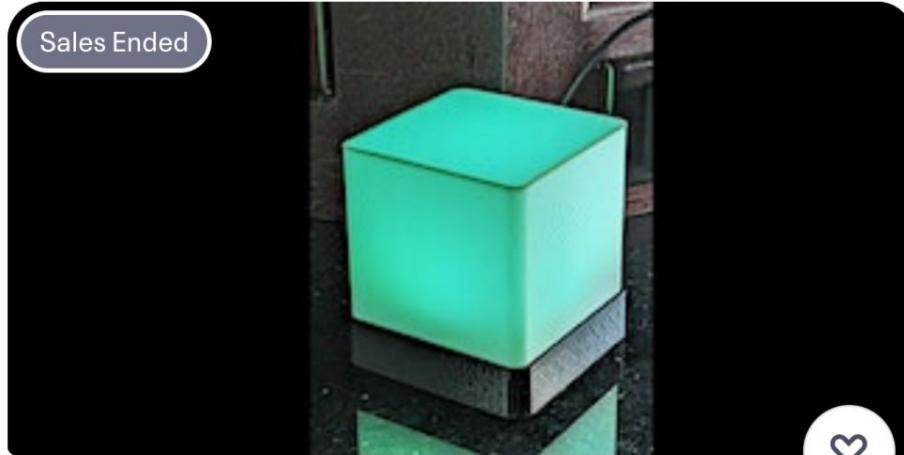
## Cat Got Your Password: A Wi-Fi Hacking Self-Defense Workshop

Sat, Nov 18 • 3:00 PM

Missoula Public Library (Cooper Room A on the 4th floor)

Free

Sales Ended



## Soldering and Microcontroller Basics: Make Your Own LED Lightbox

Sat, Oct 21 • 3:30 PM

MPL Makerspace

Free

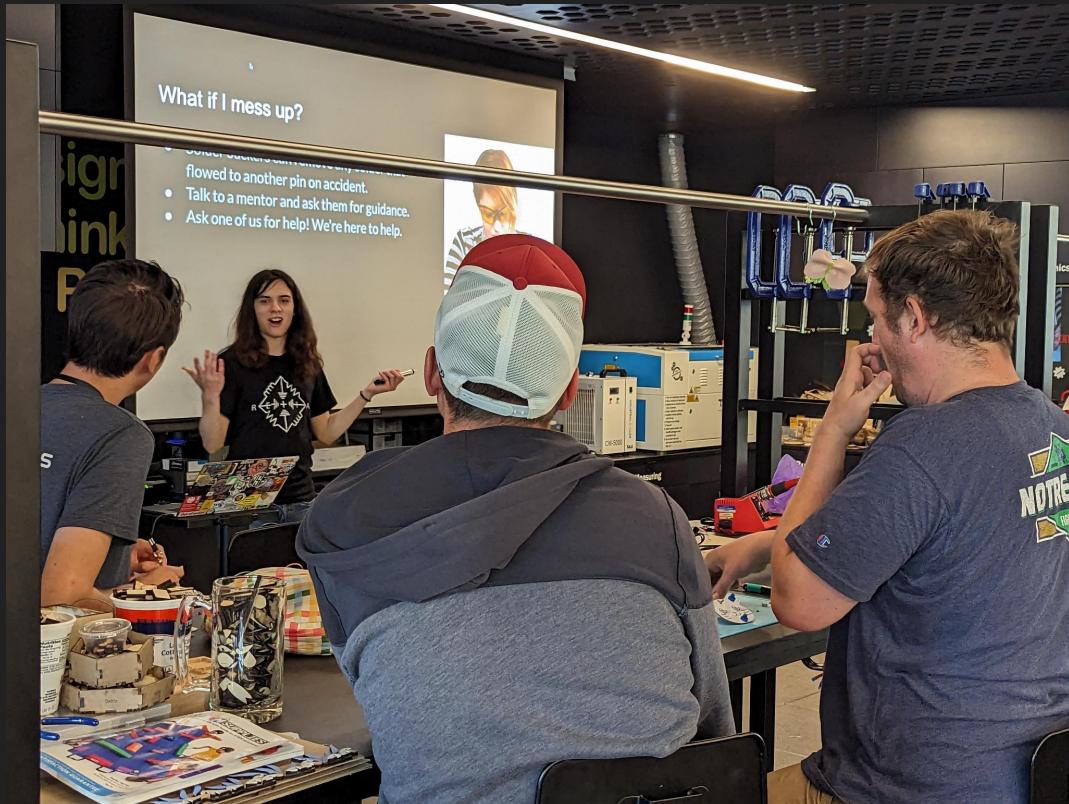
# Grant Sponsored Community Wi-Fi Self Defense Classes

- Grants from Friends of the Missoula Library
- Wrote grant proposals
- Library buys materials and provides classes for free
- High no-show rate
- We usually lose money on free classes from travel expenses



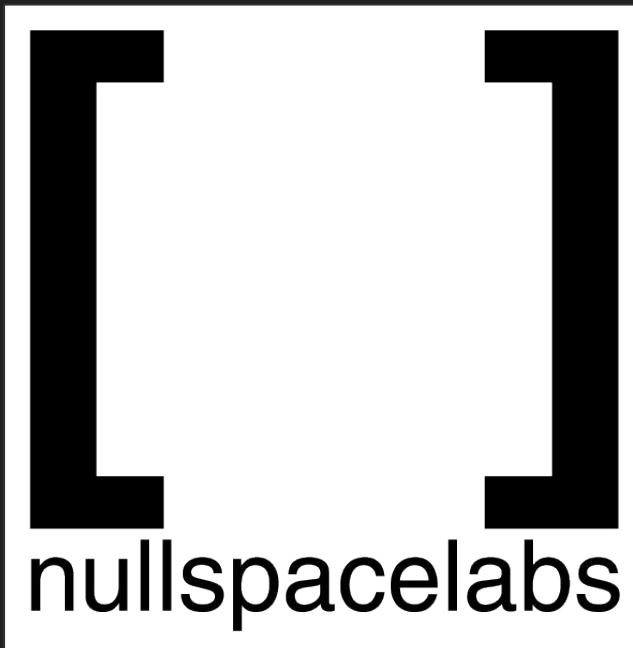
# Community Soldering Classes - IoT Light Box

- Taught back to back classes
- Only time we've ever made money from free makerspace classes
- Wide age range and lots of interest



# Null Space Labs

Hackerspace in Los Angeles



# Conclusion

Teaching Microcontrollers has evolved from complex setups to accessible, beginner-friendly fun.

You can engage beginners on a budget with only a few dollars of budget.



# Have a grant for us?

Our team loves to design custom:

- Workshops
- Hardware
- Cyber Camps

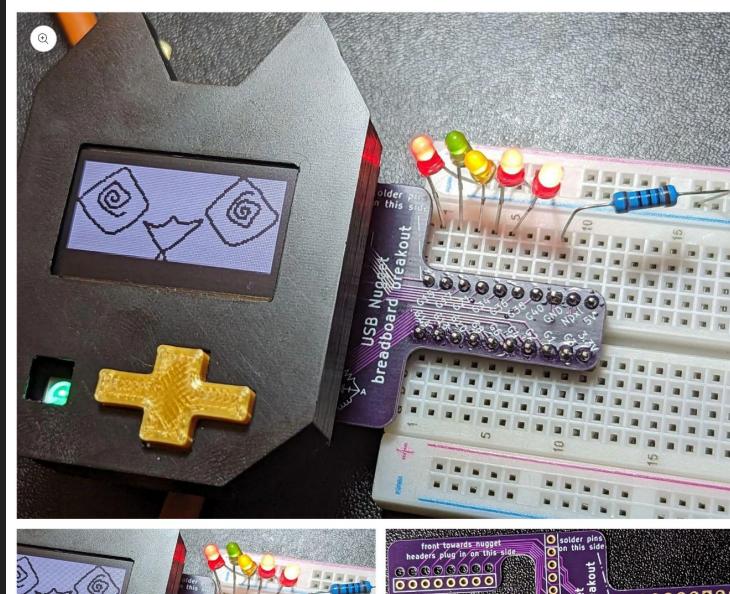
Reach out: [kody@retia.io](mailto:kody@retia.io)



# Try it yourself

We have kits on Retia.io and discounts for instructors!

- Nuggets
- Add-ons
- Online classes



RETIA.IO

**USB Nugget  
Breadboard Tail  
Breakout**

\$15.00 USD  
Tax included.

Quantity

Add to cart

Buy with  

More payment options

This cute Breadboard tail breakout allows for easy connection to a breadboard for electronics prototyping. It was designed to be used with CircuitPython or Arduino to prototype hardware with the USB Nugget

# Keep in Touch!

Want to learn more? You can find me here:

- Personal: [Hack.gay](https://Hack.gay)
- Store: [Retia.io](https://Retia.io)
- Nugget Flasher & Discord Link: [Nugget.dev](https://Nugget.dev)
- Livestreams: [youtube.com/@SecurityFWD](https://youtube.com/@SecurityFWD)

